

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 | Lucas Nicioli Bandeira |
| Project title | The role of ecological niche evolution on diversification of Neotropical treefrogs and on potential impacts of climate change |
| RSG reference | 23763-1 |
| Reporting period | 2017-2018 |
| Amount of grant | £5000 |
| Your email address | azebandeira@gmail.com |
| Date of this report | 4 th January 2019 |

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 |
|---|--------------|--------------------|----------------|--|
| Data collection: "visits to collections and museums" | | | | At the end of this stage eight, museums or collections were visited. Seven were Brazilian institutions (five based on the southeast region and two in the northern region) and one North American. A visit was added to the planned total and two exchanges were made: the collection of the University of Brasilia – UNB, Brasilia, Federal District, Brazil by the Museum of Natural Sciences of Pontificia Universidade Catolica de Minas - PUCMG, Belo Horizonte, MG, Brazil and the scheduled visit to the American Museum of Natural History in New York by the Natural History Museum at the University of Kansas - KU. |
| Data collection: "obtaining data in the scientific literature" | | | | Scientific journals whose scopes are related to the theme of the project were accessed to obtain records of occurrence for the species of interest and thus complement the datasets. It is worth mentioning that the records acquired with this type of search were actually added to the "final" set of data if the information made available could be confirmed. |
| Data validation: "taxonomic checking" | | | | This step, among the two components of the validation process, was the one that identified the largest number of errors. Of the 2949 specimens accessed and analysed in the collections, 323 presented taxonomic designations that were not consistent with the formal descriptions. More than 90% (207 out of 232) were immediately corrected; the remainder (given the |

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| | | | greater complexity of these cases) was evaluated by PhDs and researchers in the taxonomy and distribution of the group (Delio Baeta & Boris Blotto). |
| Data validation: "georeferencing" | | | After taxonomic validation (see above for more detail), all the spatial information (geographic coordinates) made available and linked to each of the specimens (e.g. collection site, municipality, etc.) were tested for their validity. For the accomplishment of this task were used free and broad access software like Google Earth © and QGIS ©. Despite the large number of records collected, we found only four georeferencing errors that prevented such records from composing the data set. |
| Final data preparation: "Data-Cleaning" | | | As our intention has always been the construction of the best possible niche models (i.e., models that represent the phenomenon of interest in the most faithful way), we have added and developed this stage, although it is not contemplated in the initial proposal. Briefly, the cleaning process consists in eliminating spatially close occurrence records to at least reduce potential spatial autocorrelation between the data. As extensively highlighted by other studies, autocorrelation between data can lead to errors in analyses that culminate in erroneous interpretations of the data. Therefore, we believe that the process of data cleansing, such as the one used here, is valid. |
| Construction of ecological niche models: "employing the formalism of modelling" | | | Through the successive application of analyses that characterise the formalism of ecological niche modelling - ENM we obtained, with total confidence, the best models possible for each of the species contemplated in the present project |

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| | | | | (given the number of records and the specific selection of environmental predictors). Such quality and refinement were achieved thanks to the recently developed "KUENM" modelling package. Grouped in this package, the three main phases of the modelling: calibration, evaluation and final models creation are automated which allows the creation of massive quantities of models (specifically for my project, on average 8000 models for each species) through the combination of different parameters and sets of environmental predictors. As highlighted above, this possibility of evaluation and selection among a large number of candidates leads to obtaining the highest quality models. |
| Post-modelling tests: "Phylogenetic Niche Conservatism- PNC" | | | | Tests that are conventionally called post-modelling tests have not yet been fully developed. In contrast, the "PNC test", the first one, was started. The conservatism test consists basically of mathematical comparisons between values that correspond to the ecological requirements of the species (and therefore represent their niche) and statistical tests to evaluate whether such comparisons are more or less similar than those expected at random. As it is necessary to have all the niches characterised to carry out their comparisons (characterization done with the modelling), this step corresponds to our next steps. |
| Post-modelling tests: "The Ecological Divergence" | | | | |
| Outcome: "The Real Impact of Climate Change" | | | | Considered as the outcome of the project, this step brings, together with the potential inferences, the possibility of applying the |

