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Botany Profile

The Guiana Shield: 20 Years and Counting

By Vicki A. Funk

The Biological Diversity of the Guiana Shield (BDG) program has operated in the National Museum of Natural History for over 20 years and although the program interacts with many departments and bureaus across the Smithsonian Institution, it is closely associated with the Department of Botany. The goals of BDG are 1) to document, study, and preserve the biodiversity of the Guiana Shield, 2) to provide the opportunity for excellent scientific research, and, 3) to make information generated by these studies useful for conservation and education.

The Guiana Shield is a distinct geological unit that underlies the northeastern corner of South America and includes much of the area east and south of the Orinoco River and east and north of the Rio Negro and Rio Amazonas. The area includes Bolívar, Amazonas, and Delta Amacuro states in Venezuela; most of Guyana, Surinam, and French Guiana; parts of northern Brazil; and parts of southeastern Colombia. The area has many unusual ecosystems including the famous tepuis of Sir Arthur Conan Doyle's "The Lost World" and the unique "Greenheart" forests of Guyana, all of which have high endemism.

The Shield's igneous-metamorphic basement was laid down in several events from 3.6 to 0.8 billion years ago. This granitic basement is easily observed in the many black "hills" of granite that dot the landscape across the Guiana Shield and is also exposed on some of the mountains and massifs. Between 1.6 and 1 billion years ago, sedimentary covers

of sand were successively laid down and cemented during thermal events. The resulting quartzite and sandstone rocks are known today as the Roraima formation. Some recent work has suggested that the eastern rocks are the oldest; this would make the Pakaraima Mountains of Guyana and the eastern parts of Venezuela older than the remainder of the Roraima formation.

The area is dotted with tepuis, the steep-walled table mountains prominently featured in photos and films, many of which support a unique flora and fauna. The easternmost peaks reach heights around 2,000 meters and include Mt. Ayanganna and Mt. Wokomung in Guyana. The highest tepui, Sierra de la Neblina, exceeds 3,000 meters and is located in the western part of the Shield on the border of Venezuela and Brazil. Many other tepuis have summits between 2,000 and 2,400 meters. A large, mid-elevation, sandy plateau between 400 and 1,500 meters, the Gran Sabana, occupies southeastern Venezuela and adjacent parts of Guyana (where it is named the Rupununi Savanna) and Brazil and there are also variously-sized areas of lowland white-sand savanna scattered throughout the Guiana Shield (e.g., Berbice Savannas of Guyana).

There are well-known floras for only a few parts of the Guiana Shield, such as Mount Roraima (Venezuela, Guyana, Brazil), the Iwokrama-Mabura Hill area and Kaieteur (Guyana), Tafelberg (Surinam), and Saül (central French Guiana). Most areas, such as the lowland forests and tepui slopes, are very poorly known.

Likewise faunal studies are in short supply so while birds and mammals have been studied in a number of places, the vast majority of the Shield remains under explored.

BDG is a field-oriented program that has been operating since 1983 (federally funded since 1987). Originally confined to botany and Guyana, the least well-known, most biologically diverse of the three Guianas, the program has since been expanded to include faunal studies and field work in the other parts of the Shield. From 1986-1998 the BDG maintained full-time plant collectors in Guyana and each year approximately six major expeditions were organized, and other expeditions, involving a total of 20-30 visiting scientists took place. The continued budget cuts of the 1990s made it impossible to continue the practice of full-time field work, and the program shifted to sending resident collectors to Guyana for 4-6 months each year or having a series of targeted expeditions. In recent years there have been resident collectors for butterflies and moths, ants, birds, and plants.

In many ways modern day field work resembles the legendary trips of old. For although it is easier on both ends of the trip (e.g., airplanes) and we collect new types of data (e.g., DNA samples, GPS coordinates), the major part of field work is essentially the same as it was during the time of Humboldt (1799-1804) and Spruce (1849-1864): a lot of

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Discovery of Rare Hawaiian Species

A recent discovery of an extremely rare new plant species in Hawaii was made in the context of a collaborative effort between the Department and the National Tropical Botanical Garden (NTBG) to discover, describe, and understand plant diversity of the Pacific Islands. This effort is critical at this time to conserving the diversity of island ecosystems. Known from only four individuals, the plant species, *Labordia lorenciana*, is among ca. 120 other extremely rare Hawaiian species that are limited to less than 50 individuals. It is currently being cultivated for conservation at NTBG.

