

### The Rufford Foundation Final Report

Congratulations on the completion of your project that was supported by The Rufford 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	Vanessa Gabrielle Nóbrega Gomes					
Project title	Reproductive ecology of cacti species from the Brazilian Chaco: implications for conservation					
RSG reference	18851-1					
Reporting period	February 2016 to February 2017					
Amount of grant	£ 4991					
Your email address	vnobrega.gomes@gmail.com					
Date of this report	April 2017					



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
Reproductive phenology				We expanded our reproductive phenology monitoring and sampling from six to 10 cacti species. Our intention was to monitor all species recorded in the Brazilian Chaco. However, some species did not present enough individuals with reproductive age. Our data shown species with extended and/or continuous flowering and fruiting periods.
Flower and fruit traits				We characterised floral and fruit traits for six cacti species, as initially proposed. The traits analysed were: flower color, external corolla length, internal corolla length, corolla diameter, anther height, stigma height, ovary length, stamen number, ovule number, ovary diameter, fruit colour, seed colour, pulp colour, seed set, length, diameter and weight of fruit and seed.
Floral biology, breeding system and nectar dynamics Focal observations and				We measured flower morphology, period and duration of anthesis, odour emission, pollen viability and stigma receptivity, breeding system experiments, and nectar dynamics for six species according to the initial proposal. Self-incompatibility was more representative among species. Accumulated nectar ranged 74±43.5µl, [%] = 21±2.5). With a sampling effort of 96 trap-



camera trap		nights and 120 hours of focal
(monitoring of visitors)		observations, we observed ca. 2300
		interactions between visitors and
		different cacti species.
Identification of floral and		All collected animals and
fruit visitors		photographs were identified by
		specialists of each animal group.
		The list includes 18 species.
Pollen load		We captured different visitors using
(animals captured with		both light traps and mist nets. We
light traps and mist net)		mounted histological slides with the
		pollen loads removed from the
		body of these animals. We have
		already processed part of the
		samples and an undergraduate
		student is helping to finalise pollen
		counts. This result, along with the
		frequency of visits, will be used to
		build a weighted network.
Pollinator exclusion		This was carried out especially for
experiments		two species Echinopsis rhodotricha
		and Stetsonia corvne, which have
		prolonged anthesis. We hoped to
		find a mixed pollination system with
		both diurnal and nocturnal visitors
		Our preliminary results showed a
		complete lack of primary pollingtors
		(nocturnal) with a low visitation rate
		by two moth species. In fact, diurnal
		pollingtors especially bees are
		ensuring the reproductive success of
		these species in the Brazilian Chaco
		Other statistical analyses of
		affectiveness will be conducted
		taking into account components
		that are still being processed such
		as pollon load of oach visitor
Network analyses		Since our network analyses is
		augntitative we will join pollon load
		data (still processing) with the visitor
		frequency to perform these
		nequency to perform these



		analyses. Since we are still missing
		some date, we have not yet
		performed this analysis.
Number of cacti		We increased the number of
species in the Brazilian		species occurring in the Brazilian
Chaco		Chaco. We have updated the list of
		species and information on
		ecological aspects, geographical
		distribution, and conservation status.
		However, with more collections this
		number could increase.
Field guide		Sharing our knowledge with the
		community is an important part of
		this project. Our results about cacti
		and their mutualists their
		importance, and their main threats
		were presented to local community
		(children, farmers, schools).
		Additionally, we will continue these
		actions with an illustrated field guide
		about cacti species from the
		Brazilian Chaco, which will be
		distributed in schools and to farmers.

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

Initially, we had some difficulties when we arrived at the farms. The farmers showed a lot of resistance in allowing us to conduct the research on their land, especially because our work involves monthly monitoring, with samples collected both during the day and at night. After explaining our research and talking to the farmers we overcame this difficulty and we were able to enter their properties.

Overall, we had no major difficulties during the fieldwork, however, our major problem was finding enough reproductive individuals to conduct the reproductive system experiments. Consequently, we were not able to monitor the aspects of reproductive ecology for all the cacti species in the Brazilian Chaco, since we registered only a few individuals for some species, making several experiments unfeasible. We had great difficulty in finding cacti species with enough individuals bearing flowers and fruits. In other words, we observed a reduced availability of individuals in reproductive stages (see updates: November 2016). Thus, we concentrated study efforts of reproductive ecology for those species that had a



sufficient amount of reproductive individuals. Due to our effort to find a minimum number of individuals for certain species, we registered new species and increased the total number of species listed for the region.

The Brazilian Chaco does not have any conservation units, so this project is carried out in remnants of vegetation located on private property. We collect in areas of legal reservation on these properties, and represent a percentage of the property that must be maintained with native vegetation which is protected by the Brazilian Forest Code. Although no cacti have been removed in the areas where we study, the actions in surrounding pastures affect the functioning of the ecosystem as a whole, which has implications for our results. Our goal is to bring awareness about negative effects of deforestation so such actions no longer occur in the region.

