

Achievements in Research | 2014



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From the President

The Missouri Botanical Garden continues to be a leader in botanical exploration, efforts to document and catalog the plants of the world, and using that information to inform and develop methods that help ensure the survival of the many plant species that are threatened in the wild. I am currently the Chair of the Council for the World Flora Online; an ambitious international collaborative effort to draw together information on all of the world's known plant species by 2020, meeting Target 1 of the Global Strategy for Plant Conservation. We continue our efforts in this area and in 2014 saw the publication of additional new volumes of the Flora of North America, Flora Mesoamericana, and the Flora of Costa Rica, as well as a two-volume catalog of the vascular plants of Bolivia. Great progress was also made during the year in deepening and expanding the Garden's role as an increasingly important international center for research in plant conservation biology. As an institution, we were not only productive, but our individual scientists were recognized as leaders. On behalf of the Garden, Dr. Jim Miller received an Arcus Award for the Garden, recognizing the institutional accomplishments for Achievement in Biosciences and honoring worldwide leadership in research focused on discovering, documenting, and conserving the world's plants. Dr. Robert Magill, Senior Curator, was awarded the St. Louis Academy of Science's Outstanding St. Louis Scientist Award. Bob served as Vice President for Science for 20 years and is widely recognized as the developer of TROPICOS, the world's most comprehensive database on plants. And Dr. Christy Edwards, the Garden's Conservation Geneticist, was recognized by the St. Louis Business Journal as one of the St. Louis 40 Under 40, the only scientist in the list. All in all, it was a great year for our team.



Dr. Peter Wyse Jackson

From the Senior Vice President of Science and Conservation

2014 was a tremendously productive year for our Science and Conservation Division. Among the many accomplishments outlined in this report, our staff discovered, described, and named 134 species of plants from 24 countries that were completely new to science. Beyond advancing the borders of our knowledge, this accomplishment has much greater significance. Garden scientists often travel to the ends of roads that lead to distant unexplored forests and natural areas and the new species that they discover and describe are almost entirely those with very restricted geographical distributions and thus of great conservation concern. If we don't find and recognize these new species, the majority may be doomed to anonymous extinction, being lost before they even have a name. As a first step toward ensuring that we save all of the world's plants for future generations, it is essential that the basic exploration to find and catalog them all is continued and completed. The Garden continues its leading efforts in research and particularly floristics, but it is more committed than ever to using the information generated by our scientists to inform and implement conservation. 2014 saw an important step in this direction with the establishment of a formal program in ecological restoration. Through all of its conservation efforts the program aims to protect natural areas and threatened species and be successful stewards for the plant kingdom.



Dr. James Miller

Mission

The mission of the Missouri Botanical Garden is "To discover and share knowledge about plants and their environment in order to preserve and enrich life." The Science and Conservation Division supports this mission by working to name and describe the patterns of plant diversity and build the tools that allow us to communicate about them, with the goal of learning about and understanding their myriad complexities and relationships and developing ways to protect and conserve them and the ecosystems they inhabit for the present and future.

RESEARCH HIGHLIGHTS 2014



Botanical Exploration & Discovery

The Missouri Botanical Garden's research scientists are involved in botanical inventory efforts in more than 30 countries and regularly conduct expeditions to poorly known regions. In 2014, MBG researchers published 134 plant species completely new to science. The new species include an array of tropical trees and shrubs, new species of mustards, some related to important crops, nine species of *Philodendron* and eleven species from the Iris family, all with ornamental potential.

The Rediscovery of a Presumed-Extinct Species



In October 2014, curators at the Missouri Botanical Garden rediscovered *Dracaena umbraculifera* in Ile St. Marie, Madagascar. This species, described more than 200 years ago from cultivated plants, had not been located in the wild since its description and was presumed extinct.

In 1797, *Dracaena umbraculifera* was described from living plants in cultivation in Vienna. The plants were presumed to have been part of a shipment of living plant material from Mauritius, although the species has never been found to grow wild there. Progeny of the cultivated plants in Vienna were eventually distributed to other gardens, including an old specimen now residing in the Climatron® at the Missouri Botanical Garden. DNA sequenced from this Missouri specimen indicated that it is not closely related to the other species of *Dracaena* that occur in Mauritius, but rather its closest relatives are in northeastern Madagascar.