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| | | | <p>knowledge acquired in practical conservation issues. Especially, from the concatenation of the information previously obtained with respect to the evolution of the niches of the species (i.e., if the characteristics that define them are conserved or diverge along the evolutionary time), we will create an index that incorporates this ecological lability and, possibly, would have made predictions for future climate scenarios more accurate. This increase in the quality of the predictions, in turn, would allow the access to a more reliable scenario of the impacts of the climatic alterations.</p> |
| <p>Outcome: "Updating the conservation status of species and analysing the efficiency of Conservation Units"</p> | | | <p>With the ecological models resulting from the intensive construction and selection routines, we will construct potential models of distribution for each of the species with high power of discrimination (presence and absence). This higher quality of information regarding the distribution of species, among other applications, will support updates on the conservation status assigned to each of the biology entities studied here. It is worth remembering that such updates are long overdue since many of the species are in categories that do not really correspond to the real threat they face. In addition, many species are still categorised as data deficient, highlighting the urgency of these reconsiderations. Finally, with access to the most probable scenario of ecological outcome of the species (if faced with climatic changes the populations will make displacements in an attempt to follow their necessary ecological requirements or will be able to deal with the changes due to high ecological lability), we will be able</p> |

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| | | | to access, in a more objective way, the actual efficiency of the existing conservation unit, as well as having scientific and technical background to propose changes or suggest the creation of others. |
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2. Please explain any unforeseen difficulties that arose during the project and how these were tackled (if relevant).

During the 1-year period, corresponding mainly to data collection, construction of niche models and initiation of post-modelling analyses, only two unforeseen difficulties appeared. The first one is of a more logistical nature and the second is related, in fact, to the development of the project.

Despite the efficiency of The Rufford Foundation team (RF hereafter) throughout the entire process from the analysis and selection of the project to the sending and deposit of the amount in my bank account, in the middle of 2017 the Brazilian Federal Government modified some of the laws related to the country's economic policy, which, in the end, had a direct influence on my project, delaying the receipt of the amount donated. In spite of this unforeseen event, the schedule for activities after receipt of the award was not affected.

The second unforeseen on the other hand had a more incisive negative effect since it made impossible the accomplishment of one of the visits that had been programmed. As explained in more detail in the proposal that was presented, each of the collections and / or museums were selected based on an objective criterion related to the largest number of species and specimens per species collected in each institution. This selection was based on the information of the collection (acervo) that was requested from each curator or administrator of each interest collection via email. In total, 56 collections were contacted throughout the Americas. Due to the greater occurrence of the species of interest in Brazil (some of them endemic to this country), the largest number of collections contacted were Brazilian. Not surprisingly, the vast majority of e-mail was cordially answered. However, two of the total number of Brazilian institutions contacted did not respond to my requests (more than two attempts were made for each collection) and, unfortunately, in these cases, solutions were not achieved and such collections were excluded.

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

Firstly, the study will bring novelties about the biodiversity patterns in the Neotropics since it is the first work done with this species complex. The study has the potential to advance in the understanding of the origin of these patterns and, through the emphasis that will be given here, of the processes and mechanisms involved. Therefore, the contribution to the theoretical field justifies briefly the realisation of this proposal and the value of their results.

Second, the results provide information that can be used as a basis for planning effective conservation strategies as well as guiding management decisions (e.g. the creation of conservation units like parks or reserves). Efficient conservation measures require that decision-making be based on information as refined as possible; the definition of the niches through the formalism of ecological modeling supply this need for refinement and make possible a robust foundation of the public policies for conservation. In addition, the application of the new methodology proposed and that will be developed with this project will allow access, in a more real way, to the real impacts that the species will face as a consequence of the climatic alterations. The existence of this possibility would allow more robust access to the efficiency of the mitigation measures already established as well as support the development and proposal of other.

In addition, the compilation of the information will be propagated to non-academic media to promote environmental education given the mounting pressure on wildlife resources induced by burgeoning human populations and, consequently, destruction of habitats.