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

- 1- In this project we increased the species richness of cacti occurring in the Brazilian Chaco. Sixteen cacti species were identified, including columnar (8), globose (3), coplanar (2), epiphyte (2) and shrub species (1). The major threat to these species is increased deforestation due to the conversion to pasture. Studies focusing on ecological and evolutionary aspects of pollination and seed dispersal processes of cacti are very common in arid and semi-arid tropical habitats, however, to the best of our knowledge, there are no such studies with cacti in the Brazilian Chaco. Currently, studies on the reproductive biology of cacti cover less than 20% of the 260 species that occur in Brazil and are concentrated in the northeastern semi-arid region (Caatinga). Therefore, we assume that our project has contributed to the understanding and conservation of cacti species, because we have expanded the results and understanding of the interactions between cacti and their mutualists beyond the eastern Brazil. With the results of this study we are beginning to fill the knowledge gaps for the Midwest cacti according to Pan Cactaceas (http://www.icmbio.gov.br/portal/images/stories/docsplano-de-acao/pan\_cactaceas/livro\_cactaceas\_web.pdf).
- 2- Most of the cacti species studied have extended or continuous flowering and fruiting phenophases and nocturnal white flowers, although we have also recorded diurnal flowers with yellow or red colours. Their fruits are attractively coloured berries. Flowers and fruits are visited by different animals (ants, bees, beetles, birds, hummingbirds, moths), which potentially act as pollinators and seed dispersers. We expected mixed pollination systems in cacti species with prolonged anthesis. These cacti species presented primarily nocturnal anthesis, however results of our pollinator exclusion experiment showed that these species ensure their reproductive success mainly through daytime (secondary) pollinators. There were significant differences in the fruit set, fruit



size and number of seeds produced after diurnal and nocturnal visits, with diurnal visitors being significantly more effective. Nocturnal pollinators seem to have a low contribution for the reproductive output of cacti species in the Brazilian Chaco. *Melipona orbignyi, Xylocopa splendidula, Heliomaster furcifer* and *Apis mellifera* are important pollinators in the Brazilian Chaco. Bird species Cacicus chrysopterus and Cacicus solitarius, hummingbird species *Hylocharis chrysura* act as floral robbers/thieves, consuming nectar without pollinating flowers.

3- We reported flower consumption of Echinopsis rhodotricha by Mazama americana (deer) and Pecari tajacu (peccary) in the Brazilian Chaco. Florivory can negatively affect reproductive success of plants due to its effects on fruit set. We quantified and compared fruit set between damaged and undamaged flowers in a natural population of *E. rhodotricha*. The florivores consumed whole flowers and no fruits developed. Our results indicated that florivory decreased fruit set in the studied population, both directly, by damaging ovary/ovules and indirectly, by reducing floral attractiveness and rewards for pollinators. We highlight that these records increased our knowledge about florivory for Cactaceae, which included mostly invertebrates. Vertebrate florivory and absence of effective pollinators could have negative impacts on the reproductive success of *E. rhodotricha*, drastically reducing their fruit set.

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

We executed different activities by giving talks at schools and to farmers, as well as by presenting our results to the local community. We contacted and received help from the farmers to alert the people to help us and keep the camera traps and discussed the importance of their collaboration and our project. In some schools, we were invited to participate in future activities, such as science fairs, to divulge our field guide. All this contact allowed us to introduce the importance of cacti conservation to maintain their life quality and local diversity, always valuing more the flora and its interactions with the fauna of the region. In this project, we made special connections with some farmers, farm employees, and their families (wives and children). One especially touching experience was when we received a letter from a child who said that she thinks our work is very important and we should continue doing it and that she hopes to become a biologist.

#### 5. Are there any plans to continue this work?

Yes, this work is part of my PhD project that is under way and currently in its third year. Fieldwork was intensified with the Rufford support and I still have one more



year to process and analyse my data and write the thesis until March 2018. After finishing my thesis, I intend to do a postdoctoral project in the Brazilian Chaco, using a genetic approach to evaluate the pollen flow of two cacti species (Frailea spp.), which are greatly affected by deforestation and listed as threatened and vulnerable, with consequent negative effects for reproductive success. Additionally, I intend to advise a student on a study focused on florivoria and its effects on the reproductive success of Echinopsis rhodotricha, through exclusion experiment of vertebrate florivores. I believe that this approach will produce interesting results. With the help of the field guide I will continue an environmental education plan with several awareness actions for the local community (students and farmers). Additionally, lectures to farmers and the local community, focusing on the importance of mutualistic interactions, are strategies to engage the local population in conservation activities. I believe this will facilitate the planning of basic guidelines to start an effective action plan for cacti conservation and management in this environment. These efforts can also help with the o implementation of a protected area in the Brazilian Chaco, which currently does not have any.

