

The Rufford Small Grants Foundation

Final Report

Congratulations on the completion of your project that was supported by The Rufford Small Grants Foundation.

We ask all grant recipients to complete a Final Report Form that helps us to gauge the success of our grant giving. The Final Report must be sent in **word format** and not PDF format or any other format. We understand that projects often do not follow the predicted course but knowledge of your experiences is valuable to us and others who may be undertaking similar work. Please be as honest as you can in answering the questions – remember that negative experiences are just as valuable as positive ones if they help others to learn from them.

Please complete the form in English and be as clear and concise as you can. Please note that the information may be edited for clarity. We will ask for further information if required. If you have any other materials produced by the project, particularly a few relevant photographs, please send these to us separately.

Please submit your final report to jane@rufford.org.

Thank you for your help.

Josh Cole, Grants Director

Grant Recipient Details	
Your name	Bráulio Almeida Santos
Project title	Understanding the interaction of the genus <i>Heliconia</i> (Heliconiaceae) with their leaf-fungal pathogens and insect herbivores in fragmented landscapes: implications for management and conservation of this important ornamental plant
RSG reference	40.08.08
Reporting period	January 2009 – December 2010
Amount of grant	£5808
Your email address	braulioalmeida@yahoo.com.br ; bsantos@oikos.unam.mx
Date of this report	17.03.2011

1. Please indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
To evaluate how rain forest fragmentation affects incidence and severity of leaf diseases and insect herbivory in tropical rain forests			X	Our results indicate that <i>Heliconia</i> species face greater levels of damage by generalist leaf-cutting ants in forest fragments and along road edges; reduced damage by specialist hispine beetles in forest fragments; and reduced damage by Lepidoptera larvae on degraded riparian corridors and road edges. Pathogen damage significantly increases in forest fragments and tends to increase on road edges and degraded riparian corridors. These results are summarised in three scientific articles, one published in <i>Biotropica</i> and two under review in <i>Conservation Biology</i> and <i>Biotropica</i> .
To identify causal agents of biotic damages in <i>Heliconia</i>		X		The identification of the main <i>Heliconia</i> insect herbivores was fully achieved. However, we failed to identify the main <i>Heliconia</i> leaf-fungal pathogens. To compensate this point, we made a global review on all organisms attacking <i>Heliconia</i> . The huge majority (> 85%) of the 157 herbivore and pathogen species recorded was represented by generalist insects and fungi that primarily attack the foliage of these ornamental plants. The profitable inflorescences were attacked by only 16% of the species, representing a positive sign for the management of these plants as cut flowers in secondary and degraded forests. These results are being considered for publication in <i>Biodiversity and Conservation</i> .
To examine how physical conditions and host plant density affect the biotic interactions			X	Our results indicate that daily microclimatic patterns and density of conspecific shoots in a 10 m radius do not account for most of the variance in herbivore and pathogen damage. Local abundance of herbivores appears to be the most important factor underlying differences in herbivore damage. We also evaluated how host quality, measured in terms of leaf toughness and

				amount of foliar condensed tannins, and local abundance of herbivores, could affect the biotic interactions considered (these variable were not initially included in the proposal). While changes in host quality had a negligible effect on the interactions, local abundance of herbivores clearly determined the levels of foliar damage. A detailed discussion of this point can be found in the manuscripts already published and in those under review.
To assess the role of landscape metrics on herbivory and disease patterns			X	These data have been not explicitly analysed yet but apparently the area, shape, isolation, and surrounding matrix of the forest fragments considered are not relevant for the establishment of <i>Heliconia</i> -herbivore and <i>Heliconia</i> -pathogen systems. The reason for that seems to be the high ability of host plants and natural enemies to disperse throughout the different habitats of the landscape. This topic is discussed in the publication which is under review in <i>Biotropica</i> .

2. Please explain any unforeseen difficulties that arose during the project and how these were tackled (if relevant).

We had logistic problems to work in the region of Los Tuxtlas, thus we travelled only once to that region and concentrated the fieldwork in the region of Chajul. In this region we increased sampling effort with respect to that mentioned in the approved proposal (i.e. we sampled ten leaves per plant instead of three), included new treatments (road edges, secondary riparian corridors, treefall gaps, forest fragments, and continuous forest, instead of the last two treatments only), and considered more potential mechanisms underlying the differences in herbivore and pathogen levels between habitats (i.e. we assessed the effects of leaf toughness, foliar condensed tannins, and local abundance of generalist and specialist herbivores, plus the effect of physical conditions and host density initially proposed). Also, data were collected every 3 months, not every 6 months as planned.

The funds of the four field trips not realised to Los Tuxtlas, including field work and personnel items, were used to purchase a laptop not budgeted initially, and to complement funds (UNAM-DGAPA Papiit IN220008) for two unforeseen academic visits to the Universidade Federal de Pernambuco (UFPE, Brazil) and University of California, Davis (UC Davis, USA). Visits lasted around 2 months each and were critical to improve the project's products. The first visit was conducted in the Department of Micology of the UFPE, with expert phytopathologists. The goal was to learn the techniques of fungal cultivation, isolation, and identification and then use the same procedure in Mexico to identify the pathogenic fungi attacking the Mexican *Heliconia*. We learned the techniques after collecting infected tissues of *H. psittacorum* in Atlantic forest fragments, but by the end of the visit, we realised that we needed to find a fungal taxonomist and invite him or her to participate in the

project. This never happened, so we decided to exclude the identification of the pathogens from the project and include the description of the disease symptoms instead. The second visit was conducted in the Department of Evolution and Ecology of UC Davis, with Dr. Donald Strong. His field experience in Costa Rica during 1970s and 80s made him a global leader on the *Heliconia* insect herbivores. The goal was to discuss the main results of the project and work on scientific manuscripts. The visit was very productive, and three papers directly benefited from his comments.

