Final Evaluation Report

Your Details	
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Project Title	Plant-Pollinator Interactions in the Endangered Campos Rupestres: The Role of Plant Diversity for the Conservation of Endemic Species
Application ID	36234-1
Date of this Report	06/03/2024

1. 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
(I) Our objective was to increase knowledge about the reproductive system of plants that occur in the Campos Rupestres of Brazil. Specifically, we aimed to identify these plants, understand their pollinators and the dependence of the plant for these pollinators, what resources are provided by these plants, and what do we know about the				The field experiment ran from September 2022 to April 2023. During this time, we found 71 plant species of 30 plant families. We recovered 404 interactions to 32 of 71 plant species. For these species we took data about resource, pollinator dependence and pollen limitation. Using the Brazilian database on these species we did not find information about extinction risk for 62 plant species. The pollinators were diverse, with bees, butterflies, flies and hummingbirds. To us, one of the challenges to conservation of the plant community is to aggregate more data about the plant species.

risk of their extinction.				
(II) Our objective here is to identify how the reproductive success of endemic and threatened plants are related to the diversity of pollinators and other plants sharing mutualists in the megadiverse and threatened environment of Campos Rupestres.				The data collected was enough to understand the objective. We could build a network using the plant-pollinator interactions. With the parameters of the plant species we could propose the species important to the maintenance of the community in the Campos Rupestres. We see the importance of different species of pollinators and reinforce the flies importance on the rupestern fields. Now, we are making the manuscript to scientific report of this information.

2. Describe the three most important outcomes of your project.

a) There is a big diversity of plant families and species in Brazilian Campos Rupestres. Therefore, there is a diversity of floral morphology and reproductive patterns. The most species that we found had no pollinator dependence and, in general, received visits from more pollinator groups. Therefore, the pollinators shared between the species is an important feature of the Campos Rupestres. These aspects are essential to consider when we propose conservation strategies.

b) There are many groups of pollinators on the rupestern field: bees, butterflies, flies and hummingbirds. Besides *Apis mellifera* being the most frequent visitor, we saw native bees and solitary bees visiting a great number of plant species, species like Melastomataceae and Fabaceae. These species have a specialised systems of pollination and depende for native bees. Also, we found important pollinators such

as the hummingbird *Augastes scutatus*, an endemic species, that visits a large diversity of generalist plants to maintain the plant diversity on the Campos Rupestres.

c) In the community of Campos Rupestres, we found species that comprise the majority of interactions, such as *Cuphea disperma*, *Lychnophora pohlii* and *Portulaca hirsutissima*. Except for the *P. hirsutissima* that received visits just by bees, the others received visits by hummingbirds and dipterans too. In addition, species such as *Piptolepsis imbricata* and *Xyris* sp. received visits by various groups (bees, butterflies, hummingbird and diptera) but without a high frequency of interactions. Our analysis reveals a specialised and modular network, where certain species have unique interactions, and plant species interact more intensively among themselves than with other plant species. Therefore, our study shows the importance of conservation strategies that take into account this network structure. Focusing on plant species with distinctive interactions and central plant species within modules is crucial for the maintenance of biodiversity and ecosystem stability.

3. Explain any unforeseen difficulties that arose during the project and how these were tackled.

We do not find unforeseen difficulties during the project. We found some days with a lot of rain, but we expected it to be rainy by the period of the experiment. So this problem is solved by changing the days of observation to avoid the rain. Another problem that we expected was the diversity of plant species and morphologies. Besides we know the diversity of the Campos Rupestres, the differences between the plant morphologies take a long time to measure the features and the reproductive success, because of that, we cannot take reproductive patterns (pollen limitation and pollinator dependence) of all plant species.

4. Describe the involvement of local communities and how they have benefitted from the project.

We used ways to talk with the citizens. One was a guide for plants and pollinators. In the guide, we start to explain about the vegetation of Brazil and Campos Rupestres. So, we explain the pollination process and what kind of animal could make this service. The next step was to show the diversity of plant species that we found during the experiment and finish the guide with some results and some ideas about how the people could help to protect the natural Campos Rupetres. The guide is not a scientific report, we tried to use popular communication to express the interactions between plants and pollinators and the importance of the interaction between them to conservation.

The other way was a children's story, the story is simple and lucid to encourage the children to view nature in a more friendly way. We constructed the story with the

help of teacher Marcia Maria Zanluca de Amorim, she tested the story in the school. All this material is published on Instagram to free access of the people. These materials were sent together to this email.

In addition, a small part of the grant was shared with the NGO Biotropicos. These NGO work in the Diamantina place. The Biotropicos are a NGO concentrated in disseminates the importance of the biodiversity and conservation to the people of Diamantina. They have for several years shown the diversity of the Campos Rupestres to people through art, science, and socio-educational actions. We expect the our project could help the NGO to work the important role to conservation of the natural areas of Diamantina.