Labordia lorenciana is described and illustrated from the Hawaiian Island of Kaua'i. This new species, named for David H. Lorence, Director of Science at NTBG, who has made many valuable contributions to Pacific botany and to the study of the large tropical family Rubiaceae (coffee family), most closely resembles the O'ahu endemic species, *Labordia kaalae*. The new species is described in a paper published in *Systematic Botany* by **Warren Wagner** and two colleagues.

Labordia (Loganiaceae: Gentianales) is one of 31 currently recognized vascular plant genera completely restricted to the Hawaiian Islands. It is closely related to the Pacific genus *Geniostoma*. *Labordia* comprises 16 species, with 11 species being single-island endemics and the remaining five species occurring on several islands. Three species and two varieties are currently listed as Federally Endangered under the Endangered Species Act. Recent field research by Ken Wood of NTBG within the northwestern canyon region of Kaua'i (i.e., Kawai'iki Valley), has documented another new species known from only a few remaining individuals and critically in need of protection.

Future Female Scientists Program

The National Museum of Natural History's Office of Guest Services sponsored the first *Smithsonian Future Female Scientists Program*, a two-day

program for 23 local high school girls that took place 8-9 March. The goal of the program was to highlight the many backgrounds, academic paths, and roles of females in science at the National Museum of Natural History, for students interested in pursuing science in college and as a career. The program was coordinated by Mollie Oremland and Amy Bolton of Guest Services and funded primarily through a Smithsonian's Women's Committee grant, with additional support for food provided by Coca-Cola.

Cristián Samper welcomed the students to the program and provided an overview of the Museum and his scientific background. Students then spent two days behind-the-scenes of the Museum learning about the work done here. Small groups of 2-3 students were matched with scientist "sponsors" to learn about their work, based on student interests. Students also participated in hands-on activities, demonstrations, and tours at NMNH and at Smithsonian's Museum Support Center (MSC) with additional female staff members. Several staff members participated in a panel discussion about the many pathways to a career in science, introduced by Associate Director for External Affairs and Public Programs, Elizabeth Duggal. At the conclusion of the first day of the program, a reception was held in the theater lobby for student participants,

their parents, teachers, and Smithsonian Women's Committee members. Nancy Newkirk of the Smithsonian Women's Committee, and Carole Baldwin of Fishes, then introduced the film *Galápagos 3D* to the attendees, and Baldwin took questions afterward.

Over 40 female staff from Research and Collections were involved in the event. **Maria Faust, Vicki Funk, Carol Kelloff, Ida Lopez** and **Alice Tangerini** represented Botany. **Elizabeth Zimmer** represented the Laboratories of Analytical Biology (L.A.B.)

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time is spent walking, paddling a canoe, cutting trail, dragging supplies in and out of boats and setting up camp in the rain and heat or rain and cold—all of this in order to collect and preserve biological specimens so that we can understand and conserve diversity.

From the start of the BDG, all collections were databased and geo-referenced. This decision has been central to the program and is true for all types of organisms collected. Furthermore, beginning in the early 1990s, the BDG began to database specimens held by the National Museum of Natural History and most this work has been completed. The result is a great legacy of data that we



Paloue sp. nov. from the Pakaraima Mountains. (Photo by Karen Redden)

have only recently begun to analyze.

In addition to collecting and research, the BDG Program has helped build the infrastructure necessary for housing Guyana's own natural history collections via the construction and enlargement of the "Centre for the Study of Biological Diversity" located on the campus of the University of Guyana; funded by the Royal Bank of Canada and USAID. BDG has also helped in the training of students and scientists both in the US and Guyana, assisting them in their research, and establishing or maintaining their collections. The Centre has organized training classes for Amerindian guides, provided lectures to the public, taught short intense taxonomy classes on various groups, helped organize the first international scientific meeting held in Guyana in recent memory, and started its own journal.

With a few exceptions, such as cities along the Río Orinoco (Venezuela), the Rupununi savanna (Guyana), and the coastal areas of the Guianas, the Guiana Shield has benefited from its isolation and low population density, and much of the vegetation is still relatively undisturbed by human activities. Unfortunately, the pace of disturbance has accelerated because of logging by Asian and local companies, gold and diamond mining by Canadian and local outfits, oil drilling, bauxite mining, dams for hydroelectric power, wildlife trade, burning, grazing, and agriculture. If these trends continue, the Guiana Shield will lose its place as part of one of the three remaining "tropical wilderness" areas in the world (Conservation International).