3. Briefly describe the three most important outcomes of your project.

- Human disturbance favours the proliferation of generalist herbivores in detriment of specialist herbivores. This is translated into increased damage levels by generalists and reduced damage levels by specialists in altered habitats, resulting in no change in the overall level of insect after disturbance. This 'functional compensation' mediated by generalist herbivores in altered habitats indicates that human-induced shifts in plant-herbivore interactions are more complex than previously envisioned.

- Human disturbance favours the proliferation of plant infectious diseases, though level of pathogen damage varies greatly from plant to plant even in the same habitat. Although we failed to properly identify the fungal pathogens, our global review and the available literature indicate that the favoured pathogens are facultative pathogens that attack a wide variety of unrelated plants, including many important crops.

- Despite the increased pathogen pressure in human disturbed habitats, there is a high potential for the production of *Heliconia* in the secondary and degraded forests of Southern Mexico. These ornamental herbs have numerous attributes associated with high tolerance to biotic damage, and therefore may grow up, survive, and reproduce irrespective to the level of foliar damage. Also, few herbivore and pathogen species attack their profitable inflorescences, which can be interpreted a good sign for its use as cut flowers. The cultivation of native *Heliconia* species is a promising instrument to help conciliate socioeconomic development with biodiversity conservation in Mexican and other neotropical rain forests.

4. Briefly describe the involvement of local communities and how they have benefitted from the project (if relevant).

Local community benefitted less from this project than I desired. Before starting the project, my goal was that the technical information generated by the project was helpful to solve potential pest and disease problems in *Heliconia* agro-ecosystems established in secondary and degraded forests. The information I had at that time was that Mexican government would possibly support *Heliconia* cultivation in tropical areas of the country. Also, some organisations that administrate funds of the Mesoamerican Biological Corridor Project in Mexico were supposed by local community to fund *Heliconia* production in Chajul. None of these initiatives succeeded. *Heliconia* keeps being treated as a weed to be removed before establishing bean, maize and chilli fields. This disappointed me because I desired to see the local people benefiting from *Heliconia* inflorescences rationally exploited, as they are in other neotropical countries. Nevertheless, I was pleased that the information generated with this RSG could be helpful for further *Heliconia* use in the region.

5. Are there any plans to continue this work?

Unfortunately no, because I'm moving from Mexico to Brazil and collaborators are engaged in other activities at this time. But hopefully a new, more applied project on the production and

commercialization of Brazilian *Heliconia* in abandoned fields and forest fragments should be submitted to the RSGF in the short term.

6. How do you plan to share the results of your work with others?

As described in question 1, the results of this project are being shared with colleagues of the scientific community through the publication of several research papers in specialised journals. A popular science article highlighting the high value of native *Heliconia* species as non-timber forest product and explaining how these plants could be used in Mexico without degrading environmental services and biodiversity has been submitted to a popular science magazine (*Cómo ves*, www.comoves.unam.mx). I hope this article makes part of the information of this project available to a general audience.

7. Timescale: Over what period was the RSG used? How does this compare to the anticipated or actual length of the project?

The RSG was used between March 2009 (three months after transfer) and October 2010 (after UC Davis visit and 2 months before ending the project). The length of the project (2 years) was not modified. I started to use the funds by purchasing the digital camera that was crucial for data collection in the field (foliar damage by herbivores and pathogens was estimated based on 10-megapixel photographs).

8. Budget: Please provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used.

Item	Budgeted Amount (1 pound = 19.7 Mexican pesos)	Actual Amount	Difference	Comments
Personal (field assistant)	1218.00	304.57	913.43	We travelled to Los Tuxtlas only once due to logistic problems. This difference was used in the items 'equipment' and 'others'.
Equipment (digital camera, external hard disk and GPS)	591.58	1134.22	-542.64	Besides this equipment, we also purchased a laptop to replace another one no longer available for the project.
Field work (air and bus tickets, food and accommodation)	3569.79	1015.83	2553.96	As mentioned above, we travelled to Los Tuxtlas only once. This difference was used in the items 'others'.
Material for laboratory (Chemical reagents, glassware etc.)	326.23	223.33	102.90	Around a third of the funds of this item left over because we found cheaper options than those budgeted. We used the difference in the item

				'others'.
Others (Paper, ink, flags, spiral notebook etc.)	101.52	3132.04	-3030.52	This item accounted for most of the project's expenses. Besides the budgeted materials, it included two unforeseen but critical academic visits to UFPE (Brazil) and UC Davis (USA). Please refer to question 2 for details.
Total	5807.12	5.809.99	-2.87	

9. Looking ahead, what do you feel are the important next steps?

I think full-time researchers of the Universidad Nacional Autónoma de México and other institutions working in Mexican tropical rain forests should insist in getting close to local communities and decision makers. In Chajul, for instance, local people are tired of seeing proposals that are not implemented and researches that just leave the *ejido* after collecting their data. Researchers could bridge the gap between local communities and decision makers by making the technical and scientific information clearer for decision markers and by listening up local communities' desires. At least to me, this is the way forward to ensure success in conservation initiatives in human-dominated tropical forests.

10. Did you use the RSGF logo in any materials produced in relation to this project? Did the RSGF receive any publicity during the course of your work?

No, I did not use the RSGF logo, but acknowledged the RSG number 40.08.08 in all scientific articles relative to this project.

11. Any other comments?

I am extremely grateful to Rufford Small Grant Foundation for funding this study. The flexibility in the use of the funds was critical to improve the interpretation of the results and their further publication in national and international journals. Thank you so much RSGF.