MBG scientists Drs. Jim Miller and Pete Lowry visited Ile St. Marie in October, where they found two native populations of *Dracaena umbraculifera* and a third population on Ile aux Nattes. Recent work by other MBG researchers also uncovered a new population at an MBG conservation site, Pointe à Larré.

Having shown that this species is not extinct in the wild, but rather was mistakenly assumed to be from Mauritius, Garden botanists are now monitoring the remaining wild populations and working to obtain material for cultivation and conservation to ensure that this wonderful species does not go extinct, as previously presumed.



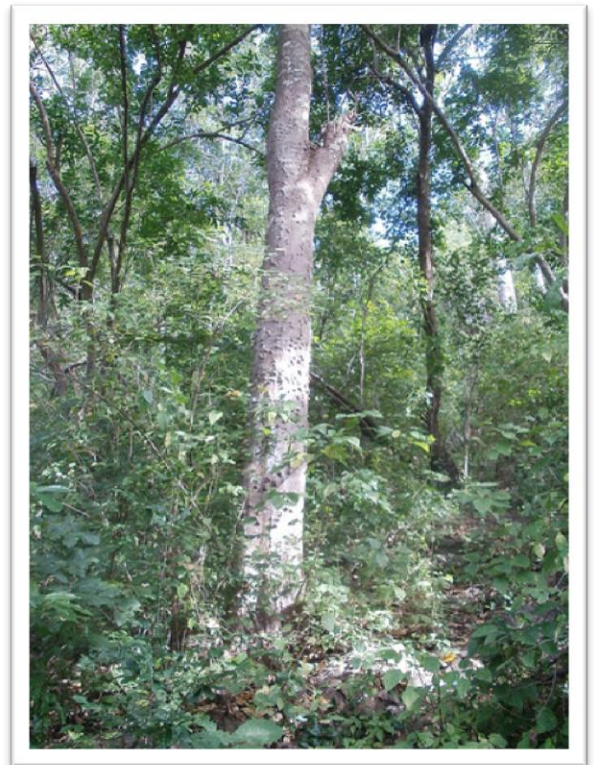
A New Genus!

Quipuanthus, a new genus from the foothills of the eastern Andes in Ecuador and Peru, was described by Garden curator Dr. Carmen Ulloa Ulloa (pictured left) and colleagues. The Missouri Botanical Garden's Herbarium collection reached 6.5 million specimens with the addition of this new genus.

Conservation of the Critically Endangered Coral Tree of East Africa

The Coral Tree of East Africa, *Erythrina schliebenii*, was never known from many individuals, and it had not been observed in nature since the 1940s. Presumed extinct, it was recently rediscovered in 2001, in southern coastal Tanzania, nearly 100 miles from where it was first discovered. A team of botanists from Tanzania and the UK found the plant but its identity was not confirmed until 2011, when a team, including Dr. Roy Gereau, of the Missouri Botanical Garden, returned, made additional collections to re-confirm its identity, and also collected seed to propagate and conserve the species.

On April 26, 2014, commemorating the 50th anniversary of the formation of the United Republic of Tanzania, President Kikwete planted a young tree of *Erythrina schliebenii* in the Presidential Garden. This formal planting recognizes the biological heritage of Tanzania and a commitment to preserving those endangered species unique to the country.

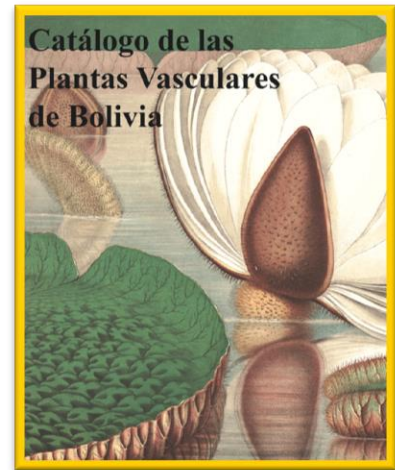


The Catalog of Vascular Plants of Bolivia

Project Overview by Peter Møller Jørgensen

The Missouri Botanical Garden has since the start of 1980 maintained a research program in Bolivia. After 35 years this effort culminated in 2014 with the publication of the *Catálogo de las Plantas Vasculares de Bolivia*.

