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Tolerance and resistance of plants to disturbance

PhD Thesis

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## INTRODUCTION

An understanding of how plants cope with disturbances, which are among the most important factors shaping plants communities, provides better insight into the functioning of most biotic systems, but also gives us a tool to manage and/or protect them. This thesis aims to reveal some aspects of tolerance and resistance of herbs to disturbance on the level of plant individuals as well as entire plant communities.

Tolerance to disturbance, enabled by resprouting from axillary or adventitious buds, is usually considered in wood communities of fire-prone habitats and is largely overlooked in herbaceous communities. This is surprising since every gardener knows that many herbaceous species are able to resprout easily and vigorously even from small fragments. Tolerance of herbs to disturbance is therefore investigated and discussed in two papers and the manuscript of this thesis. The main objectives were to: (1) assess and compare the role of resprouting of herbs with other common plant traits in selected man-made habitats, (2) interpret the role of nutrient availability on resprouting and seeding strategy of two related species (*Plantago lanceolata* and *P. media*) and (3) propose a set of more specific traits including the bud bank to predict the responses of communities to changed environmental conditions in disturbed man-made habitats.

While tolerance can be realized in a broad spectrum of disturbance severity, resistance is connected with the production of defense mechanisms and is thus more efficient in the coping with less intensive disturbances originated for example by pathogens or herbivores. Plants need to allocate limited resources into growth and reproduction and into the production of defenses. The production of defense mechanisms could therefore negatively affect plants growth and fitness if benefits of defenses do not outweigh its costs. The main goal of the last chapter of this thesis was to evaluate the costs and benefits of induced resistance to disturbance in the model clonal species *Trifolium repens*.

## SUMMARY OF THE THESIS

### TOLERANCE TO DISTURBANCE: RESPROUTING OF HERBS

Jitka Klimešová, Vít Latzel, Francesco deBello & Jan M van Groenendael - Plant functional traits in studies of vegetation changes under grazing and mowing: towards a use of more specific traits. *Preslia* [in press]

Plants' abilities to perform ecological functions are difficult to evaluate directly in the field. Therefore, a number of attempts were made to determine easily measurable proxies - plant functional traits (PFTs). In particular, the value of PFTs as tools for predicting vegetation responses to management (i.e. grazing and mowing) was the focus of a large number of researches. However, recent studies searching for consistency in PFT predictions concerning pasture management in different regions did not confirm a consistent predictive value of the same set of PFTs. The use of more specific traits better suited for a specific region was suggested for future studies. We consider this an important goal that can help us select the most adaptive traits in response to grazing and mowing for different biomes. Using temperate grasslands in Europe as an example, we showed that (a) plant height, often considered as the best predictor of species response to grassland management, is coupled with other more relevant functional traits, and that (b) clonal traits have important, often neglected functions in the response of species to grassland management. We concluded that simple traits cannot be the only basis for predictions of vegetation changes under pasture management and, therefore, a functional analysis of the trade-off between key traits is needed.

Vit Latzel, Stanislav Mihulka & Jitka Klimešová - Plant traits and regeneration of urban plant community after disturbance: Does the bud bank play any role? *Appl Veg Sci* (2008) 11: 387-394.

Main questions of this study were: What is the relative role of the bud bank, seed and various species traits in the regeneration of urban plant communities after severe disturbances? Do invasive and exotic species, highly abundant on disturbed communities, regenerate better than native species after disturbance?

Results revealed that the bud bank played a key role in regeneration in the plots where the resprouting of herbs was not inhibited by herbicide. In the plots with herbicide treatment, the seed bank was important in re-establishing vegetation after disturbance. Exclusion of the bud bank by using herbicide allowed the establishment of small annuals, whereas biennials were successful in plots where the bud bank was not inhibited. Exotic species with a long residence time in the local flora were successful in plots where regeneration from the bud bank was excluded, whereas species with short residence times or that were invasive were suppressed by both types of disturbance.

We conclude that in response to various types of disturbance, species with different regeneration strategies (either seeds or bud bank) were promoted. Exotic species were suppressed primarily by disturbance, which suggests that factors other than just regenerative capability contributed to the high abundance of exotics in urban communities

Vit Latzel & Jitka Klimešová - Fitness of resprouters versus seeders in relation to nutrient availability in two *Plantago* species differing by nutrient demands. Manuscript

Two contrasting strategies of plants from disturbed areas, resprouters investing to storage and capable of vegetative regeneration after disturbance and seeders investing into seed production and regenerating from seeds, are reported to depend on nutrient availability. While resprouting is predicted to be enhanced in nutrient poor conditions, seeding prevails in nutrient rich conditions. To test this idea, we assessed the fitness of individuals regenerated from seeds and root fragments in two species with contrasting nutrient demands and hypothesized that 1) plants with higher nutrient demands have higher fitness as seeders without respect to nutrient availability or 2) both species will have higher fitness as resprouters under lower nutrient availability and as seeders when nutrient availability is higher. Nutrient availability was also manipulated prior to and after disturbance. We did not reject the first but rejected the second hypothesis in a pot experiment with *Plantago lanceolata* and *Plantago media*, species with high and low nutrient demands, respectively. Moreover, high nutrient availability prior to disturbance negatively affected resprouting success, but the growth and fitness of successfully regenerated individuals was enhanced under higher nutrient availability. We concluded that resprouting from roots after disturbance is affected by nutrient availability, however, because the effect considerably differs with individual life-history stages, the resulting life history variability might buffer against a resprouter/seedler dichotomy up to some threshold of disturbance severity and frequency.

