Project Follow-Up Report
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Sampling and identification of the flora of a cloud forest reserve in Costa Rica

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Since having returned from Cloudbridge after four months of research from June to October of 2007, my project has continued through to December 2007 as further data were added and herbarium specimens were made at Arizona State University. This follow up report serves to update the previous report written in November and to outline new findings as this project has developed.

To review, the objectives of this study were 1) to identify unknown plants of the Cloudbridge Reserve within the Smithsonian Institution Hectare and Bio-monitoring sites; 2) to make collections of plants to preserve at herbaria in the U.S. and Costa Rica; 3) to create images and descriptions of plants for databases; and 4) to update the Bio-monitoring field book with reference pages. While in Costa Rica, I accomplished: making 112 collections total of unknown plants, acquiring several identifications, entering images and data in the Cloudbridge Bio-monitoring database, and updating the Bio-monitoring field book, having added new IDs to previous pages and creating 10 new species pages. In addition, I presented my project and findings to the community at the Energy and Environment Ministry (MINAE) station of San Gerardo. When I returned to the Arizona, I was able to identify many more samples, create 58 herbarium specimens for ASU, and enter new data into the ASU herbarium database. I also presented an oral defense of this project as my undergraduate thesis to a committee of College of Liberal Arts and Sciences professionals, composed the written report, and translated it into Spanish for MINAE. What follows are more details of the progress made on objectives since the November report.

Plant Identification

*Correction: In the previous report, it was stated that out of the 112 plants, 58 were from the SI/MAB hectare and 54 were from the sites. Under further scrutiny, it was found that only 52 of the samples collected were of SI/MAB trees while 60 were shrubs, vines, grasses, or herbs from the other sites.

At the time of writing the original report, only 6 of the 52 Smithsonian Hectare trees were identified and 29 of the 60 plants from the sites were identified. Now, all 60 of the plants from sites have been identified, but no further identifications have been acquired for the Smithsonian hectare.

	IDs in Nov.	Current IDs	Total samples
SI/MAB Hectare	6	6	52
Sites	29	60	60
Totals	35	66	112

Smithsonian Institution Monitoring and Assessment of Biodiversity (SI/MAB) Program

It is unfortunate to say that this part of my project was unsuccessful. In the field, I collected leaf samples from 52 trees using the Big Shot Sling Shot with the help of volunteer, James Macpherson. I pressed each sample and sent them to the Museo Nacional (National Museum) hoping to find someone who could identify them. I also tried to compare the samples I had to previously identified trees in the hectare. Several problems hindered success.

Primarily, the trees were not fruiting or flowering during the months of my research. Without reproductive structures, these trees could not be identified, not even by specialists.

The second problem was that the leaf samples taken from the trees were not in acceptable condition for herbarium purposes. Because of the age of the trees, as well as difficulty in acquiring samples of the leaves, the specimens were largely broken and damaged by insects, sun scorch, and moss or mold growth. They were of poor quality and thus, the Museo Nacional disposed of all material I collected from the hectare.

Third, even for the few trees I *was* able to identify, mainly by familiarizing myself with a few unique or common identified trees in the forest and finding their same species in the field, I was not able to enter the data into the BIOMON database developed by the Smithsonian Institution. A few weeks into my research at the reserve, the Cloudbridge computer was replaced after a fateful tea-spilling incident. I earnestly attempted for quite some time to get the BIOMON program to work properly on the new replacement computer, but after re-installing and working through a few errors, I still was unable to enter data into the database. Thus, I was not able to accomplish my objectives for this part of the study. I did, however, enter data for some known tree species into the Bio-monitoring database.

Overall, of my 52 tree collections, only six were identified and the remaining 46 are likely to remain nameless. I was able to identify a few more trees without collecting them, and I found three that were dead. This project as a whole presents a great challenge for Cloudbridge because it is difficult to find volunteers with enough taxonomic expertise to be able to make progress on the study, and hiring experts, which would be the most efficient and accurate way to complete this work, is expensive.

Cloudbridge Bio-monitoring Study

Apart from the SI/MAB hectare, I made collections of plants in other sites at Cloudbridge, mainly the seven Bio-monitoring sites. This part of the study was a success, as the 60 samples I had collected were all identified before the end of the year. At the end of this document, I have attached several revised species lists (*Appendices 1 and 2*) as well as a list of specialists who helped to identify the species (*Appendix 3*). Most notable perhaps is Michael Grayum of the Missouri Botanical Garden, expert in Costa Rican floristics and very knowledgeable of many types of plants that grow in the country.