Finally, we consider relevant to emphasise the importance of biological collections and museums. The collections not only preserve the information through vouchers deposited, but also accumulate and concentrate the knowledge acquired over time which, in turn, allows the construction of the mega database. Currently, more and more studies are developed using only data from these banks that quickly show us its importance. Therefore, through the dissemination and potential repercussion of the present work and its results, we intend to generate support for a reconsideration of the role of these collections in the national and international research scenario.

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

We can define two different, but complementary, types of involvement of local communities based on whether the involvement had (or has) direct influence on project development. In the middle of February of 2018 two expeditions to the field were carried out. Each of these expeditions happened in specific localities and had as main objectives the confirmation of activity and identity of the species *Pithecopus hypochondrialis*. As part of the team, three community members were contracted to perform the following specific roles: field guide and cook. Given the lack of resources in these communities and the economic difficulties of the people who are part of them, we believe that, despite being simple and for a short period of time, such interaction has provided the least amount of help.

In addition, we seek to involve as many community members as possible in theoretical and practical activities indirectly related to the project. Lectures were held in both communities, highlighting the main points of my work, the importance of species conservation and the ecological system in which the community is inserted. As a latent theme, I tried to address how conservation would provide direct benefits to the community, such as ecotourism. Additionally, as an idea resulting from these expeditions, but still in development, we intend to produce a herpetofauna guide

(book) of some areas (covering such communities); we believe that the production of this type of document can also benefit the communities by highlighting them, its people, its diversity biological and culture.

5. Are there any plans to continue this work?

Yes. Firstly, because the steps completed here correspond only to the initial phase of the project (collection and validation of records of occurrence and construction of ecological niche models) (see item "1" for details) and define 2 of the 4 years allocated to project development. Following, which corresponds to the part of interpretations, inferential and analysis of my doctorate (conventionally called the post-modelling stage), are in the initial phase of development both by the acquisition of some theoretical basis through theoretical-scientific reading and completion of courses as well as the development of some of the analyses.

Secondly, for a future not so distant, there are plans and possibilities for exploring questions related to my project or the same theme for all the species of the Phyllomedusidae family. This idea had its genesis during my stage abroad with professor and co-supervisor of this project Andrew Townsend Peterson and was fruit of the difficulties and suggestions then faced in the development of my thesis. Such ideas would be developed in a new postdoctoral level project.

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

This project has already been disseminated through three lectures given by the research leader. The first one was held in May 2018 at the Amazon Research Institute - INPA, Manaus, AM, Brazil in compliance with the invitation made by the coordinating team of the "Ciencia com Certeza -CC" program. The CC consists of a perennial cycle of lectures organised and carried out, mainly, by masters and doctoral students of the post-graduation programme in ecology of INPA that is destined to the students of this program as well as to undergraduate and graduate students belonging to others programmes and even other state and federal institutions. The second lecture was given to an audience composed of students of the Biological Sciences and Ecology degree course of the Universidade Estadual Paulista - UNESP, Rio Claro, SP, Brazil as part of the lectures and courses offered at the biology studies week of that university. Finally, the third one consisted of a presentation of the ideas and objectives of my project to the students of the Laboratory of Macroecology and Evolution of the University of Kansas - KU, Lawrence, KS, United States of America.

Complementary, frequent updates have been carried out in the platform of scientific dissemination Research Gate; This platform has wide acceptance in the scientific community mainly by reducing the barriers to access information, speeding the contact between researchers and accentuating debates, exchange of experiences, ideas and information. Therefore, I believe that the existence of a specific home portal about this project contributes in a robust way to its dissemination and improvement.

In addition to these disseminations, I will disseminate the results referring to the first chapter of my thesis at the XV Brazilian Congress of Herpetology through a lecture

and a visual presentation (poster). In addition, the presentation of some other results in the XIV Brazilian Congress of Ecology is included in my plans.

