Review of the PhD thesis of Petra Janečková: *Coexistence of plant species in fragmented landscape*

The submitted thesis consists of well-done, detailed introductory chapter, the scientific papers, out of which Petra Janečková led two, and summary. Considering several aspects such as scientific importance, extend, author contribution, or complexity, I generally characterise the thesis as standard in the field of plant ecology at European research universities. I hence recommend its acceptance. I have the following concerns and questions for discussion:

Introductory chapter is generally well written and detailed. One could be surprised by putting some methodological information (p. 11) before defining the aims. I was further a bit surprised by the statement that "*the detrimental effect of fragmentation per se is recently considered to be a zombie idea that has been refuted many times but still survives.*" I wonder why author, if she agrees with this conclusion, then focused her PhD thesis on testing the "*zombie idea*". Or does she disagree? In such a case, she would discuss this statement. I do not know Fahrig´s papers, but could the point be in different diversity measures (overall diversity versus diversity of habitat specialists) or different definition of fragmentation (splitting previously continuous habitat versus decreasing connectivity of naturally patchy habitat)?

Paper 1 demonstrates the author´s ability to work as a team member, and I realised that this paper is not the principal one in the thesis. I will therefore not evaluate it in detail. Only one comment – it seems me a bit funny to imagine "practitioners" to build trait databases to know that abandonment or fertilisation will promote tall, competitive species. Or should they create such databases from another reason?

Papers 2 and 3 are very ambitious. Author´s team, led by Petra Janečková, aimed to utilise extensive regional data set on species composition of all existing grassland fragments to test the effect of patch area and connectivity to functional composition (paper 2) and diversity (paper 3). The idea seems indeed hyper-ambitious. The authors collected data on species composition of 1307 (!) grassland patches, sampled within five years by 4 (or how many?) researchers. Considering the hypothesis tested and the analytical tools (the occupancy index), reliable records on species absences are as important as records on species presences. It means to sample thoroughly all species in each patch, on 1307 patches within five years (always in the period between May and summer cutting, I expect). It seems even super-human. How was it technically realised? How many researchers and how long time sampled one patch? Can we trust species absences in the data set?

Paper 2 indeed found support for the hypothesis that dispersal and competition-related traits matter for species occupancy in fragmented landscape. I like this result. It is a pity that conclusions in the abstract are written very vaguely and sounds not very fascinating. I am afraid that the abstract will not attract as much attention from the readers as the paper actually deserves. Another shortcoming, according to my opinion, is putting the difference between species frequency and species occupancy on the foreground. I think the differences between the two is somewhat trivial because the two different questions are addressed. One (frequency) focuses on variation across different habitats and has to do something with niche breadth along the moisture gradient in some analyses, while another (occupancy) is more relevant for testing the fragmentation effects. No wonder that different traits are important for different processes. When focusing on the occupancy, I have the following questions to be discussed:

(i) What is generally more important for species occupancy in a habitat that was fragmented quite recently? Is it dispersal ability (allowing re-colonisation after random extinction), or is it an ability to prevent extinction in a small patch (i.e., presence of large belowground organs)?

(ii) I look at the species with the lowest occupancy index. It seems it is a mishmash of generalist species that could colonise the patches from surrounding agricultural landscape (*Anthriscus sylvestris, Campanula rapunculoides*) and habitat specialists that must disperse among patches. Do you expect different results if you would consider only habitat specialists?

(iii) Some species with low occupancy index, e.g., *Dactylorhiza majalis*, have many light seeds and hence good dispersal distance. Could traits associated with germination and seedling establishment play role as well?

Paper 3 focuses on the richness parameters, using the same data set. The number of sites is 752, i.e. one half as compared to the previous study. Does it mean that only a subset was analysed? How was it selected? The paper well demonstrates the effect of patch size and connectivity on grassland diversity. In some parts (title, beginning of Discussion) authors state that they aimed to test the effect of fragmentation and management, while in Introduction and the end of the Abstract they instead state that they aimed to test relationships among diversity measures and how they are affected by management and vegetation type. If the paper is not yet accepted, I recommend clarifying this contradiction[1]. I have the following questions to this chapter:

(i) Is abundance-weighted diversity relevant for the testing the fragmentation effects? How fragmentation affects evenness or even functional and phylogenetic evenness? What theory is behind?

(ii) What do we generally know about richness-area and evenness-area relationships for functional diversity? Is heterogeneity the only cause of the richness-area relationship, as you mention in Discussion? If yes, make it sense to analyse functional diversity in large patches? If a large patch is formed by a mosaic of

different habitats (i.e., wet and dry grassland together), what is then the functional unit? A patch as a whole or individual communities inside it?

(iii) You state that "*Our results do not support the hypothesis that species richness, but not necessarily functional and phylogenetic richness, decreases with decreasing habitat patch size and connectivity….*". What the word "*not necessarily*" mean? Functional and phylogenetic richness were significantly affected as well, yet the effect was weaker. Does "*not necessarily*" mean slightly yet significantly? That now they were affected, but slightly, therefore in some other case they might not be affected? How could the hypothesis about non-necessity of some effect be tested?

(iv) When speaking about resilience of grasslands due to lower richness, do you mean resistance or resilience? I think these terms are not synonymous.

