DAVIS EXPEDITION FUND

REPORT ON EXPEDITION / PROJECT

Expedition/Project Title:	Systematics and biogeography of *Ceiba* Mill. (Malvaceae, Bombacoideae) – sampling Brazilian species
Travel Dates:	June 13th - September 24th 2017
Location:	Brazil – Minas Gerais, Bahia, Tocantins, Rio de Janeiro, Pernambuco, Paraíba, Rio Grande do Norte, Ceará, Alagoas and Sergipe states.
Group Members:	Flávia Fonseca Pezzini
Aims:	The main aim of my field work trip was to collect species of *Ceiba* in Brazil, the centre of diversification of the genus.

Outcome (not less than 300 words):-

Systematics and biogeography of *Ceiba* Mill. (Malvaceae, Bombacoideae)

Flávia Fonseca Pezzini

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December 2017

*A flowering individual of *Ceiba rubriflora* in Cavernas do Peruaçu National Park, Minas Gerais, Brasil – June 2017.

Introduction

The main aim of this expedition was to collect samples of *Ceiba*, the focus genus of my PhD project entitled "Systematics and biogeography of *Ceiba* Mill. (Malvaceae, Bombacoideae)". *Ceiba* is one of the most conspicuous elements of Neotropical seasonally dry tropical forests (SDTFs), some of the most threatened and least studied forests in the world. For my PhD project I am interested in investigating if evolutionary and biogeographic processes in this biome are distinct from those in other biomes such as rain forest. The samples collected in this expedition will be included in a well-resolved, multi-locus and densely sampled species-level phylogenetic tree for *Ceiba*. Such a tree would also be a powerful tool to investigate boundaries of *Ceiba* species. Specifically, I focused in the species from NE Brazil, the center of diversification of the genus where at least five of the 18 *Ceiba* species are present.

This was the second expedition for my PhD project. The first expedition, carried out between March and May 2016, provided samples to include in the second round of the next generation sequencing analysis and complement the phylogenetic tree generated during the first year of my PhD. The new phylogenetic tree comprises 50 samples belonging to 17 species of *Ceiba* and revealed: (i) five main clades with a strong geographical phylogenetic structure, showing a Central America SDTF clade separated from a South America SDTF clade; (ii) ecological structure with the wet forest clade separated from both SDTF clades; and (iii) a third clade with *Ceiba samauma*, a under collected species occurring mainly in semi-deciduous forests (Figure 1). Other results were even more intriguing. For example, the morphologically distinct species *C. jasminodora* is sister group to the rest of the species and might be best recognised as a new genus. In addition, within the S American SDTF clade, a nested pattern where a monophyletic taxonomic species is nested with a paraphyletic taxonomic species suggests evidence of recent ancestor-descendent species relationships that could be case studies for speciation (Figure 1). However, during my first expedition I mostly found sterile specimens that could not be identified with confidence. Therefore, this second expedition was focused in the South America SDTF clade to try to elucidate relationships within the nested species by including multiple accessions per species and to re-sampling sterile individuals from the first expedition that could not be identified.

Expedition Participants & associates

Moabe Ferreira Fernandes – PhD student at Universidade Estadual de Feira de Santana
Matheus Martins Teixeira Cota - PhD student at Universidade Estadual de Feira de Santana
Dr. Luciano Queiroz - Curator of HUEFS herbarium, where the samples were deposited in Brazil.
Dr. Antonin Portelli – University of Edinburgh
Tatiane Gomes Calaça Menezes – PhD student at Universidade Federal de Pernambuco
Dr. Felipe Melo – Researcher at Universidade Federal de Pernambuco

