

Review of the thesis “**The role of the brown bear *Ursus arctos* as seed disperser: a case study with the bilberry *Vaccinium myrtillus***” submitted by Alberto García Rodríguez.

General comments

This thesis tackles a surprisingly overlooked topic: the functional role as seed disperser of the brown bear, the most widely distributed megafaunal frugivore across the Holarctic region. The set of studies included in the thesis are not only relevant to understand the seed-dispersal functions performed by brown bears where they occur, but also to highlight the loss of these functions where brown bears became extinct in the last centuries.

The thesis is very well written, the design is in general clear and robust to reach conclusions from the results obtained, which are nicely discussed and interpreted.

The following major aspects of this thesis deserve to be highlighted for their value:

- Multiple approaches: a remarkable value of this thesis is the fact that it includes several approaches to tackle the different questions addressed. These include literature review along with quantitative data analyses (Chapter 1), the use of novel DNA-based molecular tools to characterise diet composition (meta-barcoding; Chapter 2) and seed-disperser identity (barcoding; Chapter 3), and a substantial amount of fieldwork conducted by the candidate (Chapters 2–4).
- Candidate’s scientific maturity: the candidate demonstrates a clear and mature understanding of the topic at all the phases of scientific research, from original data collection to publication. He clearly understands the technical aspects of the work and the conceptual backgrounds. Indeed, the thesis is built on a very good overview of the literature within the field of seed-dispersal effectiveness and ecological functions provided by megafauna.
- Publications: All chapter of the thesis are published or to be published as scientific articles. Part of the thesis has already been published (Chapter 1) and part submitted to relevant and prestigious journals within their respective research fields.

I just have two general comments on the thesis. However, I would like to make clear first the fact that these do not represent major issues or problems that are fundamental for the quality of the thesis.

My first general criticism is only about the format. In my opinion, a thesis should be a thesis (a publication) rather than a collection of manuscripts (pre-prints). In this line, figures and tables should ideally be embedded in the text where they are cited, and not at the end of the text of each chapter. Besides, many “supplementary figures/tables” or “appendices” can be converted into figures and tables of their corresponding chapters. In fact, some supplementary elements (e.g. Fig. S1-S5 of chapter 3) are forced to be “supplementary” for publication in scientific journals owing to space limitation in articles, but this should not be a problem in a thesis. Another example is that, across the thesis, the author refers to information from other chapters by citing “García-Rodríguez and Selva submitted” or “García-Rodríguez

et al. submitted”. Again, this makes sense for manuscripts but or a thesis it would have been more appropriate to cite “Chapter 4” and “Chapter 3”, respectively.

My second comment is that I have missed a General Discussion wrapping the whole thesis prior to the list of Conclusions.

Some specific and minor comments

P13 and P15: it would have been better crafting new (conceptual) figures inspired on Fig. 1 and Fig. 2 of the Introduction, and making reference to the originals, than directly using graphical material from other publications.

P35: the species selected for the experiment are not listed in the Methods.

P38: missing P-value for the Spearman’s rank correlation.

P138: it would have been nice to report the approximate size (hectares) of a polygon/area including all transects within this valley.

P175: in “Field sampling” it would be good to explain the reader the phenological meaning of revisiting the samples one year later in September, that is, seeds are dispersed in autumn, then covered by snow in winter and they are expected to germinate in summer (???).

P177: measures of central tendency like “mean \pm sd” are useful to characterise a normal distribution but not a highly skewed distribution such seedling numbers. Median and quartiles are more appropriate and are better describing the data.

Questions for discussion with the candidate

These questions do not represent major criticisms or concerns, but just aim at developing a fruitful discussion with the candidate on different aspects of his thesis.

(1) What do you think is the most relevant contribution of this thesis on what was already known about seed dispersal by bears before your research?

(2) The thesis emphasises the important role of the brown bear for long-distance seed dispersal while tacking analytically seed-dispersal effectiveness. Spiegel & Nathan (2007 *Ecology Letters*) incorporated dispersal distances on the seed-dispersal effectiveness framework but this is something that has not rooted (Schupp et al. 2010 *New Phytologist*) and “effectiveness” and “distances” are typically considered as different components of the seed dispersal services provided by a frugivore species. What is you view on these components?

(3) You write in page 32 that “*Legitimate seed dispersers are usually defined as true mutualist agents that combine a high quality and quantity of seed dispersal*”. I do not agree. Can you discuss the factors responsible for a high quantity component?

(4) Among the fruit species found to be dispersed by bears in Chapter 1, do you think that some of them have megafaunal traits (large fruits)?

(5) Can you comment on the challenges or limitations you face during meta-barcoding analysis? How do you think that results from Chapter 2 using a traditional morphological analysis of scat content would have differed from those obtained using meta-barcoding?

(6) Chapter 2 is focused on the potential impact of tourism on diet and the scats were geo-referenced. Why you did not conducted a spatially explicit analysis testing the effect of landscape/habitat features on dietary content?

(7) Also about Chapter 2: you conducted the study in a mountainous are with high bear density and high bilberry density. At the same time you point out that the dispersal service could be at risk owing to anthropogenic food. Is not this a bit paradoxical? When reading this Chapter one could think that the Slovenian side is the right place to test the effects of anthropogenic food.

(8) Regarding Chapter 3: How well do you that seed-dispersal events mediated by birds and bears track suitable microsites for recruitment? i.e. relatively few very large seed depositions vs. a lot of tiny depositions. Do you think it would have been interesting analysing the density of seed deposition sites, measured as deposition points per hectare?

(9) In Chapter 4, I missed a deeper justification of quantifying “seedlings per hectare” and “seedlings per gram of faecal sample”. What is the meaning of the later? Do you think that “seedlings per dropping” would be an interesting metric?

(10) Also regarding Chapter 4, do you thin that the “recruitment at windows of opportunity” previously attributed to the bilberry was related to studies on this species in placed without bears or with a more impoverished disperser assemblages?

Conclusion

In conclusion, I believe that the doctoral dissertation presented for review, whose author is Alberto García Rodríguez, M.Sc., meets the criteria for doctoral dissertations set out in Article 13 of the Act of 14 March 2003 on Scientific Degrees and Academic Title and Degrees and Titles in Art (Journal of Laws of 2017, item 1789) and in the Act of 20 July 2018, Law on Higher Education and Science (Dz. U. of 2018, item 1668, as amended) and the Act of 3 July 2018, Introductory provisions of the Act - Law on higher education and science (Journal of Laws of 2018, item 1669, as amended). In view of the above, I put forward a motion to the Scientific Council of the Institute of Nature Conservation of the Polish Academy of Sciences in Krakow to admit Mr. Alberto García Rodríguez to further stages of the doctoral dissertation.

Moreover, I think that this work deserves to be considered for a honourable mention.

A handwritten signature in blue ink, consisting of a stylized 'J' and 'P' followed by a horizontal line extending to the right.

Yours sincerely,

Dr. Juan Pedro González Varo