Aiming to reach the non-academic population, we began in the middle of the second semester of 2018 to establish contact with publishers of Brazilian non-scientific journals of wide access (as for example, Science Today, Super Interesting). We believe that the dissemination of information obtained through the development of the project is of general interest and should be public knowledge. In fact, we believe that the theme related to the real impacts of climate change on continental biodiversity (or at least some species belonging to it may have broad repercussions and acceptance.

Finally, we intend to reach a considerable share of the scientific community through high impact publications. In fact, the construction of the initial stages of some of the manuscripts has already begun; and it is of extreme interest to the author and the other component members of his research group that the results are gradually published until the end of my PhD.

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

The amount requested with the RF was used, as justified in the submitted proposal, for the accomplishment of the visits to the collections and museums. All expenses related to these expeditions (air and land transportation, lodging and food) were paid for with the amount donated. In all, eight institutions (seven Brazilian and one North American) were visited throughout the period, not sequential, from April to November 2018. The schedule defined at the beginning of project development (approved by my advisors and by the board of faculty members of the PPG-ECO evaluation commission, INPA) was fully complied and no drastic changes were required which could jeopardize the activities.

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 |
|-----------------------|-----------------|---------------|------------|--|
| Airline / Bus tickets | 2250£ | 2250£ | | As the visits were pre-programmed the tickets to the locations in which the collections / museums are based were also acquired with a certain advance. This practice avoided high prices, mainly for the air passages. |

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| Accommodation | 1250£ | 1250£ | | As for airfare / land ticket purchases, the booking of rooms in hostels or private houses (e.g. AirBnB ©) were also made in advance. This practice avoided the inflation of the previously established budget. |
| Food Supplies or Alimentation | 750£ | 800£ | -50£ | As food products are subject to frequent variations anywhere in the world, our previously defined budget has undergone a variation. However, as we can see this variation was not as different from the initial request as I have tried to keep strictly within what was initially proposed. |
| Field Assistant | 500£ | 0 | +500£ | As field trips were carried out jointly with other expeditions, referring to other projects under development, the costs originally foreseen for these activities were extinguished. As a result, we obtained an "extra" revenue that was used to purchase other items (see below) |
| Fieldwork food supplies | 250£ | 0 | +250£ | Same comment above |
| USA TRAVEL'S documentation (VISA, Health insurance etc.) | 0£ | 700£ | -700£ | For the conclusion of the data collection and construction of niche models as already highlighted in the above, I completed a training course at the Natural History Museum of the University of Kansas – KU, Lawrence, KS, USA. To do so, it was necessary to obtain an American visa from the embassy in Sao Paulo, SP, Brazil and the contracting of health insurance. Both items added an expense not foreseen in the initial proposal; however, thanks to the relocation of the amounts donated, I was able to pay such expenses and carry out the totality of the proposed activities. |
| TOTAL AMOUNT | 5000£ | 5000£ | | |

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

The next steps are definitely important because their developments will allow us to reach the next results, access the next questions and successfully complete my PhD.

Namely, as a next step I will finish the comparisons between ecological niches. This post-modelling analysis aims to quantify the degree of similarity between pre-determined specific ecological characters (i.e., niche) between sister-species, i.e., through a sequential set of analyses tests the degree of niche phylogenetic conservatism (PNC). In general, the PNC test investigates whether these characters are more similar between the two species being compared to what we would expect at random, which, by theory, suggests conservatism. In addition, we will apply other sets of analyses that aim, unlike the first one, to access the degree of divergence between the pre-determined ecological characters.

With the combined information of these two different but complementary types of analysis we will be able to develop a new indicator and a new methodology of analysis through the incorporation of this index in ecological predictions for future scenarios. As previously pointed out in questions "1" and "3", such methodology has a high potential for solving a methodological problem intrinsic to modelling and prediction for future (i.e., the premise that niches are conserved over evolutionary time for any and all the species). As emphasised by a considerable amount of recent studies such a premise is not always true and therefore has led to erroneous conclusions in several works and added some degree of discretion to this analytical formalism. Briefly, with access to information on "behaviour" (if the niche has been preserved or changed in the evolutionary history of each species), predictions for the future have the possibility of being more reliable to the real scenario by which species passed and, with some optimism, such a methodological change would allow access to the impacts of climate change in a more faithful way.