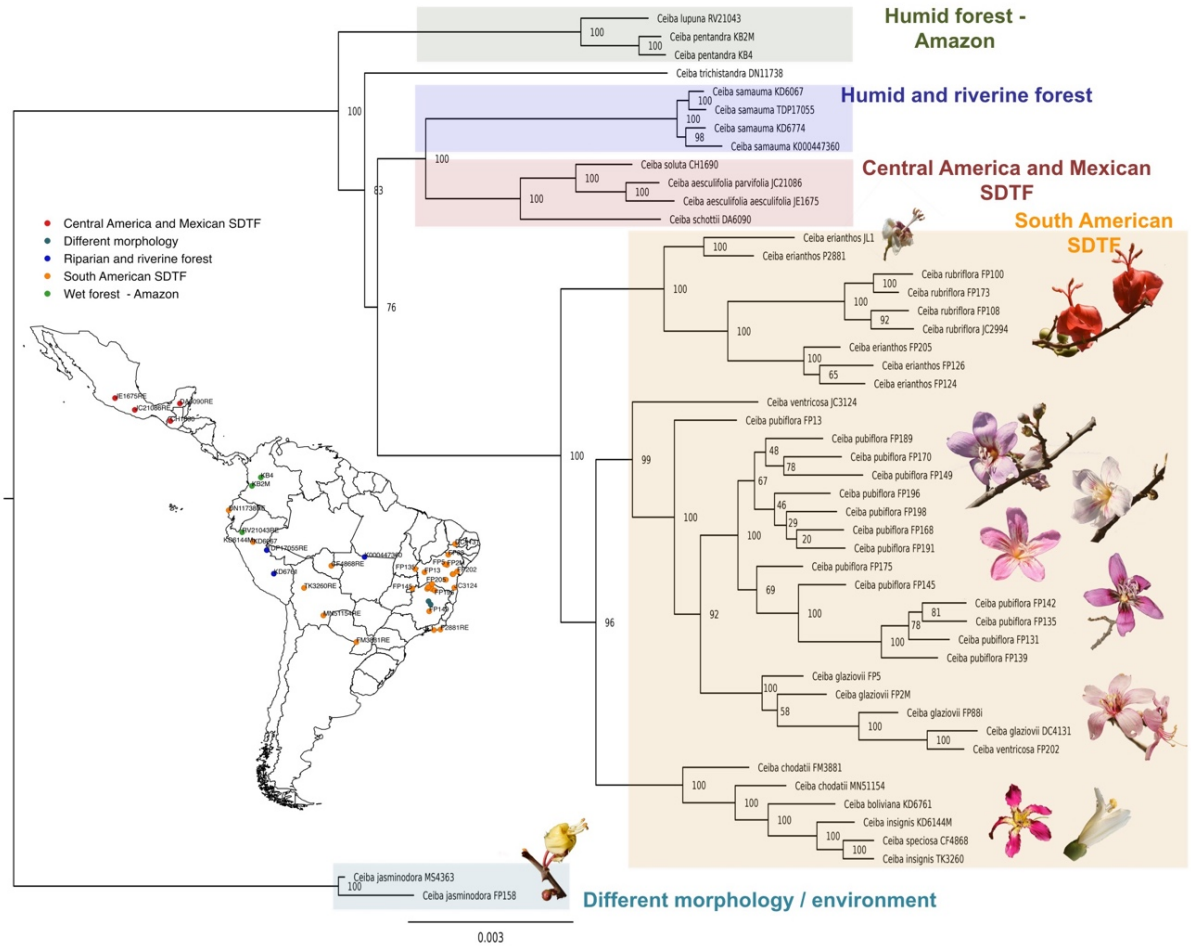

Figure 1. Phylogram derived from Maximum Likelihood analysis for 377 target genes for 17 species of *Ceiba*. Photographs of actual samples.

Methods

The expedition was divided in five trips, each followed by a few days to dry and prepare material. From mid-June until early September ca. 8,000 km were travelled through the Brazilian states of Minas Gerais, Bahia, Tocantins, Rio de Janeiro, Pernambuco, Paraíba, Rio Grande do Norte, Ceará, Alagoas and Sergipe (Figure 2). A total of 117 samples were collected, including samples of other representative species of SDTF belonging to the families Leguminosae, Euphorbiaceae, Begoniaceae and Cactaceae. Six species of *Ceiba* were collected:

- *Ceiba crispiflora* (Kunth) Ravenna
- *Ceiba erianthos* (Cav.) K. Schum.
- *Ceiba glaziovii* (Kuntze) K. Schum.
- *Ceiba pubiflora* (A. St. Hil.) K. Schum
- *Ceiba rubriflora* Carv.-Sobr. & L. P. Queiroz
- *Ceiba ventricosa* (Nees & Mart.) Ravenna

Ceiba glaziovii in August 2017.

Samples of *Ceiba pubiflora* in June and August 2017.

Samples of *Ceiba rubriflora* in June and August 2017.

Ceiba ventricosa from Serra do Teimoso, Bahia.

Ceiba erianthos in Itatim, Bahia.

For each individual, I collected a voucher to be deposited in the local Brazilian herbarium (HUEFS) as well as at RBGE, a leaf sample dried in silica-gel, geographical coordinates, a full photographic record, and measures of the individual (height, diameter of the swollen part of the trunk and the base) when possible. To avoid the use of alcohol in the samples, I constructed a portable oven to pre-dry the samples while in the field, which proved to be very successful.

Figure 2. Collecting localities represented by the blue flags during the 2017 *Ceiba* expedition.

