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Prof. Oldřich Nedvěd
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Report for doctoral examination of Mgr. Lucie Ambrožová

Dear Prof. Nedvěd,

Please find my report on the doctoral thesis of Mgr. Lucie Ambrožová 'Dung beetles of Central Europe: Diversity and Conservation'.

The thesis is well written and presented and presents the results of field-based research and analysis on the dung beetles of Central Europe and gives recommendations on their conservation and management. The thesis chapters have a combination of observational and experimental studies and so demonstrate the candidate's ability to both undertake fieldwork, design experiments, and perform analysis on large datasets. As such the thesis presents new and interesting results for the region and demonstrates impact by providing concrete suggestions based on evidence-led research on how best to conserve dung beetles within Central European landscapes. Chapter 3, in particular, makes a very nice contribution to the field, and combines the large dataset obtained with some original modelling techniques, to provide management suggestions.

The structure of the thesis is good, with a short summary at the end and good introduction. The structure of the chapters are mostly clear and easy to follow and the figures generally clear and informative. Do make sure all information needed to understand a figure is in the legend (e.g. Ch1, Fig. 1. It is not clear what the letters after the site numbers are). The candidate has cited the relevant literature and appears well-versed and knowledgeable about the broader issues surrounding dung beetle ecology and conservation, as well as the more specific aspects of her research. Throughout the thesis there is good discussion across the topics of conservation and management of habitats both for the focal taxa and at a wider scale. However, while the general aims of each chapter were clear and well explained, the specific hypotheses and predictions were not clearly outlined. In future publications, I would encourage the candidate to include specific hypotheses and predictions at the end of the introduction and I feel this would have helped guide the structure of the paper and results, particularly in Chapters 1 and 2. I would also have liked to have seen clearer reporting of the statistical models used, and the statistics obtained. For example, I found the analysis in Chapter 1, in particular, hard to follow. Numerator and denominator degrees of freedom, R2 values, and F/X2 and p values as well as coefficients should be reported for all

models and the variance explained by random factors, so that the statistics are clear and transparent, and the design of the experiment and analysis assessed.

Below I provide a short assessment of each chapter.

Chapter 1 provides an interesting analysis on the impacts of ivermectin treatment on dung beetle communities. The dataset is spatially and temporally large and shows a huge amount of work. In some ways this is the less novel of the three chapters as the effects of ivermectin on dung beetles in Europe has been fairly well studied. However, the chapter attempts to provide some novelty by conducting the study over wide spatial and environmental scales and dividing the dataset into two treatment categories – recently and long-ago treated. The study finds evidence that ivermectin use affects both taxonomic species richness and abundance but also functional richness, but not biomass, and that this lasts even in the long-ago treated sites. While I liked the idea of the study, the design seems very complicated, and I found it difficult to understand exactly how this had been analysed with so many explanatory variables involved and then repeated measures on the same sites across seasons, but with different treatments, and the sites having different dung types. There seem to be many confounding factors, particularly between season and treatment and I wonder how these were separated out in the analyses (see Questions below).

Chapter 2 provides a nice experiment to test the effects of coppicing and topsoil removal as management techniques on dung-inhabiting beetles. It would have been nice if the design had been fully factorial with a topsoil removal alone treatment and had more replicate blocks but I can understand that this was probably due to constraints in time and application in the field, and I appreciate the amount of work that has gone into this chapter. I missed the rationale and hypotheses about how and why dung beetles would be expected to respond to these treatments from the end of the introduction and this would helped to have framed the study. The study was nicely analysed and presented, and the findings that certain dung-inhabiting beetles were positively affected by both management regimes will be useful evidence for forest and landscape managers. However, I do find it concerning that the results of the statistics are not reported in the results (F/X2, numerator and denominator df, R2, variance of random effect), only the results of the multiple comparisons are in the Appendix Tables.

I really enjoyed reading Chapter 3 and learned a lot from this chapter. For me this was the most impactful and interesting chapter and brought together well the discussions form the previous chapters. The chapter was clearly written, and the analyses well explained, and this chapter will have strong applied and conservation importance for dung beetle conservation in the region. I appreciated the hypotheses at the end of the introduction of this chapter, although why the direction of the hypotheses was given as such was missing (e.g. why did the candidate expect geographical factors to be stronger than management, and turnover greater importance than nestedness). The simulations creating the response surface graphs were an interesting way to look at the data and provide a useful tool to assess the importance of the variables for maintaining diversity. There are few areas where dung beetles have been assessed on this landscape scale and I think this paper makes a great contribution to dung beetle conservation. I hope it can be used as an inspiration for future analyses of dung beetle responses on large scales.

I appreciate the amount of work and effort that has gone into this thesis and the applied impact it will have for dung beetle conservation in the region. All three chapters are already published in well-respected ecology journals and overall, I find the quality of the thesis such that I am happy to recommend the thesis for a doctoral degree. I look forward to further discussion on my questions in the examination.

Please feel free to contact me if you require any further information.

Yours sincerely,

[redacted]

Dr Eleanor Slade

Questions for the candidate

1. The study design and analysis of Chapter 1 was the most confusing bit of the thesis for me. Could you explain/draw out the study design and statistical models you used to analyse the data in Chapter 1 and explain the rationale for the analyses. From Table A1 it seems like you did repeated measures on the same sites in different seasons, so these are not independent data points. If I understand correctly, you had 15 sites with ivermectin treatment, but in some seasons, these were recently treated and in others long-ago treated? So, there is a confounding factor of season and treatment within each site. For example, summer has no recent treatment. How did you account for this in the models? Season only seems to have 1 df, but there are 3 seasons. It seems like you maybe analysed this as a continuous variable, can you explain why? It also seems like you don't have 26 truly independent sites as some sites are the same but just different dung types. I counted 17 different sites in the table. Thus, dung type is nested in sites in some cases, and it wasn't clear to me if this was accounted for in the analysis. How balanced were the numbers of replicates for each dung type and treatment category? How might this affect the results? As no denominator degrees of freedom are reported it was unclear how many replicates you had in each category in total. Why did you decide to fit herbivore dung type as a random factor? How much variance was explained by the random factors? What about spatial autocorrelation?

2. Chapter 2. Why do you think dung beetles would be particularly affected by coppicing and topsoil removal/nitrogen addition? I was wondering if they depend more on the presence of dung. Did the mammal populations differ between the treatments, meaning the results could be due to indirect rather than a direct effects? You used cattle dung but the main dung types were wild boar and deer and sheep, do you think that your results would differ if you used those dung types instead?

3. In Chapter 2 Figure 2 why do you think that dung beetles and rove beetles show the reverse pattern (e.g. higher dung beetle species in clear cut, then topsoil, then forest, but for rove beetles higher species richness in forest) but then in Fig 4 – functional diversity highest for dung beetles in forest and lowest for rove beetles in forest? Why do they show such different responses?

4. I found the classification of the dung beetle functional groups interesting, In Chapter 3 I was wondering why you lumped relocating beetles together and didn't separate into tunnellers and rollers? Did you think they might have shown different patterns in response to the environmental gradients? I ask because in SE Asia we find that rollers are most disturbance intolerant. Also your tables in Chapter 3 include results for visitors but you do not report these? Did they respond differently to dwellers?