Finally, for a future not so distant, the next steps are the compilation and logical organisation of all the information obtained during the development of the parts (chapters) components of the thesis, which we hope to result in scientific articles. From then on, disseminate these results to the widest possible spectrum, i.e. including the scientific community, managers, public administrators, etc. As an integral part of the initial proposal and latent goal of the project we hope that our future results will be incorporated into future reconsiderations regarding the conservation status of these species as well as the use of this information as a support for the development of new conservation policies and measures to mitigate the loss of Brazilian and South American biodiversity.

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?

We used the RF logo in all lectures and informal exposition of any subject related to this project. It is worth remembering that we will be grateful for the foundation in all

the publications resulting from this work and in the final written version of the doctoral thesis.

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

Lucas Nicioli Bandeira. PhD candidate at National Institute of Amazon Research – INPA, Manaus, AM, Brazil and at Natural History Museum, Biodiversity Institute of University of Kansas – KU, Lawrence, KS, United States of America.

Status: Leader and principal investigator of the project. Lucas is the main responsible for the all phases of the project.

Marina Ancaes. Evolutionary Biology and Animal Behavior Lab. – LABECA, National Institute of Amazonian Research – INPA, Manaus, AM, Brazil.

Status: Lucas' PhD advisor.

Marina is an ornithologist with an interest in animal behavior, geographic distribution and ecology of species including conservation biology. Specifically, the researcher works and maintains under her supervision graduate students who develop issues on diversification and speciation at the ecological, behavioral and molecular levels. The professor is committed to the project since its genesis. She was responsible for valuable contributions (from suggestions on scientific literature to ideas on application of methodologies and analyses) even before the approval of the student and the research to integrate the body of students and research being carried out at PPG-ECO, INPA. As coordinator of the Laboratory of Evolutionary Biology and Animal Behaviour - LABECA, laboratory to which I belong, Marina actively contributes with new suggestions, helps in solving diverse problems and in establishing partnerships. She is an expert on the theory that supports the construction of ecological models and the application of ecological modelling methodology (methodology that is actively used in this project) and, together with the other members of the project, is responsible for the idea, improvement and construction of the index of ecological lability and the new methodology that we propose for the accomplishment of better ecological predictions for future scenarios of climatic alterations.

Fernanda de Pinho Werneck. Adjunct researcher and vice curator of the herpetological collection of the National Institute of Amazonian Research – INPA, Manaus, AM, Brazil.

Status: Lucas' PhD co-advisor.

Fernanda's main research lines integrate ecological and evolutionary approaches to investigate the processes responsible by patterns of diversity, genetic variation and diversification of Neotropical amphibians and reptiles.

Like Marina, the professor was present in the initial stages of development of this project. She was one of the members of the INPA's project selection committee that evaluated this project prior to its approval and, consequently, made numerous contributions to its improvement. Given her active participation and incisive contributions, I believe it was worth inviting her to officially be part of the research team. Fernanda has immense experience and works of the highest quality in topics

such as: Phylogenetics, Phylogeography and Conservation Biology; fields closely related to the issues of my work.

Andrew Townsend Peterson. University of Kansas Distinguished Professor. Research Center – Ecology & Evolutionary Biology. KU Biodiversity Institute, Lawrence, KS, United States of America.

Status: Lucas' stage abroad advisor and Lucas' PhD co-advisor.

Peterson's main research lines focuses on aspects of the geography of biodiversity, with a focus on tropical ornithology and systematics, distributional ecology, and disease transmission risk mapping. My group of students and colleagues is diverse and global, including people interested in the three themes of my interests, from many countries and backgrounds. Specifically, his work with the geographic and ecology of species' distributions has taken him into other fields, including conservation biology and planning as well as invasive species biology.