Efforts to conserve this unique region vary according to country: Venezuela has set up seven national parks, 29 natural monuments, and two biosphere reserves covering 142,280 km² which comprises almost 31% of the Shield that lies in Venezuela and about 15% of the country. Guyana has only one major national park, the expanded Kaieteur National Park (627 km² or about 3% of the country). Surinam has 12 conservation areas encompassing 20,000 km²; 12% of the country. French Guiana has no designated protected areas but there are 18 proposed sites that total 6,710 km² and make up 7.5%. However, an indication on the map of a park or reserve does not mean that the area will actually be protected. As with many countries, areas in the Guiana Shield that



Kaieteur Falls, Guyana, in the Guiana Shield. (Photo by Carol Kelloff)

are designated as parks are often only "paper" parks, and lack the infrastructure and financial backing necessary for effective protection. Each of the five countries of the Guiana Shield has a different administrative structure and official language(s), and there are a number of border disputes. The borders are generally porous to drug, gold, and wildlife trafficking, and there are serious political and environmental issues in regards to the native peoples of the region. All of these problems will have to be dealt with in order to design and maintain a viable reserve system for the Guiana Shield.

The efforts of the BDG program are important as a major part of the process of gaining an understanding of the flora and fauna so that informed decisions can be made on critical areas with a high priority for conservation, and so data can be collected from areas that may ultimately be degraded. Also, because this region was long neglected by biologists, it is often an area of "missing information" for many biological analyses. The BDG program is designed to provide specimens and data to address biodiversity questions across many groups. The assembled information is being used to produce checklists, vegetation maps, floristic and faunistic studies as well as to address the more theoretical aspects of spatial biodiversity models.

By far the most important activity was building and expanding of the Centre for

the Study of Biological Diversity (CSBD), at the University of Guyana (paid for by the Royal Bank of Canada and a USAID grant). The herbarium was moved into the new addition and is now fully functional. The zoology collections have been re-organized and are waiting additional shelving to finish their expansion. The biggest remaining problems are that the library needs to be moved into the new space and the small hut next to the Centre needs to be renovated into a drying room for plants. The Centre currently houses 45,000 collections of plants, ca. 10,000 animals, and ca. 22,000 insects.

The symposium "The Biodiversity of Guyana: A Global Perspective for the Future" was held in Georgetown, Guyana from 7 – 10 October 2001. It was co-hosted by BDG and the University of Guyana (UG). For many years, institutions and research organizations in Guyana and around the world, including the Smithsonian Institution, have been working in Guyana collecting plant and animal data, discussing conservation strategies, and evaluating areas for preservation. In 1999 the CSBD and its collaborators decided that the time had arrived to evaluate the level of our knowledge of the biodiversity of Guyana and to use those data to address question such as "What do we know about the diversity of various groups of organisms in Guyana?", "How does the diversity

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compare regionally and globally?”, “How can it be conserved?”, and “How might conservation efforts affect the people of Guyana?”

In 2002 the CSBD decided to publish its own peer reviewed journal that would focus on biodiversity issues of the Guiana Shield and provide a forum for selected senior theses to be published. The BDG program has been actively involved in both the editing and reviewing process and in 2003 the first volume was issued. The *Contribution to the Study of Biological Diversity* journal is currently distributed to the major institutions worldwide that have had an interest in this region of South America. Two volumes have been published and a third one is nearly finished.

The *Checklist of the Terrestrial Vertebrates of the Guiana Shield* was published in 2005. It contains all known terrestrial vertebrates (and their distribution on the Shield) and so has chapters on birds, mammals, herps, and reptiles. Edited by Hollowell and Reynolds, the chapter authors are from Canada, Venezuela, Brazil, and the USA and the Director of NMNH, Cristián Samper, wrote the forward. The only missing part of the vertebrates is the fishes and a project is underway to synthesize the *Checklist of the Freshwater Fishes of South and Central America*. BDG now has a list of 3,507 fishes from the Guiana Shield. This checklist should be finished during 2007 and at that point all known vertebrates

from the Guiana Shield will be listed.

