Changes in species diversity and floristic composition of alpine grasslands under renewed cattle grazing in the Hrubý Jeseník Mts.

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INTRODUCTION

Grazing is considered as a suitable tool for maintaining the biodiversity of grasslands as documented by Metera et al. (2010). The same was proven for the territory of the Czech Republic (Veselý 2000, Žáková et al. 2004, Hejcman et al. 2006, Hofhanzlová 2006, Mládek et al. 2006, Pavlů et al. 2007, Brabec et al. 2011). For this reason, grazing is renewed in the Czech Republic in the protected areas where it was carried out in the past (*e.g.* the White Carpathian Mountains (Mts.), the Giant Mts., the Beskydy Mts.).

In 2012, grazing was restored in the Hrubý Jeseník Mts. (the Praděd National Natural Reserve) in the Švýcárna lodge surroundings. The main aim of cattle grazing reintroduction was to reinforce of non-productive functions of alpine grasslands, mainly floristic diversity. The aim of the study was to evaluate changes in floristic composition in the locality of Švýcárna lodge (1304 m a.s.l., the Praděd National Natural Reserve), where cattle grazing was introduced in 2012 after a long-term (70 years) management cessation.

MATERIAL AND METHODS

Study site

The research was conducted in the mountain area near Švýcárna lodge situated in the Hrubý Jeseník Mts. (the Praděd National Nature Reserve; 1 304 m a.s.l.). An average annual temperature and annual precipitation in Praděd (around 2.5 km distant from the Švýcárna lodge) is 0.9°C and 1 231 mm, respectively. The vegetation in the lodge surroundings was characterized as a mosaic of close alpine grasslands, subalpine *Vaccinium* vegetation, subalpine tall grasslands and subalpine tall-forb vegetation (Chytrý et al. 2010), with the dominant species *Nardus stricta, Deschampsia cespitosa*, *Avenella flexuosa, Bistorta officinalis, Calamagrostis villosa, Festuca supina* and *Luzula sylvatica.*

The rotational grazing system (three grazing cycles per year) was conducted on the site, which was divided by the road into two grazing sub-localities differing in dominant grass species. The sub-locality P1 (Nar) with a dominance of *Nardus stricta* and *Avenella flexuosa* was situated above the lodge while the sub-locality P2 (Des) with a dominance of *Deschampsia cespitosa* was situated below the lodge. The whole plot area was 3.6 ha. The stocking rate was up to 1 livestock unit per ha and year.

Evaluated parameters

To monitor changes in floristic composition, five permanent plots (one plot area: 5x5 m) were established in 2012 at different sites on the grazed area (two in the sub-locality P1: P1-A, P1-B; and three in the sub-locality P2: P2-A, P2-B, P2-C). The floristic composition was determined each year at the beginning of July. We evaluated recorded phytosociological relevés (Moravec et al. 1994) on the permanent plots, while the projective dominance of particular species was estimated visually in %. The nomenclature of vascular plants followed Danihelka et al. (2012). The vascular plant species were classified into five categories according to their threat status (Grulich 2017).

Statistical analysis

The number of species for each plot was plotted and their relation to year was calculated by means of a linear regression model in the Statistica program (version 13.2).

RESULTS

Figure 1 shows the results of changes in plant species diversity of the experimental plots from 2012 to 2017. 67 plant species in total were found in the experimental area over the 6 years. On all experimental plots, an increase in species richness was found (Fig. 1). The most remarkable increase and the highest number of species were recorded on plots with high soil moisture (P2-B and P2-C), probably as a consequence of mechanical soil disturbance caused by cattle movement and thus creation of small open habitats free of vegetation and the possibility of establishing new species. Soil moisture, however, was evaluated only visually.

Of the total number of plant species found, 15 are in the Red List of Vascular Plants of the Czech Republic (Grulich 2017): 1 critically endangered, 2 endangered, 2 vulnerable, 6 near threatened, and 4 of least concern. On most of the plots, an increase in the number of rare and endangered species was noticed as recorded during 2012–2017. For plot P1-A, the following plant species occurred newly in the vegetation during the years of monitoring: *Hieracium stygium*, *Ligusticum mutellina*, *Luzula sudetica*, *Potentilla aurea* and *Trientalis europaea.* In plot P1-B *Trientalis europaea* was recorded as a new species in 2014 comparing with the year 2012. Plot P2-A was characterized by the following new species occurrences: *Ligusticum mutellina* and *Trientalis europaea*. In plot P2-B the following species were newly found: *Crepis mollis* subsp. *succisifolia* and *Phleum alpinum.* In plot P2-C the following plant species occurred newly in the vegetation: *Epilobium palustre*, *Luzula sudetica*, *Tephroseris crispa* and *Viola biflora*. Regarding changes in the dominance of particular plant species, P1-A and P1-B plots were characterized by a higher dominance of *Avenella flexuosa* which slightly decreased within experimental years. This decrease was also noticed for *Vaccinium myrtillus* and *Calamagrostis villosa*. In contrast, the dominance of the species *Festuca supina* slightly increased during the six years of monitoring. On plot P1-B, the dominance of *Nardus stricta* significantly increased and gained dominance in the place of *Avenella flexuosa*. On plot P2-A, *Avenella flexuosa* was the dominating species but it significantly decreased within the study period. The dominance of *Deschampsia caespitosa* substantially increased. An increase in the dominance was also noticed for *Anthoxanthum odoratum*. The dominance of *Calamagrostis villosa* significantly decreased, a slight decrease was also noticed for *Festuca supina*, *Luzula sylvatica* and *Bistorta officinalis.* On plots P2-B and P2-C, the dominating species was *Deschampsia cespitosa* (with a slight decrease on

P2-B over years). On both plots, we recorded a significant decrease in the dominance of *Chaerophyllum hirsutum*. On plot P2-B, the dominance of species *Stellaria nemorum* slightly decreased. On plot P2-C, the dominance of *Ranunculus repens* increased.

