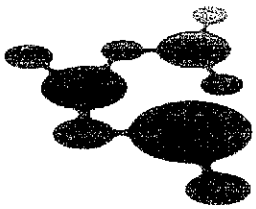

wasser
cluster
lunz

WasserCluster Lunz - Biologische Station GmbH
Dr. Carl Kupelwieser Promenade 5
A– 3293 Lunz am See
Tel. 07486 20060 Fax 07486 20060 20
office@wcl.ac.at
www.wcl.ac.at

To
Prof. RNDr. Karel Prach
Přírodovědecká fakulta JU
CZ-370 05 České Budějovice

Lunz am See, June 2014

Review of the PhD Thesis of Terezie Rychtecká, MSc

Biodiversity—functioning studies in grasslands:
Their design, analysis and the importance of realized diversity

Dear Prof. Karel Prach,

With much interest I read the thesis of Terezie Rychtecká. Overall, I was impressed by the work performed and by the analytical tools that were used in this study. I therefore definitely support the formal admission of this thesis for defense.

I am working in the field of biodiversity-functioning research for a number of years. Though I am aquatic ecologist, I have also been involved in data analysis of the Jena Project, so the general topic of the thesis falls into my area of expertise.

BEF experiments manipulate diversity in terms of assembling synthetic communities, where the number of taxa is given through controlled seed dispersal. Parameters of ecosystem functioning are then commonly interpreted as a function of sown diversity.

A major objective of the thesis of Mag. Rychtecká is to differentiate between the sown diversity and the actual realized diversity, which commonly is well below the sown diversity. This approach is inherently linked to landscape ecology in the sense that sown diversity would correspond to a regional species pool, while the realized diversity is the number of taxa locally coexisting, as a combined result of dispersal and local sporting. This issue that definitely deserves more attention, as the common interpretation of BEF relationships relies solely on the sown diversity, which is then often misinterpreted as a community parameter.

Below I summarize a few comments and questions that came to my mind when reading the thesis. For practical reasons, I formulated the questions as being addressed to the PhD candidate

1. I have one general remark about the data analysis. Like most BEF studies, the analyses focuses on the change in mean along gradients of diversity (e.g. Fig 1&2, Chapter II, Fig. 1, Chapter III), while changes in variance receive little attention (apart from a paragraph in the discussion Chapter II, while I found no mentioning of variance in chapter III). Even if the causal link to temporal stability may be debated – how would you rate temporal variability as ecosystem functioning parameter?
2. Effect size generally tends to increase with time in BEF experiments (e.g. Isbell et al. Nature 2011; Allan et al. PNAS 2011). How do you interpret such time trends against the background of sown vs realized diversity?
3. In Chapter III, you show that evenness and number of survivors both are inversely linked to the success of a dominant species. Would you consider the inverse relationship between numbers of survivors and biomass production an artifact of short term experiments (or, in case of Jena-experiment, yearly sowing)? Can the results be linked to the debate about the importance of rare taxa ('rareness is common') for community functioning in natural communities?
4. Regarding chapter IV, about the effect of sown density on the results of BEF experiments. There is an obvious relationship between the duration of such an experiment and the potential effect size. From your results, what recommendations would you make for BEF in order to yield meaningful results (in terms of having relevance for natural systems)?
5. Considering other measures of ecosystem functioning than average biomass production, would you expect different results regarding the potential effect of realized diversity?

Congratulations for this nice piece of work. I am looking forward for meeting the candidate as well as the committee.

With my best wishes,

Dr. Robert Ptacnik

WESTFÄLISCHE
WILHELMS-UNIVERSITÄT
MÜNSTER

ILÖK
Institut für Landschaftsökologie

WWU | ILÖK | Robert-Koch-Str. 26 | 48149 Münster

To
Prof. RNDr. Karel Prach CSc
Head of the Committee for PhD
studies in Botany
Faculty of Science
University of South Bohemia
Branišovská 31
37005 Budweis
Czech Republic

PD Dr. Till
Kleinebecker

Working Group Ecosystem
Research
Institute of Landscape
Ecology
Heisenbergstraße 2
48149 Münster
Germany

Tel. +49 251 83-39766
Fax +49 251 83-38338

tillhan@uni-muenster.de
www.uni-muenster.de/
Oekosystemforschung

Datum 18. June 2014

Evaluation of the PhD-thesis of Terezie Rychtecká

The thesis submitted by Terezie Rychtecká is dealing with relationships between biodiversity and biomass production making use of two different approaches: a theoretical modelling approach and the analysis of experimental data. This work is a cumulative thesis consisting of four articles, which are topically related. In three articles, Terezie Rychtecká is acting as first author and in one as second author. Two articles have already been published in peer-reviewed international ecology journals and two articles are given as manuscripts that have been submitted to a journal. The articles are embedded into a general introduction giving the necessary background and a final summarizing discussion.

The first part of Chapter I (general introduction) gives a short but comprehensive overview of the history of biodiversity and ecosystem functioning (BEF) research. In the second part, potential mechanisms that were used to explain BEF results are introduced addressing particularly the importance of the definition of diversity (i.e. sown vs. realized diversity). The third part of the general introduction summarizes some analysis techniques, which are frequently used in BEF experiments. These three parts are followed by a short outline of the thesis.