To finish, the Federal University of Valleys of Jequitinhonha and Mucuri is a university concentrated inside the Campos Rupestres. The majority of students at the university are local people. Some of these students helped us during the project. Sum our data with these students aggregated the knowledge to produce strategies about conscious use and conservation of the Campos Rupestres and help to disseminate ideas between the university and the local people.

5. Are there any plans to continue this work?

This project is part of my thesis, so we will continue exploring the data for different analyses. We hope to use these data to a better comprehension about the plant-pollinators interactions. Particularly, I intend to continue studying the Campos Rupestres and your plant-pollinators interactions. Also, this work is part of a continuous research that is occurring now in the Diamantina. Sharing our data in some years we hope to have enough data to plan efficient conservation strategies to maintain the diversity of plants, animals and interactions on the Campos Rupestres.

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

We intend to share the results of our project with the population and scientific community. For the population we used social media to share the results, the main ways are the history and the guide of plants and pollinators. Using social media we could share the results with people and increase the range that could access knowledge. For the scientific community, we already made a presentation of the results in congress, but we will also pretend to publish scientific articles in important magazines about ecology, such as Ecology, Ecology Letters and Biological Conservation.

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

For the local community, it is important to continuously share the results of our project and about other projects too; the community is very important to conservation strategies. Therefore, it essentially creates a closer relationship between the university and the local people. For the scientific community we expected that this work could fit with the knowledge about the plant-animal interactions and fill some gaps about the pollination process. In addition, by sharing this work with other researchers we hope to attract more people interested in continuous learning about the Campos Rupestres. Besides the insides that our work had to help conservation strategies, we also open more questions that are important to solve to create efficient conservation plans.

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

After the data collected we made two presentations, one at the symposium of Scandinavian Association for Pollination Ecology 2023 and another in the symposium ECOFLOR of Spanish Association of Terrestrial Ecology 2024. We also presented one study about one of the plants found during this study on the Congresso Nacional de Botânica Brazil in 2023. To finish, we made a presentation on Instagram, with the guide of plant-pollinators and children's story and in You Tube video with the interactions. We will also include the Rufford in two manuscripts ready to be submitted and others that utilise the data collected during this research.

9. Provide a full list of all the members of your team and their role in the project.

Luis Gustavo Perugini (Master student at the Federal University of Valleys of Jequitinhonha and Mucuri) and **Sabrina Aparecida Lopes** (PhD student at Federal University of Valleys of Jequitinhonha and Mucuri). They made the field together with me. Also, they help on the laboratory part, count the pollen and seed.

Thiago Marques Salgueiro (PhD student at Federal University of Minas Gerais) and **Marcia Maria Zanluca de Amorim** (Professor at the Municipal Center of Infantile Education). They help on the community divulgation, made the guide of plant and animal species and children's story and the implementation on school.

Leticia Pataca (Specialist on bees Taxonomy, integrate of the support lab from Federal University of Valleys of Jequitinhonha and Mucuri). She made the identification of the animal species, mainly bees.

Pietro Kiyoshi Maruyama Mendonça (Professor at the Federal University of Minas Gerais) and **Pedro Joaquim Bergamo** (Professor at the State Universidade of Campinas). They are my advisors and help to make the structure of the project and the theory biologic part of the study.

André Rodrigo Rech (Professor at the Federal University of Valleys of Jequitinhonha and Mucuri). He was a collaborator and provided the laboratory that worked as support during the fields.

Alexsander and the NGO Biotrópicos (non-governmental organization). He and his NGO helped with the bank transfers to the Rufford Grant and it was an important collaboration to the project.

10. Any other comments?

We want to express our gratitude to The Rufford Foundation for their support; without it, the study would have been very challenging. Institutions like Rufford play a crucial role in enhancing our knowledge about nature, which is essential for maintaining our ecosystem. We would also like to extend our thanks to other individuals who supported us during this study. Our project aims to contribute to a better understanding of the Rupestern field in Brazil, focusing on the interactions between plants and pollinators. Many of the key species identified during the project had poorly understood reproductive patterns, and our findings have allowed us to compile valuable information about these species. In some way, this knowledge is necessary for creating effective plans to preserve our nature. To conclude, we present a list of plant species and plant animals documented during the course of the project.

List of plants found during the study. It is very concerning that the majority of species are "Not Evaluated".