Bolivia is a land-locked country of slightly more than 1,000,000 km² or close to the combined size of Texas and California. The size of the country and its many different vegetation types sets the stage for its biological diversity. There are three major regions in Bolivia: the *Altiplano*, a huge relatively flat plateau, with several different types of vegetation mostly dependent on the level of precipitation; it is replaced to the north and east by the *Andean* slopes that feature a mosaic of wet and dry forests, along a latitudinal and corresponding precipitation gradient; the *lowlands* to the north and east of the Andes varies from wet tropical rain forest to dry, deciduous forest of the Chaco to the south, intermixed with several types of savannas, some of which are regularly inundated. The elevational gradient found within Bolivia runs from about 100 to 6,542 m, well above the physiological tolerance for vascular plants.



By the end of 2014, Michael H. Nee, Stephan G. Beck, and Garden curator Peter M. Jørgensen finished editing the two volumes that list almost 50,000 plant names that have been used for the 15,345 species known from Bolivia. The project was conceived as a collaborative project between three institutions in Bolivia and two in the USA, with Missouri Botanical Garden as the main editorial center. The execution of the project was highly dependent on nearly 250 plant specialist scattered across Europe, USA, and South America, who were either contributing authors or reviewers.

The catalog is a compilation of what has been published in the botanical literature – more than 3,400 references are cited – and the collections made in Bolivia. The documentation of the plants growing in Bolivia may have started as early as 1710, but documentation of the collections made by Louis Feuillée is extremely scarce. For sure collecting began in 1747 with Joseph Jussieu, but here also most collections never arrived at the botanical research institution in Europe. Thaddeus Haenke settled in Cochabamba, Bolivia, but most of his collections from Bolivia were lost, while many from his earlier participation in the Malaspina Expedition survived. After these three came C.V.D. D'Orbigny, H.A. Weddell, R.W. Pearce, G. Mandon, C.E.O. Kuntze, H.H. Rusby, M. Bang, K.A.G. Fiebrig, J. Steinbach, and M. Cárdenas among others. The most active collectors in the last decades have been S.G. Beck, M.H. Nee (co-editors of the book), J.R.I. Wood, A.F. Fuentes, J. Solomon, and F. Zenteno.

The first checklist of plants growing in Bolivia listed 9,431 species (Foster 1958), however almost 1,000 species were included under a wrong name. These mistakes have to some degree been resolved in the catalogue, but the documentation Foster used for inclusion could not always be

examined. Bolivia is a very species-rich country and similar to Peru and Ecuador. However, Bolivia is situated at the southern edge of the tropics in the center of South America, which may explain its slightly lower number of species. On the other hand, it is also true that numerous species, currently unknown to science, are still being discovered in the forests and grasslands of Bolivia or recognized among the specimens already present in the world's herbaria.

Of the 15,345 species given in the *Catálogo de las Plantas Vasculares*, 2,343 are endemic (15.3%). These species will definitely need to be assessed for their IUCN threat level, monitored, and actively protected if such measures are judged appropriate. No other country can undertake this effort, but resources are few and it may only happen if international collaborative projects are developed.

World Flora Online

The World Flora Online project was launched in India, at an event held during the 11th Conference of the Parties to the Convention on Biological Diversity in October 2012, where the COP also adopted a decision welcoming the World Flora Online initiative. In January 2013, a Memorandum of Understanding on the World Flora Online was opened for signature. At the end of August 2014, 24 institutions and organizations signed a Memorandum of Understanding to participate in the project. Additional institutions and organizations worldwide have also been invited to participate in the WFO Consortium.



The World Flora Online will be an open-access, Web-based compendium of the world's plant species. It will be a collaborative, international project, building upon existing knowledge and published floras, checklists and revisions but will also require the collection and generation of new information on poorly known plant groups and plants from under explored or unexplored regions.

The project represents a major step forward in developing a consolidated global information service on the world's flora.

Restore the Forest: Ankarabolava-Agnakatrika



Ankarabolava-Agnakatrika Forest is a roughly 16 km² area in Southeastern Madagascar. The forest is located in a Priority Area for Plant Conservation, which means it contains a very diverse flora with several locally endemic species.

It is also home to the endangered *Eulemur cinereiceps* or white-collared brown lemur as well as a species of mouse lemur previously unknown to science.

But the area also provides timber for construction, as well as plants used in traditional medicine, and is the source for several rivers that are used to irrigate local rice fields. Clearly it is important for both conservation and local economic concerns. The question becomes: is there a way to address both concerns simultaneously and to the benefit of all? We believe the answer is YES.