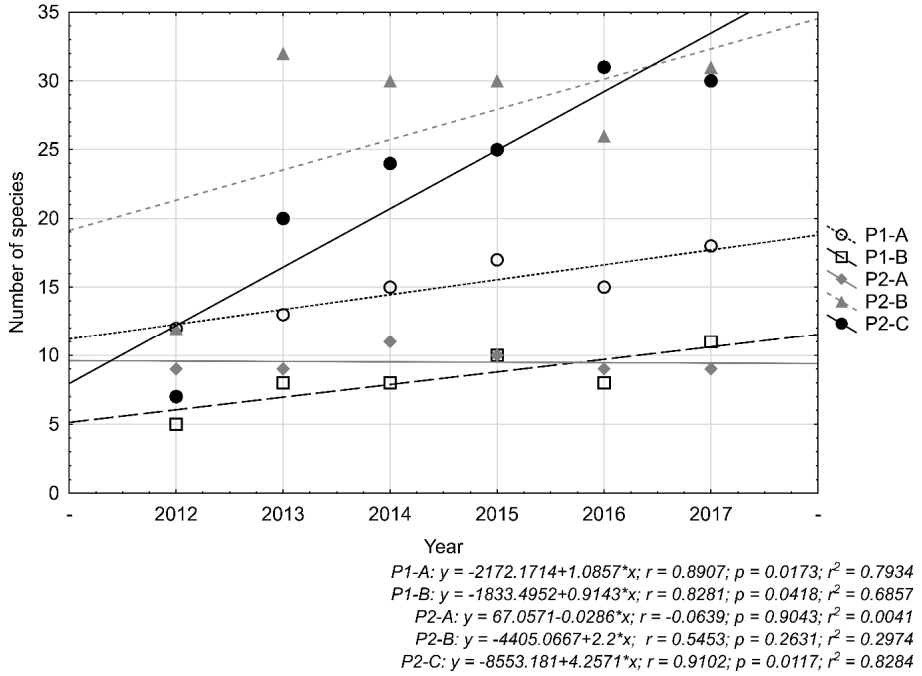

Fig. 1. Scatterplot and linear regression of the species number in different plots versus the experimental year; regression equations, regression coefficients (R^2) and correlation coefficients (r).

DISCUSSION

Many authors have shown that almost independently of vegetation type, cessation of grassland management leads to a successional change and loss of plant species diversity (Isselstein et al. 2005). Therefore, positive changes in localities where renewed grazing was introduced after a long-term of grassland management cessation can be expected regarding floristic composition and plant species diversity. Animal browsing and trampling causes the creation of open habitats which enable many plant species to germinate and survive. Grazing also affects the return of nutrients into the soil, which changes chemical properties of the soil (Krahulec et al. 1996).

So far, ecologists have not been able to establish one general, unifying theory for successionally induced changes in species composition following abandonment. In fact, the course of succession seems to be unique for each site and year (Kahmen, Poschlod, 2004). As Tasser, Tappeiner (2002) explained, succession starts immediately after abandonment. Depending on altitude, succession proceeds at variable speeds and with different numbers of stages. According to Hejcman et al. (2002) the typical pasture sward does not recreate itself earlier than 40 years after the renewed grazing introduction. Nevertheless, some positive results can be found in short-term periods as some current studies indicate.

Our study showed that renewed cattle grazing results in an increase in plant species richness and moreover the occurrence of rare plant species was enhanced. Another example of the successful introduction of renewed grazing of small ruminants is the experimental pasture of sheep in the National Nature Reserve Mohelno Serpentine Steppe. As Veselý and Řepka (2005) documented, five years after the renewed grazing introduction an increase of plant species diversity was found on monitored plots. A similar approach with positive results was also applied in the Protected Landscape Area Beskydy and in the Protected Landscape Area Bílé Karpaty (Piro and Wolfová 2008). Traditional ways of grassland management via sheep and cattle grazing are used in the Krkonoše National Park and in the Louny Central Uplands in the Czech Republic. In the above protected areas, grazing should help to preserve biological diversity, ecological stability and the landscape-forming function of semi-natural grasslands.

CONCLUSION

This study conducted in the Protected Landscape Area Jeseníky, shows that renewed cattle grazing in the surroundings of Švýcárna lodge is both a symbolic revival of the traditional way of grassland management and primarily a tool for suppressing ecological succession (which leads to the overgrowing of biologically valuable habitats) and to enhance species diversity. After six years of restored grazing, the overall species richness was enhanced and a greater dominance of rare and endangered species was noticed. This is most likely due to cattle trampling and enabling the creation of small open habitats for new species germination and survival. The dominance of some common species like *Vaccinium myrtillus* and *Calamagrostis villosa* tended to decrease within the grazing period in favour of a new species colonisation.

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