Table 1. Schedule for the *Ceiba* expedition 2017

Date	Activity
13 - 14 June de 2017	Flying to Brazil (overnight).
15 -18 June	Acclimation, gathering/construct field work equipment in Belo Horizonte – Minas Gerais.
19 June – 30 June 2017	Travel to and collection in Rio São Francisco basin in Minas Gerais and Bahia state, including Cavernas do Peruaçu National Park. Visit UESC Herbarium.
01 -02 July 2017	Travel to and drying and preparing plants for deposit at HUEFS herbarium in Feira de Santana – Bahia.
03 July – 06 July 2017	Travel to and collections in West and Southwest Bahia state, including areas in Serra de São José, Serra do Teimoso and Itatim.
07-09 July 2017	Travel to and drying and preparing plants for deposit at HUEFS herbarium in Feira de Santana – Bahia.
10 – 17 July 2017	Travel to and collection in West Bahia state and southwest Tocantins state including areas in Gruta do Brejão, São Desidério, and Dianópolis.
18 - 19 July 2017	Travel to and drying and preparing plants for deposit at HUEFS herbarium in Feira de Santana – Bahia.
20 – 29 July August 2017	Arrangement of logistics for next trip. Flying to Rio de Janeiro. Collections in Rio de Janeiro state including areas in Búzios, and Serra de Petrópolis. Travelling to Minas Gerais collecting on route.
30 July – 4 August 2017	Drying and preparing plants for deposit in Belo Horizonte – Minas Gerais state.
5 – 14 August 2017	Travel to and collection in north Minas Gerais and south Bahia state, including Cavernas do Peruaçu National Park for fruit sampling, and Iuiú.
15 – 20 August 2017	Drying and preparing plants for deposit in Belo Horizonte – Minas Gerais state. Arrangement of logistics for next trip.
21 August	Flying to Recife, Pernambuco, in NE Brazil.
22-29 August 2017	Travelling around Pernambuco, Paraíba, Rio Grande do Norte, Ceará, Alagoas and Sergipe states for collection.
30 August – 01 September 2017	Flying to Feira de Santana – Bahia. Drying and preparing plants for deposit at HUEFS herbarium.
02 September 2017	Flying to Minas Gerais.
04-14 September 2017	Sorting samples, finalizing documentation for deposit of plants, preparing data and documents for shipping samples.
14-23 September	Rest.
24 September	Flying to Edinburgh.

Outcome

The specimens collected during this expedition contributed to the collections of Brazilian herbaria as well as the RBGE herbarium, including the silica-dried samples, hoping to fill the gaps of poorly collected areas and improve *Ceiba* species taxonomy, especially within the South American SDTF clade in where the species boundaries are confused. This expedition was important in the re-collection of *Ceiba* species in order to have more complete samples with leaves, flowers and fruits, wherever possible belonging to the same individuals.

Future Directions

Unfortunately no fertile individuals of *Ceiba ventricosa* were found in both localities visited (Serra de São José and Serra do Teimoso, both in Bahia state). The current phylogenetic tree shows both individuals from this species in different clades. Those accessions are from sterile specimens therefore in order to confirm its identity a new field trip should be carried out. Likewise, no fertile individuals of *Ceiba crispiflora* were found in Rio de Janeiro state. This is the only species of *Ceiba* still not included in the phylogeny. For both species the flowering timing reported by local researches and communities is between January and February.

The specimens collected during this expedition will be included in the third round of the next generation sequencing analysis and produce a new phylogenetic tree.

Expenditure

The expedition costed £5,200 of which £4575 was kindly provided by the Davis Expedition Fund. The remaining cost was covered by the applicant (table 2).

Table 2. *Ceiba* expedition 2017 detailed cost. Permanent equipment (eg. GPS and photography camera) provided by the applicant and RBGE are not included.

Item	Description	Total (£)
Air tickets to Scotland – Brazil - Scotland	-	870
Accommodation	For two people (field assistant)	1,500
Food	For two people (field assistant)	1,000
Car hire /gas	-	1,290
Air tickets inside Brazil		540
	TOTAL	**£ 5, 200**

Acknowledgements

I would like to express my gratitude to the Davis Expedition Fund Committee for the generous support for this project and contribution to the research in the highly threatened Neotropical seasonally dry tropical forests. I am most thankful to all the local people and communities that I contacted during this expedition whose deep knowledge of their home

contributed enormously to my understanding of the biology of the species and their environment. This expedition was only possible thanks to all the people who assisted me during field collection, with a special mention of the very interesting discussions during the almost infinite hours of driving through Brazilian roads. I would like to specially thank all the people in the Brazilian institutions (herbaria, research institutes and conservation units) that contributed for this expedition to run smoothly. Finally, I would like to thank the Brazilian institutions that contributed to my work.