## CURRICULUM VITAE

### RESISTANCE TO DISTURBANCE: INDUCED DEFENSES

Sara Gómez, Vit Latzel, Yolanda Verhulst & Josef F. Stuefer - Costs and benefits of induced resistance in a clonal plant network. *Oecologia* (2007) 153: 921–930.

Plant defense theory suggests that inducible resistance has evolved to reduce the costs of constitutive defense expression. To assess the functional and potentially adaptive value of induced resistance it is necessary to quantify the costs and benefits associated with this plastic response. The ecological and evolutionary viability of induced defenses ultimately depends on the long-term balance between advantageous and disadvantageous consequences of defense induction. Stoloniferous plants can use their inter-ramet connections to share resources and signals and to systemically activate defense expression after local herbivory. This network-specific early-warning system may confer clonal plants with potentially high benefits. However, systemic defense induction can also be costly if local herbivory is not followed by a subsequent attack on connected ramets. We found significant costs and benefits of systemic induced resistance by comparing growth and performance of induced and control plants of the stoloniferous herb *Trifolium repens* in the presence and absence of herbivores.

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1999-2001: bachelor degree, bachelor work: Response of three *Ranunculus* species on competition and nutrient enhancement. Supervisor: Prof. Jan Š. Lepš.

2001-2004: master degree, diploma thesis: Influence of competition and nutrients to growth of three *Ranunculus* species. Supervisor: Prof. Jan Š. Lepš.

Scientific research: bud bank functioning, maternal effect, epigenetics.

Stay abroad

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### PRESENTATION ON CONFERENCES

Sara Gómez, Vit Latzel, Yolanda Verhulst & Josef F. Stuefer: The importance of being connected. Induced systemic resistance to herbivory in ramets of a clonal plant network. The 13th Symposium on Insect-Plant Relationships (SIP13), Uppsala, Sweden, July 29 – August 2, 2007. Poster. Best Poster Award.

Vit Latzel, Stanislav Mihulka & Jitka Klimešová: The role of the bud bank in disturbed biotopes. The 20th Annual Conference of the Plant Population Biology Section of the Ecological Society of Germany, Switzerland and Austria, 17-19 May 2007, Poster.

Vit Latzel, Stanislav Mihulka & Jitka Klimešová: Plant Functional Traits in a man-Made Habitat. 19th Annual conference of the Section Plant Population Biology of the Ecological Society of Germany, Switzerland and Austria. 24 - 27 May 2006 Halle/Saale, Germany, Poster.

Sara Gómez, Vit Latzel, Yolanda Verhulst & Josef F. Stuefer: The importance of being connected. Induced systemic resistance to herbivory in ramets of a clonal plant network. 14th New Phytologist Symposium. New directions in plant ecological development. The Royal Society, London, UK, 23- 24 January 2006, Poster.

Jitka Klimešová, Vít Latzel & Leoš Klimeš: Functional morphology of plants and persistence traits sensitive to grazing and mowing. GFÖ. Ecological Society, 35th Annual Conference, 19 – 23 September 2005, Regensburg, Germany, Talk.

Vít Latzel: Growth of three co-occurring *Ranunculus* species in a wet oligotrophic meadow: Effect of competition and nutrient addition. 18th Annual Conference of the Ecological Society of Germany, Switzerland and Austria, Progress in Plant Population Biology, Potsdam, Germany, May 2004, Poster.

Vít Latzel & Jan Š. Lepš: Comparative biology of three *Ranunculus* species. British Ecological Society, Coventry, UK, December 2002, Poster.

#### **PUBLICATIONS**

Jitka Klimešová, Vít Latzel, Francesco deBello & Jan M van Groenendael (2008) Plant functional traits in studies of vegetation changes under grazing and mowing: towards a use of more specific traits. *Preslia* [in press]

Vít Latzel, Stanislav Mihulka & Jitka Klimešová (2008) Plant traits and regeneration of urban plant communities after disturbance: Does the bud bank play any role? *Appl Veg Sci* 11: 387-394.

Sara Gómez, Vít Latzel, Yolanda Verhulst & Josef F. Stuefer (2007) Costs and benefits of induced resistance in a clonal plant network. *Oecologia* 153: 921–930.

Vít Latzel (2007) Je výhodné být on-line, aneb K čemu je dobrý rostlinám intranet? *Vesmír* 11: 688