El Museo Nacional

Apart from being able to identify plant samples by sending field images to experts, I had hoped to preserve my physical plant collection material in herbaria such as that of ASU and the Museo Nacional in San José, Costa Rica. After having received my scientific passport from MINAE, giving me permission to collect and extract plants from the country, arrangements were made between myself and the Museo. I would make collections at the reserve, making sure to press, treat with alcohol, and seal every specimen in airtight bags, and deposit these at the Museo Nacional. The Museo then was supposed to dry the specimens, keep a duplicate, and send the rest to ASU (all shipping expenses covered by ASU). Unfortunately, my plant samples still have not been sent. We have been unable to reach my contact person at the Museo, but granted that he still has the specimens, we will attempt to recover them this month as an ASU herbarium employee makes a visit to San José.

ASU Herbarium

Although I did not have my plant materials from Costa Rica, I was able to work on making photo herbarium specimens using the digital images I had accumulated in my research. Using Photoshop, I manually edited and re-sized two to three photos of each species to print out, cut out, and mount as a sample for the herbarium. Each sample included printed labels (translated back from Spanish) and a barcode for the herbarium inventory. Finally, I entered all data from my samples into the ASU Herbarium database and filed away the specimens.

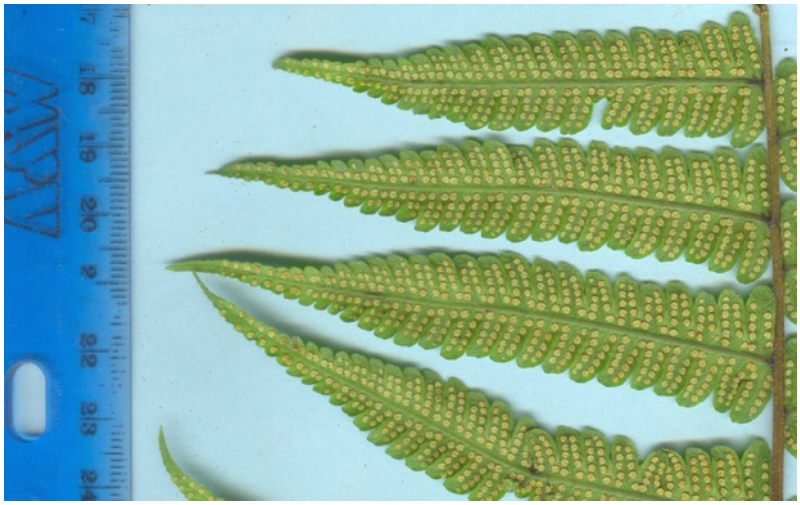
Of the 58 samples, around 40 were "firsts" at the ASU herbarium; they had not been previously collected and deposited there. Many were new species and some were even new genera, such as the acanths *Pseuderanthemum*, *Stenostephanus*, and *Megaskepasma erythrochlamys*. For now my work at the ASU herbarium is complete, but if my collections from Costa Rica are recovered, then I will have real plant material to mount and add to the herbarium's growing compilation of useful floristic data.