Currently, the total number of plant records held by the BDG program is 125,387, which consist of 49,527 BDG collections, 71,136 plant specimens from the US National Herbarium, and 4,724 miscellaneous collections, all of which have been databased and most have been barcoded. Other databases include approximately 4,302 records of birds (plus 5,923 bird tissue samples), 9,000 spiders, 8,235 Lepidoptera, 75,000 ants, 23,000 aquatic insects, 450 termites, 3,388 amphibians and reptiles, and 1,300 mammals. The BDG could not function without the collaboration of over 300 scientists from around the world. These colleagues collect and identify specimens, send books and supplies to Guyana, prepare specimens to be returned to the host countries, and train students.

In 2000 we began publishing the *Smithsonian Plant Collections, Guyana* series starting with our first collector. The main purpose of this publication series is to make the results of the field work widely available to botanical and conservation communities. These publications describe and discuss the collecting trips and list all identified collections by number and by name. Three have been published so far (Pipoly, Gillespie, McDowell) and two are just about ready to send out for review (Clarke, Miscellaneous Collectors).

The BDG program has a website and a numbered publication series for papers supported by BDG funds, staff, and specimens. To date there are over 200 publications and the website lists them

and provides some copies <www.mnh.si.edu/biodiversity/bdg>. In addition, a number of synthetic papers have been published using the BDG data. Topics include, predicting plant and animal distributions, identifying survey gaps, and determining areas of species richness.

The *Checklist of the Plants of the Guiana Shield* is in press. It covers all vascular plants known to occur in the Guiana Shield region of northeastern South America. It was done in collaboration with the Missouri Botanical Garden. This checklist along with the Terrestrial Vertebrates and the Fishes publications represent a new research and conservation resource which highlights three critical facets of taxonomic work: research, collections, and expeditions.

Training has always been a big component of the BDG. The first intern from Guyana arrived at the Smithsonian in 1987 and over the years there have been 29 summer interns (12 from Guyana), 14 Guyanese visitors, eight masters students (six from Guyana), and 15 doctoral students (four from Guyana). Outside of the more formal education programs the program has sponsored several bird and plant workshops for students at the University, Amerindian training in classes and in the field, and hundreds of local participants in field trips.

In February 2007, NMNH Director Cristián Samper and the Associate Director for Research and Collections, Hans Sues, visited Guyana to learn more about the BDG. They spent a week visiting field sites, including a flight over some of the table top mountains of Guyana, and one day in Georgetown meeting with University officials and the US Ambassador to Guyana.

The University of Guyana has been the home base since the beginning of the program. Beginning with George Walcott and continuing down through a series of Vice Chancellors, Deans, and Head of Departments, to the current Dean, Philip DaSilva, and the Manager of the Centre, Calvin Barnard, the program has been fortunate to work with many kindred spirits. Currently the University is doing an excellent job fund raising and administering the Centre and the collections are in great shape.

As always, BDG thanks the Office of the Director at NMNH for continued funding (and of course to Congress for



The Centre for the Study of Biological Diversity, University of Guyana, Georgetown, Guyana. (Photo by Carol Kelloff)



Vicki Funk, Cristián Samper, and Hans Sues do their best jacana imitation while visiting Karanambu, Guyana, in February 2007. (Photo by Carol Kelloff)

the Global Change money many years ago). Also, the Program could not run without the help of Carol Kelloff, the Assistant Director of BDG. On the down side, Tom Hollowell, Data Manager for nine years, left in November 2005 and the program has not been able to replace him. His departure has slowed our ability to synthesize the data.

In 2005 BDG was reviewed by an external committee. The report was positive and was approved by the Office of the Director and the Associate Director for Science. There were several important recommendations including finishing the database, putting the data online, and finishing the synthetic work. They also recommended soon ending the BDG program and they suggested a competition so that the funds could be used to work in another area of the world or on another group in the same area. Further study of this topic is underway.

Finally, it is my belief that the BDG program fulfills the goals of the Smithsonian Institution by gathering new information and distributing it to those who use it to produce checklists, floras and faunas of a relatively unknown area, by supplying data for the identification and preservation of biologically diverse areas for conservation activities, by providing specimens that are used in systematic

studies both within the Institution and throughout the world, by building infrastructure in the host countries, and by providing training for university students and Amerindians. I think it is something we can all be proud of and I thank everyone who has helped along the way.

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