Written assessment of PhD thesis of Conor Redmond - 27th June 2019

Reviewer: Dr Rebecca J. Morris

Conor's thesis focuses on plant-herbivore interaction networks in tropical rain forest in Papua New Guinea, and specifically on the drivers of network structure and herbivore specialisation. To do this he has analysed probably the largest plant-herbivore interaction data set ever collected for replicate whole-forest plots along elevational and successional gradients; and he has also conducted a year of field sampling and project supervision in Papua New Guinea.

Conor's thesis introduction demonstrates a broad knowledge and understanding of the diverse topics relating to plant-herbivore networks, including specialisation and succession. He includes four data chapters in his thesis, of which the first has been published in Ecography (currently ranked 23rd out of 160 Ecology journals), and the final chapter has been submitted to a journal, with Conor as second author. The other two chapters are ready to be submitted and will likely have been submitted by the time of the thesis defence.

Conor's work scales up previous efforts over the past 15 years to understand the drivers of network structure and herbivore specialisation. He has achieved this by using much larger and more comprehensive data sets than have been previously used. More importantly, Conor looks beyond the patterns that have often been the goal of ecological network projects in the past, to investigate the mechanisms or drivers that are causing the observed patterns. In doing so Conor has contributed a deeper understanding of why plant-herbivore change along environmental gradients; developed a new method of modelling secondary forest networks based on sub-sampling primary forest networks; and put into practice a recently developed distance based specialisation index. More generally his results have relevance for conservation, adding a greater level of knowledge about how plant-herbivore networks respond to anthropogenic change; how we might make predictions about impacts on networks (Chapter 2); and which species might be least able to respond to environmental changes (Chapter 3).

Conor's main results include that along a successional tropical forest gradient in montane forest, specialisation remains high and there is limited change in network structure. This is despite the phylogenetic diversity of hosts declining throughout succession, and there being high network beta diversity, which indicates that general rules of network assembly likely apply across forest types. In Chapter 2, Conor finds evidence for bottom-up structuring of plant-herbivore interaction networks in both primary and secondary forest, finding that host properties, most notably abundance and host taxonomy, can predict herbivore abundance and species richness, and network architecture, respectively. In Chapter 3, Conor focuses on phylogenetic specialisation of tropical herbivores, using the distance based specialisation

index, finding that it varies with elevation, guild and habitat use, with lowland species being less specialised than montane species. Finally in Chapter 4, Conor, tests 3 methods for comprehensively sampling and quantifying plant-arthropod interactions in forest canopies, proposing whole forest plot-based sampling as a general approach to enable global network comparisons.

Overall Conor's thesis provides original contributions to the plant-herbivore network literature, and more generally to the ecological literature, specifically through his analytical approaches, including phylogenetic analyses and predictive models,. Conor shows an excellent understanding of the relevant literature, and he has used this to explain his own results, elucidating the mechanisms structuring networks and affecting herbivore specialisation. I would particularly like to highlight his insight into the importance of phylogeny in herbivore specialisation, which is an aspect that has been overlooked in the past. I recommend that Conor's thesis should be accepted, but do have a few questions that I would like to ask:

1. There is a lack of understanding of the mechanisms shaping interaction networks, and here you have contributed original insights on this topic from a comprehensive plant-herbivore study in Papua New Guinea. Can your results be generalised beyond Papua New Guinea, and even beyond plant-herbivore networks?

2. Can you explain the widespread belief that increased diversity and specialisation are tightly linked and why do your results contradict this idea?

3. You have focused on herbivore specialisation and taken a phylogenetic approach to analysing this. How does specialisation at the level of individual herbivores affect specialisation at the plant-herbivore network level, and would it be possible to include a phlogenrtic component to measures of network specialisation?

4. Your thesis focuses on plant-herbivore networks, and on the importance of bottom-up effects in driving network structure, but how will these networks be affected by the inclusion of parasitoids or predators?

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Review of doctoral thesis

Student: Conor Redmond **16.6.2019**
Opponent: Štěpán Janeček

The Thesis "Plant-herbivore interactions along ecological gradients in tropical rainforest: Drivers of network structure and specialization" contain one published and three unpublished studies. The main aims of the first three manuscripts are: 1/ to describe plant-herbivore networks, 2/ in more detail to study specialization of plant-herbivore interactions and the effects of succession and/or altitude 3/ To reveal how are network properties affected by plant and vegetation traits. In the last manuscript (Chapter 4) is author comparing different methods to study plant-herbivore interactions in forest canopy.

The thesis are based on huge datasets, which were collected by many people. It nevertheless seems that Conor Redmond was one of the main contributors. The thesis are well written with small number of typos etc. I recommend PhD thesis for defense. Nevertheless, I have some comments and questions:

Introduction

I would expect a bit more detail description of studied localities in the introduction (not many people are familiar with PNG forests).

I understand that when somebody is studying networks is bored by visualization of network parameters, which are in so many papers (as modularity or nestedness). On the other hand, I think that for many readers from different fields of ecology it will be useful to have such a visualization in the introduction.