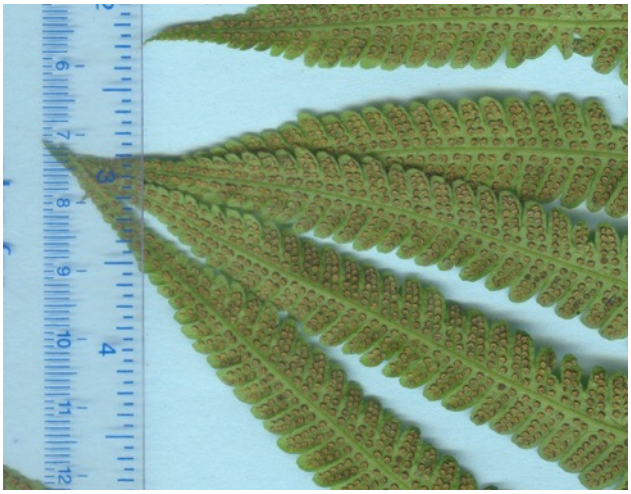
New Plant Information

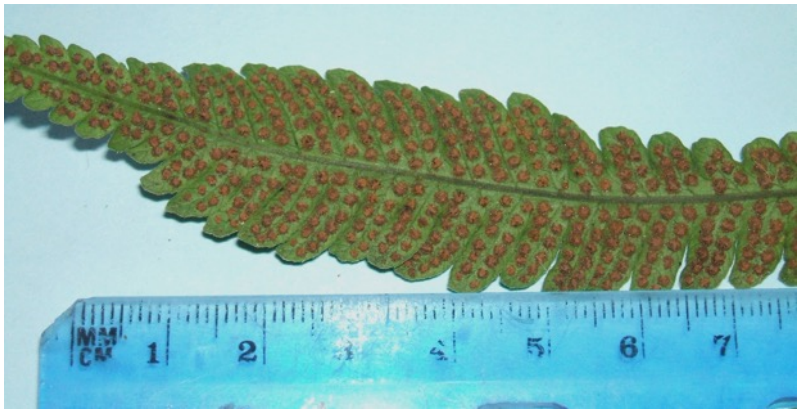
Why did I make only 58 herbarium samples when I had identified 66 total plants? Several of them were repeat species, mainly in the fern category. Some repeat collections I made voluntarily because I had gone back to collect roots of a fern I had missed before, or I had collected an orchid a second time because it was in flower. Many, however, were involuntary. I thought I was collecting a different species of fern when it was actually the same species, just in a different form. Several repeat species are found in the Bio-monitoring field book as well. For example, Fern003 and Fern022 are both *Phlebodium pseudoaureum* as confirmed by fern specialist Robbin Moran of the New York Botanical Garden. Fern022 is just a younger form of Fern003, but the species is highly variable so they are easily confused.

Phlebodium pseudoaureum
Top left: younger version, Bio-monitoring Fern022
Top right: older version, Bio-monitoring Fern003

Another example is *Thelypteris dentata*, a fern that I collected three times (Fern004).







Thelypteris dentata
Above left: with yellow indusia
Above: with brown indusia, more mature
Left: sori exposed, most mature

All three images above are from three separate collections of what was apparently the same fern. Notice that the sori (spore-containing clusters) on the bottom part of the leaflets appear very different. An explanation is based on maturity. When the fern is young, it develops bright yellow indusia, a protective covering for the spores. Later on, the indusia darken as the sori bulge underneath them. When the spores are mature, the indusia break off, leaving the sori uncovered. Other fern duplicates collected were the *Pteridium arachnoideum, Thelypteris rudis* and *Pityrogramma ebenea*. Future Cloudbridge collectors or bio-monitoring investigators should familiarize themselves with ferns in their different forms and try to remember the characteristics that distinguish each species. Some of these are listed in the Bio-monitoring notebook.

As for the SI/MAB trees, volunteers who take on this project should particularly learn to recognize the *Clusia* sp., *Posoqueria latifolia*, and *Oreopanax xalapense*. These were the most abundant trees in the hectare.

*Corrections for the SI/MAB data: The official name for the *Oreopanax xalapense* is such, not *Oreopanax xalapensis* nor *Oreopanax xalopansis,* misspellings used in previous Cloudbridge data. To verify any taxonomic plant names, refer to The International Plant Names Index (http://www.ipni.org/). This website is a database that contains up to date information on plant names and can be used to check spellings and authors.

For clarification, it is also of interesting note that some of the trees that have been classified as CLUSPP (*Clusia sp.*) may actually belong to the *Chrysochlamys* genus instead of *Clusia*. I sent images and descriptions of a plant collection from this particular tree to Barry Hammel of INBio, who responded saying that the sample I collected was *Chrysochlamys allenii.* The *Clusia* species, he states, have smaller and more seeds per locule, and most are actually epiphytes. Both genera belong to the Clusiaceae family, which is why the species code was CLUSPP.

Lastly, in the SI/MAB Program Interim report, some ecological formulas were presented to make measurements of the trees in the hectare such as relative dominance, basal area, relative frequency and relative diversity. One of them is misprinted as relative density, the number of individuals of a species/ total number of individuals of all species. While density has to do with the number of trees in a certain area, this formula actually measures relative abundance.

*Cloudbridge Bio-monitoring data: For a list of identifications done especially for the Bio-monitoring field book, refer to *Appendix 4*. New information is in bold and should be added to the book.