In Brno, 25 September 2019

doc. Mgr. Michal Hájek, PhD

[1] I suggest focussing on the fragmentation effects rather than to mere comparison of indexes and to adjust aims and Abstract accordingly. I further suggest reformulating the result´s part of Abstract that was very confusing for me as an uninformed reader. I understood it only after repeated reading of both Abstract and Table 3. The problem is in the "*including evenness*" that incorrectly suggests that there were several diversity measures calculated and one of them was evenness (e.g., Pielou's evenness index). The following sentence starts with "This" while it is unclear to what it refers. Firstly, I misunderstood it. In Abstract, you refer to richness-based measures, while in Tab. 3 to presence-based measures. It is further not clear in Abstract what is the difference between taxonomic diversity and species richness. I suggest something like "*Patch area and connectivity affected diversity in terms of all its presence-based measures and the Simpson´s diversity index, with greater effect on species and phylogenetic richness than on other diversity facets. Management affected only species richness. The abundance-weighted functional and phylogenetic diversities were affected only by habitat.*"

16th October 2019

Thesis Report Part A

[synopsis to be read during the defence (322 words)]

While divergent views exist on conservation biodiversity in the Anthropocene , biodiversity change, present and continued, is unequivocal. How these changes manifest, how they vary across ecosystems and time, and what (at time scales relevant to todays society) will be the resultant impacts to ecosystems, their functioning and services upon which human societies depend are all **priority questions for science and policy.** The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) has identified that reporting trends of biodiversity not only at macro-scale levels but **importantly regional and local levels** are paramount for the development and evaluation of policy options. Further, the United Nations sustainable development goals (SDGs and the Convention on Biological Diversity Aichi targets, recognize and indeed are committed to addressing biodiversity loss, functional change and consequential degradation to human well-being.

The work of Petra Janeckova presented here as a thesis for evaluation for Doctor of Philosophy is therefore exceptionally timely and relevant to present societal and environmental challenges. Land-use change and intensification are among the most widespread pressures facing terrestrial biodiversity worldwide, with habitat degradation particularly through human land-use for commodity production being, and expected to remain, the number one driver of biodiversity loss. With a focus on vascular plant biodiversity of central European semi natural grasslands (a species rich habitat type dependant on low intensity human management), the work imbedded here vastly improves our understanding of not only taxonomic but especially functional diversity patterns, patterns identified to vary with scale and across ecological gradients. This thesis thus makes a significant contribution to science. Furthering our understanding of how the biodiversity of cultural landscapes are governed is absolutely necessary for the successful development and implementation of future conservation policy ensuring the functions, services and biodiversity are protected. I personally commend Petra Janeckova on delivering a coherent, thoroughly interesting and timely research thesis and it is my recommendation that this work be **accepted** for defence for achieving a Doctorate of Philosophy.

Thesis Report Part B

[Pre-prepared questions for the candidate]

Q1: How do the Semi Natural Grasslands (SNGs) of Czechia, especially those characteristic of your study area compare to other SNGs of Europe e.g. hyper-oceanic SNGs of Scotland and/or floodplain meadows or alvars or Estonia?

Q2a: The work compiled in the thesis clearly acknowledges and emphasises the importance of scale dependence for understanding and explaining patterns of diversity among Semi-Natural Grasslands (SNGs). Please discuss and/or hypothesise from your experience and understanding which environmental explanatory variables to be the most significant in describing spatial patterns of diversity among SNGs of Europe, how they vary with scale and whether there exist non-stationarity relationship in space. For example: Variable *x* explains most variance at spatial scale *n*, while variable *y* explains most variance at spatial scale *d*, however the explanatory power of variable *y* varies (or hypothesised to vary) along environmental gradient *z*.

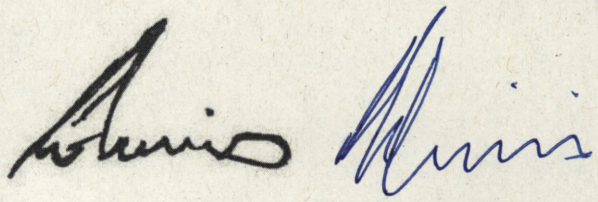
Q2b: Further, comment on how you might statistically explore and validate the spatial structure, dependence and patterns of biological diversity environment relationships?

Q3: A commonly assumed hypotheses in trait-based studies such as those presented in this thesis is that the intraspecific trait variability is lower than the interspecific trait variability. What is the likelihood of intraspecific variability across the four simulated land-use treatment described on page 11-12 and more generally across semi-natural grasslands along environmental gradients? How might variability in trait values as a result of measured vs aggregated trait data sourced from databases impact community weighted mean measurements? And, consequently what is the potential influence (if any) of intraspecific trait variability upon inferences made from the study presented in Chapter II?

Q4: Results from the thesis infer that simple plant traits can be used to explain communities responses within a given regional species pool. Do the same suite of traits hold the same predictive power across differing regional species pools? And, how might an enhanced knowledge and understanding of species pools further our understanding of (1) local and macroecological patterns of biodiversity and (2) compliment and/or facilitate conservation management?

Q5: Discuss the relevance of the thesis broadly in the context of current global anthropogenic land-use change and furthermore, specifically in the context of contributing to the strategic goals of Aichi Biodiversity Targets and the EU sustainable development goal 15?

Dr Rob J Lewis



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