Nome científico	**Família**	**Extinction risk**
Richterago elegans Roque	Asteraceae	Vulnerable
Emilia fosbergii Nicolson	Asteraceae	Not Evaluated
Asteraceae Bercht. & J.Presl	Asteraceae	Not Evaluated
Symphyopappus angustifolius Cabrera	Asteraceae	Not Evaluated
Lychnophora pohlii Sch.Bip.	Asteraceae	Endangered
Trichogonia villosa (Spreng.) Sch.Bip. ex Baker	Asteraceae	Not

Nome científico	Família	Extinction risk
		Evaluated
Ageratum conyzoides L.	Asteraceae	Not Evaluated
Ageratum fastigiatum (Gardner) R.M.King & H.Rob.	Asteraceae	Not Evaluated
Lepidaploa lilacina (Mart. ex DC.) H.Rob.	Asteraceae	Not Evaluated
Lepidaploa rufogrisea (A.St.-Hil.) H.Rob.	Asteraceae	Not Evaluated
Chromolaena cylindrocephala (Sch.Bip. ex Baker) R.M.King & H.Rob.	Asteraceae	Not Evaluated
Chromolaena horminoides DC.	Asteraceae	Not Evaluated
Chromolaena sp	Asteraceae	Not Evaluated
Baccharis dracunculifolia DC.	Asteraceae	Not Evaluated
Jacaranda oxyphylla Cham.	Bignoniaceae	Not Evaluated
Chamaecrista choriophylla (Vogel) H.S.Irwin & Barneby	Fabaceae	Data Deficient
Chamaecrista Moench	Fabaceae	Not Evaluated
Chamaecrista Moench	Fabaceae	Not Evaluated
Cuphea diosmifolia A.St.-Hil.	Lythraceae	Not Evaluated
Cuphea disperma Koehne	Lythraceae	Least Concern
Crotalaria unifoliolata Benth.	Fabaceae	Not Evaluated
Stylosanthes gracilis Kunth	Fabaceae	Not Evaluated
Ludwigia myrtifolia (Cambess.) H.Hara	Onagraceae	Not Evaluated
Ouratea floribunda (A.St.-Hil.) Engl.	Ochnaceae	Not Evaluated
Borreria verticillata (L.) G.Mey.	Rubiaceae	Not Evaluated

Nome científico	Família	Extinction risk
Richardia grandiflora (Cham. & Schltdl.) Steud.	Rubiaceae	Not Evaluated
Mandevilla tenuifolia (J.C.Mikan) Woodson	Apocynaceae	Not Evaluated
Bulbophyllum Thouars	Orchidaceae	Not Evaluated
Pfaffia denudata (Moq.) Kuntze	Amaranthaceae	Not Evaluated
Campomanesia adamantium (Cambess.) O.Berg	Myrtaceae	Not Evaluated
Guapira noxia (Netto) Lundell	Nyctaginaceae	Not Evaluated
Erythroxylum suberosum A.St.-Hil.	Erythroxylaceae	Not Evaluated
Microstachys daphnoides (Mart. & Zucc.) Müll.Arg.	Euphorbiaceae	Not Evaluated
Myrsine monticola Mart.	Primulaceae	Not Evaluated
Pfaffia aphylla Suess.	Amaranthaceae	Not Evaluated
Smilax oblongifolia Pohl ex Griseb.	Smilacaceae	Not Evaluated
Croton antisyphiliticus Mart.	Euphorbiaceae	Not Evaluated
Evolvulus glomeratus Nees & Mart.	Convolvulaceae	Not Evaluated
Frangula sphaerosperma (Sw.) Kartesz & Gandhi	Rhamnaceae	Not Evaluated
Angelonia goyazensis Benth.	Plantaginaceae	Not Evaluated
Encholirium scrutor (L.B.Sm.) Rauh	Bromeliaceae	Endangered
Waltheria indica L.	Malvaceae	Not Evaluated
Portulaca hirsutissima Cambess.	Portulacaceae	Not Evaluated
Croton campestris A.St.-Hil.	Euphorbiaceae	Not Evaluated
Marsypianthes chamaedrys (Vahl) Kuntze	Lamiaceae	Not Evaluated

Nome científico	Família	Extinction risk
Diplusodon helianthemifolius DC.	Lythraceae	Not Evaluated
Minaria cordata (Turcz.) T.U.P.Konno & Rapini	Apocynaceae	Not Evaluated
Gaylussacia virgata Mart. ex Meisn.	Ericaceae	Not Evaluated
Hyptis passerina Mart. ex Benth.	Lamiaceae	Not Evaluated
Lantana hypoleuca Briq.	Verbenaceae	Not Evaluated
Tetrapterys microphylla (A.Juss.) Nied.	Malpighiaceae	Least Concern
Fritzschia sertularia (Schrank & Mart. ex DC.) M.J.R.Rocha & P.J.F.Guim.	Melastomataceae	Not Evaluated
Melastomataceae A . Juss.	Melastomataceae	Not Evaluated
Lavoisiera sampaioana Barreto	Melastomataceae	Data Deficient
Marcetia canescens Naudin	Melastomataceae	Not Evaluated
Pleroma candolleanum (Mart. ex DC.) Triana	Melastomataceae	Least Concern
Microlicia D.Don	Melastomataceae	Not Evaluated
Pleroma heteromallum (D. Don) D.Don	Melastomataceae	Not Evaluated
Microlicia pilosissima Cogn.	Melastomataceae	Not Evaluated
Lavoisiera caryophyllea A.St.-Hil. ex Naudin	Melastomataceae	Endangered
Orchidaceae A.Juss.	Orchidaceae	Not Evaluated
Palicourea rigida Kunth	Rubiaceae	Not Evaluated
Piptolepis imbricata (Gardner) Sch.Bip.	Asteraceae	Not Evaluated
Psyllocarpus laricoides Mart. ex Mart. & Zucc.	Rubiaceae	Not Evaluated
Eriocaulaceae Martinov	Eriocaulaceae	Not Evaluated