Here I must highlight the importance that this partnership established between my group in Brazil and the group of Professor Townsend Peterson assumes. Given the relevant role that modelling has in this project, the orientation received by me by one of the creators and most active researchers of the area (both in the improvement of the methodology, proposition of new and through the theoretical lapidation), is configured as a unique training, whose resulting learning will produced extremely positive results.

Specifically, during the three-month period corresponding to my internship abroad Professor Townsend contributed to the development of the project in a number of ways. At the beginning, the exchange of ideas and discussions led to the definition of outstanding issues as well as to the improvement of pre-existing questions. Regarding the methodology, the modifications and suggestions were positively more incisive. For example, we decided (for various reasons highlighted in question 1) to use the "KUENM" package for the construction of our models. Consequently, the best models for the species studied here have been constructed and will definitely lead to a more refined resolution of the issues addressed. In addition, we started the development of the ecological lability index, which, although still in its initial stages, shows signs of great potential. Given the timid progress we have made particularly for this stage, a new visit is being programmed to Professor Peterson's laboratory for a full development of this idea and methodology. Therefore, reiterating its potential, we believe that the investment of time and resources is valid and justified.

Delio Pontes Baeta da Costa.

Status: project's collaborator

Delio has been working with the Phyllomedusidae family, their genera and species since graduating in Biology from the Federal University of Ouro Preto - UFOP, Ouro Preto, MG, Brazil. Throughout his career as a researcher he has developed and still develops papers addressing the most different issues related to the most diverse areas of knowledge (ecology, genetics, taxonomy, etc.) for the species allocated in this group. Since his doctorate he has focused on the elaboration of phylogenetic hypotheses aiming to understand the relationships of parentencos among these entities. Due to the vast knowledge of the researcher about the evolutionary history

of the component species of this family, besides knowledge about the taxonomy and distribution we deem it valid to invite him to participate in the team once his contributions will raise the quality of our results. Specifically, Delio contributes with revisions, construction of ideas, suggesting books and scientific papers for reading, resolution of problems related to taxonomy and distribution, and especially with phylogenetic calibration (making data available) as well as in its interpretations.

Fabricio Villalobos. Evolutionary Macroecology Lab., National Institute of Ecology – INECOL, Xalapa, Veracruz, México.

Status: project's collaborator.

Fabrício focuses on the intersection between macroecology and macroevolution, considering macroecological patterns under an evolutionary perspective and evolutionary patterns and processes on a spatial context. In short, he works with macroecological theory and methods integrating macroecology with phylogenetic approaches to understand geographic patterns of biodiversity. He is also part of the Ecology & Evolution and Animal Biodiversity Graduate Programs of the Universidade Federal de Goiás - UFG, GO, Brazil. In addition, Fabrício participates in the Applied Geographical Ecology group and Latin American Network for the study of Neotropical Biogeography (Red-Bion).

The professor has participated in the construction and lapidation of the project, suggestion of appropriate methodologies to solve specific issues, targeting macroevolutionary and macroecological interpretations, among others. With several works of high impact in areas such as Macroecology, Evolution, Conservation, Biogeography etc., his participation as an official member of the team of researchers of this project is more than justified. Specifically, the collaboration consists of guiding me in the "construction" of potential historical scenarios that will support my interpretations regarding the ecological-evolutionary processes that led to the diversification of my target group. In addition, how was planned and justified, I intended to do another stage abroad at the National Institute of Ecology - INECOL, Xalapa, Vera Cruz, Mexico where Fabricio is currently a professor. At this stage Fabricio would be my supervisor and the activities, briefly explained above, would be completed and, if necessary, improved.

12. Any other comments?

I would like to enhance the importance of The Rufford Foundation for conservation research and researchers in undeveloped countries. Especially in Brazil, we are passing by a political crises where funds to research are been reduced by 50%, while the oxen/agricultural pressure is increasing. In this scenario, young researches have every time fewer chances to get grants for development their researches and carrier. So, initiatives like RF are enabling that we, undeveloped countries ecological, evolutionary and conservation researches, can do high level research in ecology and conservation on threatened environments and species.