In this project we are endeavoring to offer forest occupants with fair monetary compensation for their land within the forest that they can use to purchase land elsewhere. But, what constitutes “fair” compensation? To make this calculation we have teamed up with the Malagasy land tenure NGO called Ezaka ho Fampanandrosoana any Ambanivohitra (Action for Rural Development” or EFA). This organization has experience with evaluating agricultural land that was derived from their work with several mining companies that operate in Madagascar. During September 2014, personnel from EFA worked with MBG-Madagascar’s agriculturalist to develop a standardized protocol for evaluating farmer’s plots within the Ankarabolava-Agnakatrika Forest. They have already tested the protocol, with acceptable results, for two contrasting forest plots. Then, in October, the entire project team met to discuss and validate this protocol.

Our Sponsors

This project was made possible with the generous support of the IUCN National Committee of the Netherlands, SavingSpecies, and the Helmsley Conservation Trust.

Supporting Infrastructure

To support the programs and goals of the Science and Conservation Division, significant infrastructure resources are essential. These include the Herbarium, Library and Archives, MBG Press and the TROPICOS database system, whose activities for 2014 are summarized below.

Herbarium

The Herbarium, a service unit within the Science and Conservation Division, supports scientific research both within and outside Missouri Botanical Garden by 1) providing access to specimens and their associated data, 2) providing facilities for staff and visiting researchers suitable for the study of specimens, 3) providing facilities for specimen preparation and conservation, 4) managing and organizing storage facilities suitable for long-term specimen care, and 5) establishing policies that ensure the ongoing preservation and availability of specimens for current and future research. The Herbarium is maintained for the benefit of the global scientific community as a whole, as well as for the specific research interests of Garden staff members. Specimens are made available to outside researchers as loans, gifts for identification, and exchange, while the Garden’s research staff receives loans and gift and exchange specimens from other institutions.



Mounted Herbarium Collection

The herbarium collection contains pressed, dried, and mounted specimens from two major plant groups: vascular plants (ferns, conifers, and flowering plants) and bryophytes (mosses

and liverworts). During 2014, 108,634 mounted specimens were added to the permanent collection (99,064 vascular plants and 9,570 bryophytes). This brought the total holdings of the herbarium collection to 6,589,861 specimens (6,034,194 vascular plants and 555,667 bryophytes).

Specimen Transactions

The single most important function of the herbarium is facilitating access to the specimens and their associated data. This is accomplished by 1) loaning specimens from the permanent collection to researchers at other botanical institutions, 2) sending gift specimens to specialist researchers in exchange for their expert identification, and 3) sending identified specimens to other botanical institutions in exchange for specimens collected by their staff.

Loans

During 2014, 144 loans, consisting of 16,419 specimens, were made to 88 botanical institutions around the world. Forty percent of the loaned specimens went to institutions in the United States, while 60% went to foreign institutions.

During the same time period, the Garden borrowed on behalf of its staff, students, and visiting researchers 8,401 specimens in 103 transactions. Seventy six percent of the borrowed specimens were from institutions within the United States, while 24% were from foreign institutions.

Gifts

Although a significant portion of newly collected specimens may be identified by Garden staff, it is equally important that specimens from groups where the Garden does not have expertise be sent to specialists at other institutions for authoritative identification. This not only enables the specialists to enrich their reference collections and improves the quality of their own studies, but also insures that the Garden's collection will be as well curated as possible for other users. In a similar manner, Garden staff receive gift specimens in return for their expert identification. During 2014, the Garden sent 10,806 specimens as gifts, while 17,406 specimens were received.

Exchanges

Exchanges are identified specimens that are sent to collaborating institutions in exchange for other specimens prepared by their staff. Exchanging specimens is the primary means for acquiring material from areas where Garden's staff do not work or from non-Garden projects in areas that are of particular research interest. During 2014, the Garden sent 15,166 specimens as exchange and received 11,595 in return.

Research visitors

During 2014, 157 foreign and national research visitors, both student and professional, utilized the Garden's herbarium and library collections and facilities. Sixty percent of research visitors were from US institutions, while 40% were from foreign institutions. Visitors may spend from one day to a year or more on-site at the Garden. This year research visitors invested an estimated 2,075 person-days of work in the herbarium and library collections.

Library and Archives

The Peter H. Raven Library began as a small collection of botany and horticultural books purchased by the Garden's founder, Henry Shaw. From those modest beginnings in 1856, the Library has grown exponentially and is now recognized as one of the most comprehensive libraries of botanical literature in the world.



