



**Review of the PhD thesis „ Plant-soil feedbacks, their mechanisms and role in plant communities“
by Msc. Eliška Kuťáková**

The thesis presents studies focused on conspecific and heterospecific plant-soil feedbacks being important moving forces in plant succession, plant invasions and an existence of complex, species diverse communities. The studies are mostly based on a classical approach – pot experiments with a conditioning phase followed by a feedback phase in which a set of plant growth characteristics is measured and compared to those of plants grown in a control soil. The candidate went into details to uncover the functioning of the “soil black box” and understand the mechanisms of the soil feedbacks. She tried to disentangle the importance of changes in soil biotic and abiotic parameters induced by a conditioning plant in the feedback on target plants. In other experiments, she made the soil system more complex by the addition of selected representatives of soil mesofauna, which is partly eliminated in common pot experiments, or used soils conditioned by the natural species-rich communities of a mountain meadow, where the main dominant was absent/present for a long term. In addition to experimental studies, the applicant also used a meta-analysis of published data and related direction and strength of heterospecific plant-soil feedbacks to selected plant functional traits, species phylogenetic distance and their co-occurrence in natural communities.

The thesis is based on a set of three thematically coherent original articles, which were published in peer-reviewed journals, mostly recognized in the given field. Since their publication in 2018 (and 2020), they have already received some citations (2, 7). The fourth chapter is in the form of manuscript, which is ready for a submission. I really appreciate that the candidate is the first author of all enclosed articles (and also of the manuscript). Her contribution to each of the studies is clearly defined.

The text of four chapters is supplemented with an informative introduction, which summarizes the present state of knowledge and clearly formulates aims of the work. It is followed by a short summary of each chapter. The thesis ends with conclusions, which interconnect results from individual papers, critically evaluate them from various perspectives and unify them into a consistent story. The text offers a balanced and realistic view of the findings obtained in this work in the context of available knowledge in the field of plant-soil feedbacks (PSF) research.

Questions and comments:

- 1) I have found several formal mistakes in the Introduction and some inconsistencies in the text and figures in Study 3. I highlighted them in the PDF version of the thesis to improve the quality of the final manuscript version. A small note - the Czech abstract is weaker in formulations than the English one. I understand that majority of existing literature is in English. However, the correct Czech wording in science is useful in purpose to advertise and popularize the research and present the results to public.
- 2) The enclosed studies as well as literature review point to a weak explanatory power of the used parameters such as plant traits, composition of microbial communities, phylogenetic distance of plant species etc. in prediction of the amplitude but also in the direction of the PSF. It seems that even the same species could evoke various feedbacks when grown in various soils. It is thus often concluded that results are context-dependent. What is the likely reason? Is it because the plant behavior and its potential effect on soil properties – the conditioning, is strongly modified (variable) by given soil characteristics? If yes, how to design the experiments to get results, which would be close to potential plant behavior in nature and could help to predict the resulting PSF? Is it more efficient (informative) to test PSF between many species in one soil or to study feedback of let say two species in many different soils to understand, which changes evoked in the soil are more important than others? Alternatively, can we derive relevant information about plant-soil feedbacks from spatio-temporal changes observed in natural communities?



- 3) The plant-soil feedback was first described in agriculture, when one crop conditions the soil and is followed by another (or the same). However, current definition of the plant-soil feedback takes it as a mechanism which can affect performance of the plants growing subsequently but also simultaneously in the soil. Could you, please, define, where is the border between the processes, which could be marked as plant-soil feedback and the plant competition for water and nutrients between co-occurring plants in the complex community? Is it possible to separate the two mechanisms when working in the field? Is it possible to tell, which one is more important in controlling the community composition and dynamics? It seems to me that a concept of a niche complementarity is strong enough to explain the co-occurrence of many species and the existence of species rich communities.
- 4) In Study 1 you tested a relation of plant-soil feedbacks to several plant traits: life span, specific leaf area and plant height. I understand that these traits are commonly used and measured by plant scientists. Please, comment on (hypothesize) how could plants characterized by the variety of the trait (annuals x perennials, plants with low x high specific area, small x high plants) modify the soil and affect the performance of subsequently growing plants? You found that the plant height was the only trait explaining significant portion of PSF variability. Why? Could the mechanisms be that the plant height is correlated with the biomass and thus with photosynthetic capacity (... and thus with the larger exudation flux and the litter input to the soil)?
- 5) In Study 3 you did not find a difference in species performance between the soil conditioned by the community with and without dominant *Festuca rubra*. *Festuca* formed “only” ca 30 % of the aboveground biomass of the community. Did you account for its presence when sampling the soil from the “*Festuca* presence” treatment? Were there any differences in soil parameters between the two original treatments which could evoke differences in the growth of tested plants?
- 6) Study 4 is an interesting experiment, where you made the soil food web more complex by an addition of defined community of soil mesofauna. Do you have any experience (did you check or did anyone published) on how poor are the communities of soil mesofauna in sieved soils commonly used in pot experiments for studying PSF? Is there any more suitable way how to treat the soil before such experiments to maintain the soil community “unaffected”?

Conclusions

The candidate has proved her ability to design and perform scientific experiments, achieve original results, analyze and interpret them in context of present state of knowledge in the field and successfully publish them in well-ranked journals.

The thesis meets the required standards in terms of the nature and quality of the work done, and the degree of “Doctor of Philosophy” can be awarded after a successful defense.

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doc. Mgr. Eva Kaštovská, Ph.D.