Nome científico	**Família**	**Extinction risk**
Vellozia ornithophila Mello-Silva	Velloziaceae	Not Evaluated
Vellozia aloifolia Mart.	Velloziaceae	Not Evaluated
Vellozia cryptantha Seub.	Velloziaceae	Not Evaluated
Vellozia variabilis Mart. ex Schult. & Schult.f.	Velloziaceae	Least Concern
Lippia stachyoides Cham.	Verbenaceae	Not Evaluated
Xyris Gronov. ex L.	Xyridaceae	Not Evaluated

List of animals observed interacting with plants during the experiment: Status: "waiting" represent species without identification yet

Order	**Family**	**Species**	**Status**
Hymenoptera		Bees sp1	Waiting
Hymenoptera		Bees sp2	Waiting
Hymenoptera		Bees sp3	Waiting
Hymenoptera		Bees sp4	Waiting
Hymenoptera		Bees sp5	Waiting
Hymenoptera	Megachilidae	Anthidiini sp1	
Hymenoptera	Megachilidae	Anthidiini sp2	
Hymenoptera	Apidae	*Apis mellifera*	
Apodiformes	Trochilidae	*Augastes scutatus*	
Hymenoptera	Halictidae	*Augochlora* sp1	
Hymenoptera	Halictidae	*Augochlora* sp2	
Hymenoptera	Halictidae	*Augochlora* sp3	
Hymenoptera	Halictidae	*Augochlora* sp4	

Order	Family	Species	Status
Hymenoptera	Halictidae	*Augochlora* sp5	
Hymenoptera	Halictidae	*Augochlorini* sp1	
Hymenoptera	Halictidae	*Augochloropsis* sp1	
Hymenoptera	Halictidae	*Augochloropsis* sp2	
Hymenoptera	Halictidae	*Augochloropsis* sp3	
Coleoptera		Beetles sp1	Waiting
Coleoptera		Beetles sp2	Waiting
Coleoptera		Beetles sp3	Waiting
Coleoptera		Beetles sp4	Waiting
Coleoptera		Beetles sp5	Waiting
Hymenoptera	Apidae	*Bombus morio*	
Hymenoptera	Apidae	*Centris* sp1	
Hymenoptera	Apidae	*Ceratina* sp1	
Apodiformes	Trochilidae	Chlorostilbon lucidus	
Lepidoptera	Hesperiidae	*Cogia* sp01	
Hymenoptera	Colletidae	Colletidae sp1	
Hymenoptera	Apidae	*Eufriesea* sp1	
Hymenoptera	Formicidae	Ant sp1	Waiting
Hymenoptera	Formicidae	Ant sp2	Waiting
Hymenoptera	Halictidae	Halictidae sp1	
Hymenoptera	Halictidae	Halictidae sp2	
Lepidoptera	Hesperiidae	Hesperiidae sp1	
Hymenoptera	Megachilidae	Megachilidae sp1	
Hymenoptera	Megachilidae	Megachilidae sp2	

Order	Family	Species	Status
Hymenoptera	Apidae	*Melipona quinquefasciata*	
Diptera		Fly sp1	Waiting
Diptera		Fly sp10	Waiting
Diptera		Fly sp2	Waiting
Diptera		Fly sp3	Waiting
Diptera		Fly sp4	Waiting
Diptera		Fly sp5	Waiting
Diptera		Fly sp6	Waiting
Diptera		Fly sp7	Waiting
Diptera		Fly sp8	Waiting
Diptera		Fly sp9	Waiting
Hymenoptera	Apidae	*Paratrigona* sp1	
Hymenoptera	Apidae	*Paratrigona* sp2	
Lepidoptera	Pieridae	Pieridae sp1	
Lepidoptera	Riodinidae	Riodinidae sp1	
Hymenoptera	Apidae	*Tetragonisca angustula*	
Hymenoptera	Apidae	*Trigona snipes*	
Hymenoptera	Vespidae	Wasp sp1	Waiting
Hymenoptera	Vespidae	Wasp sp2	Waiting