The Library is a research facility, and its holdings do not circulate. Those interested in using the collection are encouraged to make an appointment. Also, the Library's Imaging Lab has digitized more than 7,200 volumes—approximately 2.5 million pages—and made them available to researchers around the world at the Biodiversity Heritage Library.

The Library collections are divided into two major components: the general collection and special collection. The special collection includes rare books dating back to 1474 and the Garden's Archives, while the general collection includes over 200,000 volumes of monographs and periodicals and more than 3,000 volumes of reference works.

The Archives contain over 4,000 linear feet of manuscripts, documents, and photographs documenting the history of Missouri Botanical Garden as well as the general history of botany and horticulture.

Loans and Reference

In 2014 the Library and Archives answered more than 1,300 reference questions. The Library serves not only visiting researchers but increasingly patrons asking questions via internet and phone. The questions range from those that take only a few minutes to answer, to those that can take hours or days. The Library also provided 460 Interlibrary Loans to individuals and institutions in 14 countries. These loans include physical books and digitized articles sent by email.

During 2014 the Library joined MOBIUS, the largest academic library consortium in Missouri. Membership in MOBIUS will provide improved service to our online catalog as well as provide new and affordable lending and borrowing privileges between the Peter H. Raven Library and 70 MOBIUS member libraries.

Exchange

In collaboration with MBG Press, the Library maintains an exchange program with more than 500 partners around the world. When new journals and books are published by MBG Press they are automatically sent to our exchange partners. In return, we receive all publication published by our exchange partners. This system has been in place since 1890 and continues to provide a significant portion of the 800 journal titles currently received by the Library.

Gifts

In January, Anne Hess donated a collection of over 200 beautiful watercolor illustrations of Ecuadorian plants painted by her late mother Mary Barnas Pomeroy in the 1930s. These paintings were accompanied by Pomeroy's unfinished manuscript *Wildflowers and Landscapes of Ecuador: The Way We Knew It*. The manuscript and illustrations were cataloged, scanned, and combined into a digital book, finally realizing the publication of Pomeroy's work. The originals of the manuscript and illustrations will be permanently accessioned into the Archives.

The Library was also pleased to receive a large donation of recently published titles dealing with horticulture, gardening, and landscape design from Rosemary Joganic. Of the 127 volumes, 89 were non-duplicate titles added to the collection.

Book Conservation

The Library and Archives welcomed Susie Cobbledick to the staff in 2014. Susie is a highly experienced book binder, paper conservator, and librarian. She has brought the book and manuscript conservation program to life, invigorating existing volunteers and adding new volunteers and students, and has already completed conservation treatments on several items that were in desperate need of restoration.

MBG Press

The Missouri Botanical Garden Press plays a key role in the Garden's mission to discover and share knowledge about plants and their environment. The Press publishes two quarterly journals, the *Annals of the Missouri Botanical Garden* and *NOVON, a Journal for Botanical Nomenclature*, as well as floras and taxonomic revisions. Other scientific titles appear through the series *Monographs in Systematic Botany from the Missouri Botanical Garden*. MBG Press provides an important outlet for the dissemination of botanical and conservation research. <http://www.mbgpress.info>

Volume 100 of the *Annals of the Missouri Botanical Garden* was published in November 2014, marking the centennial of the journal. In addition to the bimonthly journals, MBG Press published seven titles in 2014:

Ireland's Generous Nature: The Past and Present Uses of Wild Plants in Ireland, an ethnobotanical compendium by Garden President Dr. Peter Wyse Jackson, which was nominated for the Council on Botanical and Horticultural Libraries annual literature award.

Red List of the Endemic Plants of the Caucasus, an unprecedented collaboration with botanical scientists from the six countries of the Caucasus (edited by Drs. James Solomon, Tatyana Shulkina, and George E. Schatz).

Academic Tapestries: Fashioning Teachers and Researchers out of Events and Experiences, an autobiographical memoir by Dr. Alan Graham, Curator of Paleobotany and Palynology.



Paleobotany and Biogeography: A Festschrift for Alan Graham in His 80th Year, containing 14 papers and published in advance of the Garden's 61st systematics symposium, which was dedicated to Alan Graham and his ground-breaking research into the geological history of New World vegetation and ecosystems (edited by Dr. W. D. Stevens, Olga Martha Montiel, and Dr. Peter H. Raven).