The first article "Species pool size and realized species richness affect productivity differently: A modeling study" has been published in 2012 in Acta Oecologica 36: 578–586. It is co-authored by Jan Lepš. According to the ISI Science Citation Index the journal has an Impact Factor of 1.62 for 2012, which means a class 2 journal in the field of ecology. In this paper, a mathematical model using Lotka-Volterra competition equation was developed to simulate relationships between productivity and both species pool size and realized species richness. The model was able to mimic findings of

BEF experiments as well as of observational studies. Increasing selection effect and complementarity were identified as the driving mechanisms to explain positive relationships between species pool size and productivity found in BEF experiments. For realized species richness, the model predicts a slightly positive and a slightly negative biodiversity-productivity relationship for small and larger species pool sizes, respectively. This outcome is explained by partially counterbalancing mechanisms: competitive exclusion and complementarity. In general, the paper is a well-made combination of (mathematic) abstraction and empirical results of BEF experiments, observational studies or similar modelling approaches. This research clearly contributes to a better understanding of the driving mechanisms of biodiversity-productivity relationships. One point came into my mind while reading the paper: The modeled realized species richness is remarkably low (the maximum output is 11 species, which is at the lower end of the diversity gradient when comparing with real world grasslands). Is there a way to increase the realized species richness to better resemble the diversity range found outside in the field? The model is kept quite simple which is generally reasonable and appropriate for the scope of the study, but I wondered what would happen, when making it a bit more complicated (i.e. allowing not only species to go extinct but also to (re-)colonize the community). In another context (Chapter III), allowing species to colonize the community is discussed, but I would be interested if it is possible to include this process of colonization in such a model, and, furthermore, how this could affect the outcomes.

The second article "Sown species richness and realized diversity can influence functioning of plant communities differently" is given as a manuscript and co-authored by Vojtěch Lanta, Iva Weiterová and Jan Lepš. Recently, it was accepted and published online in the Journal "Naturwissenschaften". According to the ISI Science Citation Index, the journal has an Impact Factor of 2.14 for 2012, which means a class 1 journal in multidisciplinary sciences. In this paper, the mathematically created relationships between plant diversity and productivity (Chapter II) are confronted with data of two experiments: a short-term pot BEF experiment and a six-year data set of the Jena experiment. Relationships between productivity and sown diversity are shown to be generally positive, whereas this is true only for half of the cases when realized diversity or survivor species richness was used instead. Partial effects of realized diversity and survivor species richness are found to be generally negative after accounting for sown species richness (significant in more than half of the cases). The outcomes of this short paper nicely underpin that positive diversity-productivity relationships may only hold when the local species pool (in BEF experiments the sown species richness) is the main factor determining realized species richness which is rarely the case under real world conditions. While reading this manuscript I wondered why sampling in June and August of the same plot were considered as discrete samples. In my opinion, it would have been closer to reality to take biomass of both cuts as one productivity estimate and to calculate realized diversity and survivor species richness across both samplings. Was this done to enlarge the amount of data for regressions? Would it change the results when analyzing the Jena experimental data on an annual basis?

The third article "Plant density affects measures of biodiversity effects" has been published in 2013 in the Journal of Plant Ecology 6: 1–11. It is co-authored by Pavel Fibich and Jan Lepš. According to the ISI Science Citation Index, the journal has an Impact Factor of 1.36 for 2012, which means a class 2 journal in the field of plant sciences. In this paper, a full-factorial pot experiment was performed with monocultures

and mixtures of up to four different meadow species in all possible combinations. Subsequently, sown communities were thinned to five density levels to test for effects of sowing density on commonly used measures of biodiversity effects, namely transgressive overyielding, net effect, complementarity effect, selection effect, trait complementarity and dominance effect. The paper nicely shows that plant density affects the yield of monocultures and species mixtures. As such values are used to calculate biodiversity effects, these effects vary across the density gradient. Density effects on biodiversity effects are strongest when the monoculture exhibits an unimodal relationship between density and yield. The presented experimental results clearly showed that density has to be carefully considered in BEF experiments. The experiment covers (only) four species, which is no criticism, but I asked myself if it is possible to identify species that severely affect biodiversity effects by specific traits. Is the unimodal density-productivity relationship that was found for *Agrostis* a general feature of grasses? To find some general traits that identify species that potentially strongly affect these measures of biodiversity effects could be very helpful.

The fourth article "Analysis of biodiversity experiments: a comparison of traditional and linear-model-based methods" is given as a manuscript and Terezie Rychtecká acts as second author. The first author is Pavel Fibich and the last author Jan Lepš. In this manuscript, three different data sets were used to compare the performance of the traditional method to evaluate BEF Experiments (additive portioning of net biodiversity effects) with linar-model-based methods. Based on the results, the authors come up with clear recommendations when to use traditional and when linear-model-based methods. Thus, the paper is a valuable contribution to the scientific community in terms of choosing the most appropriate evaluation technique to answer specific questions in BEF experiments.

The articles presented in this thesis provide a very comprehensive and scientifically sound picture on different facets of biodiversity-productivity relationships und underlying mechanisms. They add new mathematical and empirical evidence on various theoretical concepts in BEF research. In general, this scientific contribution is of international visibility (three papers already published) and fully matches modern scientific quality standards in ecology.

In conclusion, Terezie Rychtecká is showing the necessary technical and scientific competence to hold a PhD. Based on the points stated above, I strongly recommend the PhD committee to allow the candidate admission to the formal PhD defense.

Münster, June 18th 2014

PD Dr. Till Kleinebecker