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

We have already started to disseminate our results through publication of a scientific article in a specialised journal. We also have been sharing our results with schools and farmers in Porto Murtinho region through presentations about threats to cacti species and how we can help preserve them. We also presented a poster at a pollination symposium in Goiás - Brazil). Other meeting, conferences and events (examples: ATBC 2017 https://www.atbc2017.org/ and Symposium on Ecology and Evolution of Plant Reproduction http://plantevol.sites.ufms.br/) are planned. We also expect to publish at least two scientific articles in peer-reviewed journals and write popular science articles for Cactus and Succulents Journal and Revista Ciência Pantanal. Additionally, the information generated in this project will complement my PhD thesis.

## 7. Timescale: Over what period was The Rufford Foundation grant used? How does this compare to the anticipated or actual length of the project?

Data collection started in October 2015 when I submitted my proposal to Rufford Foundation. However all activities regarding fieldwork were intensified from February 2016 after receiving the grant, which was essential for acquiring equipment (especially camera traps) and field assistance. The grant intensified my fieldwork and collection because I had the autonomy to stay in the field for more time, especially during the flowering and fruiting peaks of the species. Now, I hope to conclude analyse of all data and provide all summarised results in my PhD thesis.



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	Actual Amount	Difference	Comments
Fuel (diesel)	745	784	-39	During the year there was a price difference due a variation in the tax per litre of diesel.
Lodging + food	2880	2640	+24 0	Received discount on bedroom rental for several days each month. Therefore, the money was used to buy another camera trap and more copies of the field guides.
Mist nets	200	198	+2	Within the expected cost.
Head flashlights	50	50	0	Fully spent.
Leather gloves	30	22	+8	The gloves were less expensive than I initially considered.
Light traps + battery + battery charger	120	69	+51	We only bought the light traps. We saved some money by borrowing battery and battery charger from another project in the lab.
Camera trap	500	620	-120	We used part of money saved with lodging to buy one more camera to increase sampling effort.
Entomological net	50	50	0	Fully spent.
Voile bags	30	30	0	Fully spent.
Cotton bags	40	40	0	Fully spent.
Alkaline batteries (AA)	46	46	0	Fully spent.
Field guide (500 copies)	300	450	-150	Spent a little more money than initially considered. Our initial idea was to produce 300 copies, however, we use part of the money saved on lodging to request another 200 copies and to provide the information to



				more people.
TOTAL	£ 4991	£ 4999	-8	The grant was converted from pound sterling to US dollar. Total = 6.921,94 USD. Local exchange in 22/02/2016: 1 USD = 3,85 Brazilian real

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

The most important steps are to conclude analyse of all data, provide all summarised results in my PhD thesis, and publish two more papers during 2017. We will continue to monitor the endangered species (*Frailea* spp.), strengthening responses of a long-term study. The long-time monitoring of mutualistic interactions facing impacts of deforestation is very important to understand specific processes and discuss ecological and evolutionary implications involved in these relations. Our study represents a starting point for better understanding interactions between cacti species and their mutualists in the Brazilian Chaco. Finally, we consider educational and scientific divulgation strategies as an excellent opportunity to emphasise conservation actions with the local community. In practice, it is important to continue promoting meetings with the population of Porto Murtinho, in order to convince the local community to put into practice the actions addressed in the field guide and how to assist in the conservation of cacti, therefore reducing the harmful effects caused to these plants. Through the participation of the local community, we can stimulate attitudes to maintain their life quality and local diversity.

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

Yes, the RSGF logo and RSG reference were cited in all my activities. I used RSGF logo on a poster presented at a symposium in Goiás – Brazil, slides for seminary presentations about the project at Federal University of Mato Grosso do Sul, as well as in the talks at the schools and to farmers in Porto Murtinho. Additionally, I will acknowledge RSGF in all papers related to this project, a poster submitted to ATBC 2017 – México (I'm waiting for abstract acceptance https://www.atbc2017.org/) and another poster (Pollination ecology of Stetsonia coryne: a bee-pollinated columnar cactus in the Brazilian Chaco) accepted for presentation (24, 25 April 2017) at the Symposium on Ecology and Evolution of Plant Reproduction (http://plantevol.sites.ufms.br/). Also, RSG has been acknowledged as funding source in my PhD thesis, in a paper published in the journal Plant Ecology (DOI 10.1007/s11258-016-0659-9), and in the illustrated field guide.



## 11. Please provide a full list of all the members of your team and briefly what was their role in the project.

#### 12. Any other comments?

I am very thankful to Rufford Foundation for financial support for this project that is contributing to cacti conservation initiatives in the Brazilian Chaco. Without this funding this work would be unfeasible. Thanks for investing in cacti ecology and diversity conservation. Thanks so much Rufford Foundation, you have allowed us to go forward with this important work.