Manual de Plantas de Costa Rica, Vol. VII Picramniaceae–Rutaceae, the sixth volume published in the *Manual de Plantas de Costa Rica* series, which represents an intensive investigation of a Central American flora (edited by Dr. Barry E. Hammel, Dr. Michael H. Grayum, Cecilia Herrera, and Dr. Nelson Zamora)

Preparing Plant Tissues for Light Microscopic Study: A Compendium of Simple Techniques, by Garden research associate Dr. Richard Keating, a compact manual that represents a lifetime in accessible microtechniques for the botanical laboratory.

Catálogo de las Plantas Vasculares de Bolivia, including 47,974 names, is more than a list of the species of plants recorded for the country: the Bolivian catalog also includes citations, synonyms, information about political distribution, types of vegetation, altitudinal distribution, and habits--information useful not only to taxonomists, but also to ecologists, conservationists, and managers of natural resources (edited by Drs. Peter Møller Jørgensen, Michael Harley Nee, and Stephan Georg Beck).

TROPICOS

TROPICOS, the botanical information system at Missouri Botanical Garden, continues to add new floristic projects around its primary authority files. The TROPICOS model is developed to allow individual Garden projects to collect information specific to their objectives while using the plant names, specimens, images, references, and people in the communally developed authority files in TROPICOS, thus not duplicating this now rich data source.



The information in these authority files have increased to over 1.29 million plant names, 4.35 million specimens, 394,000 images, and over 2.45 million pages in the botanical literature portal, *Botanicus*.

During 2014, the specimen georeferencing project recorded coordinates for an additional 500,000 legacy collections resulting in 2,903,000 georeferenced specimens in TROPICOS; a significant resource for GIS modeling, mapping, and analysis.

A primary focus of the continued data collection in TROPICOS will also support the World Flora Online. This global effort to provide a platform for information about all of the world's plants is well underway. As the system is developed, the Garden's floras and monographs are being collected in standard format in TROPICOS and will serve as the Garden's contribution to the World Flora Online. <http://www.tropicos.org>

Science and Conservation Programs

Africa

The Garden's Africa and Madagascar Program is headed by Dr. Porter P. Lowry II from his base in Paris. The Garden's collections from continental Africa are the largest in North America and now number almost 650,000, with more than 15,000 new specimens being accessioned each year.

The Garden's program focuses its efforts on the tropical floras and vegetation of Gabon, Madagascar, and Tanzania, with additional interest in Cameroon, Congo, and Equatorial Guinea, among other countries, and the temperate but unusually rich flora of southern Africa.



Bryology

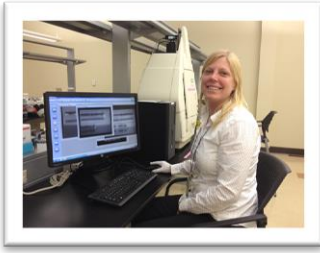
Liverworts and mosses, collectively known as bryophytes, form a significant component of the World's forests, woodlands, and grasslands. These small plants contribute to ecosystems by collecting and slowly releasing water, gathering wind-blown soil, and providing incubators for seeds and small invertebrates. Found on every continent, bryophytes are not only known from moist, tropical rainforests but can be found in the harshest environments from the cold of Antarctica to the deserts of the Americas, Africa, and Asia.



The Missouri Botanical Garden maintains a bryophyte collection of over half a million specimens from around the world. These specimens support the research of six staff bryologists, as well as students and visiting researchers from around the world. The goals of the bryological group are to understand the diversity, relationships, distribution, and contribution of bryophytes to the plant communities they occupy. In this regard the staff is completing this year several major floristic studies on bryophytes: Mosses of Central America, including three new species of the genus *Aptychopsis*

which was previously known only from South America as were the recent discoveries of *Polytrichadelphus longisetum* and *Stenocarpidiopsis selicicola*; Mosses of South Africa, containing a new species of *Plagiothecium* with its closest relative in Australia; the bryophyte volumes for Flora of North America; and recently a detailed study of the bryophytes of Missouri that will detail the distribution of bryophytes in the state and better identify areas of diversity. Eight liverworts have recently been added to Missouri from staff collecting, including: *Bazzania trilobata* var. *depauperata*, *Cephaloziella hyalina*, *Odontoschisma denudatum*, *Riccia campbelliana*, *Riccia tenella*, *Frullania virginica*, *Frullania stylifera*, and *Fuscocephaloziopsis macrostachya*. The new stations for *Frullania stylifera* are especially significant because they are the first records of this species outside of the type locality in Minnesota. *Frullania stylifera* is now known from 12 counties in Missouri.