Why the author believes, that the interactions between plants and their phytophagous herbivores are the most important ones (i.e. for example why are more important than plant-pollinator or plant-detrivore interactions)?

You are sampling all woody species above 5cm DBH and you are considering it as "*whole forest*" approach. Nevertheless, trees are not the only plants growing in the forest. For example, on Mt. Cameroon, where we are working, are 32% of plant species terrestrial herbs, 10% epiphytic herbs or 10% shrubs<3m. Do you have any idea what are these proportions in the forests where are you working?

Chapter 1: "High specialization and limited structural change in plant-herbivore networks along a successional chronosequence in tropical montane forest."

0.2 ha is in tropical forest quite a big plot, on the other hand it can host for example just a few upper canopy trees. What can be the effect of different tree sizes on differences in taxonomical and phylogenetic diversities among treatments? What was the mean number of trees in individual treatments? Can these tree size differences also influence properties of plant-herbivore networks? (see Oksanen 1996: Journal of Ecology 84: 293-295). By the way this effect is probably also the reason why in the chapter 2 you observed lower diversity and bigger trees in mature secondary (compare to young secondary) plots.

I am not expert on null models, but I do not understand how it was done. Can you please explain it in detail? I expect that in community distance matrix are phylogenetical distances among species..... no? How were in these matrices shuffled species abundances? Community distance matrix means that there were different matrices for young secondary, mature secondary and primary forest communities? Or there was one matrix?

MTD and MNTD reflect only one aspect of phylogenetic diversity. Why you decided to use these two phylogenetical diversity measures? (see Tucker et al. 2017: Biol.Rev. 92: 698-715)

Maybe more useful for understanding to distance-based specialization index (DSI) will be to show the equation.

The general problem (also somehow discussed by authors) of plot-based approach for interaction networks is that that there is relatively low sampling effort for rare species. It is also obvious from the table A1, where many plants have very low number of replications (quite often just one). Moreover, in chapter 2 there is demonstrated clear effect of host abundance on vulnerability. How can this fact effect network properties such as specialization? I do not understand to the sentence at the end of the third paragraph on page 29 ("However, despite the low number of replicates, clear trends emerge from metrics were variance was low, suggesting patterns are like robust").

In discussion on page 28 is author explaining the unusual observed pattern, when the phylogenetic diversity decreased with succession by the lack of abundant dominant diverse genera as *Ficus* and *Macaranga*). Nevertheless, the patter when phylogenetic diversity increase with succession is more common and is known also from other types of forests (e.g. Pastore and Scherer 2016: Ecosphere 7:e01592). Is the absence of these diverse genera really the only explanation of the observed pattern?

Chapter 2: "Bottom-up structuring of plant-herbivore interaction network during rainforest succession"

How can be 0.2 hectare plot divided into four 20 x 20 m? 20 x 20 m is 0.04 hectare and 4 plots are 0.16 hectare?
What does it mean "TRIN" in the model name?
Page 63 "TRIN Rarefaction Model" paragraph: there should be in the brackets rather "whole-primary forest dataset" then "primary dataset".
What is the correlation among individual host plant community traits and how it could affect analyses and interpretation? For example, SLA and C:N ratio should be very closely correlated. Was there no problem with collinearity in multiple regression models?
In discussion are you explaining the little effect of tree size distribution by preferences of herbivores for smaller trees. How can these preferences for individual trees and/or tree size classes change during the year depending on tree phenology?

Chapter 3: Phylogenetic specialization of tropical herbivores varies with elevation, guild and habitat use.

Observed specialization is often used for predictions on species extinction, community stability etc. Nevertheless, organisms can be specialized to some resource only if it is available. If not, they do not need to disappear, but they can simply switch to other less preferred resource. Do you have any idea what can happened with populations of herbivores in your system if the resource to which they are specialized disappear (i.e. switch or extinction)?

In introduction (page 85, 2nd paragraph) author claim that disturbance reduces plant diversity, and this can favor more generalist herbivores. Nevertheless, it was shown in many studies, that the relationship between disturbance intensity and plant diversity need not to be simply linear. It is also in contrast to previous chapters showing big diversity in secondary forest. Really author assume that there can not be any positive effect of disturbances on diversity?
For plant community phylogeny you used rbcL and psbA-trnH. What was universality and discrimination of these loci for species in your plant community?
How can be specialization of caterpillars related with the life histories of adults. Can be for example expected that caterpillars of butterflies with higher longevity will be more generalized?

Chapter 4: Quantitative assessment of arthropod-plant interactions in forest canopies: a plot-based approach

I do not think that it is possible to compare methods which were used in so different forest types. From my point of view, it is not possible to say if the differences in sampling effort or foliage access is due to forest type, the method or their interaction.

If I understand well, the crane method was not just collecting of leaves and herbivores from the crane, but using of ladder and climbing was needed. Are these activities included in area-based sampling effort estimation? If so, it will be nice to see how effective these activities are.

The maximum height from the crane gondola is 40,5. How did you managed higher trees?

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