The bryological group at the Garden continues to collect specimens in unexplored or under explored areas where there is little information on the diversity of the moss and liverwort flora. Recent collecting efforts have been concentrated in Nicaragua, Guinea, and Vietnam/Laos.



Conservation Genetics

The main focus of the conservation genetics program at MBG is to use genetic approaches to understand the evolutionary and ecological causes and consequences of rarity in endangered plant species. The program began with completion of construction on the conservation genetics lab in January 2014. Early 2014 was devoted to purchasing genetics lab equipment and supplies and setting up the lab. Genetic data collection began in April 2014. A graduate student and part-time technician were recruited to the program and an undergraduate student was trained in the lab over the summer. Ongoing projects in the lab are focused on the following topics: 1) using genetic data to help understand the ecology and reproductive biology of endangered plants, 2) using genetic analysis of botanical garden collections to aid in applied conservation and restoration efforts, 3) understanding the relationship between geographic range size and levels of genetic diversity in lineages with rare and widespread plant species and identifying the factors affecting levels of genetic diversity of rare species, 4) elucidating patterns of evolutionary history and species boundaries in closely related species complexes containing endangered plant species, and 5) understanding phenotypic plasticity, the potential for adaptive evolution, and the genetic architecture of phenotypic traits of plants in response to environmental stress/variation. Projects span a broad range of taxonomic groups and geographic areas, but the unifying focus of the program is to use genetic data to help conserve rare plants more effectively.

Ecological Restoration

Unsustainable use of natural resources has degraded natural environments and threatened plant diversity worldwide. The Global Strategy for Plant Conservation, a catalyst to halt the global loss of biodiversity that is spearheaded by the Garden's president, Dr. Peter Wyse Jackson, calls for the restoration of native plant communities along with the comprehensive seed banking efforts necessary to provide seed for these efforts. In response to the current biodiversity crisis, Botanic Gardens Conservation International recently formed the Ecological Restoration Alliance (ERA), an international alliance of 18 member gardens from 10 countries, including the Missouri Botanical Garden, that are collaborating to restore 100 damaged, degraded, or destroyed ecosystems including tropical rainforests, temperate woodlands, grasslands, beaches, wetlands, and more through partnerships with academic groups, industry, and government. In July 2014, MBG hosted an ERA meeting which featured presentations by several garden scientists that highlighted MBG's restoration work in Madagascar, South America, and the United States.

To advance ecological restoration and restoration science at the Missouri Botanical Garden, CCSD recently hired two restoration ecologists, Dr. James Aronson and Dr. Leighton Reid. Dr. Aronson is a leading figure in the global restoration community. Dr. Reid recently completed his PhD on tropical



forest restoration in southern Costa Rica. In November 2014, Dr. Reid initiated an experiment in San Vito, Costa Rica, which examines whether planting keystone fig species can enhance forest regeneration on recovering agricultural lands. Details about this project and others are now documented in a new CCSD blog entitled “Natural History of Ecological Restoration,” which is maintained by Dr. Reid. In December 2014, Dr. Reid also received a small grant from PARTNERS (People and Reforestation in the Tropics) to start a research project evaluating the temporal dimensions of tropical forest restoration.

Over the past decade, Garden scientists in Madagascar have collaborated with local communities to restore native forest throughout this remarkably diverse island nation. The botanical expertise of Garden scientists has been essential for documenting the diversity of native forests and thus providing a reference for restoration efforts. Collaboration with local communities to plant trees and protect forests from destructive activities has helped to improve livelihoods, further reducing pressure on the forest and accelerating the restoration process.

Ethnobotany

The William L. Brown Center’s ethnobotany program has recently conducted research in northwestern South America, eastern Asia, and Madagascar. In the United States, the Brown Center has collaborated with Native American tribes and with academic researchers studying the benefits of medicinal plants. Areas of research interest include the economic and cultural importance of wild-harvested useful plants such as foods and construction materials; the identification and bioactivities of medicinal plants; and the impacts of climate change and other human activities on ecosystems and the people who depend upon them. Projects documenting traditional knowledge return compiled knowledge in a usable format to local communities. The Brown Center develops relationships with communities in areas where it works that facilitate local preservation of useful plants and associated knowledge (e.g., through community gardens) and sustainable development projects.



Graduate Education

The Missouri Botanical Garden offers a broad-based program of graduate studies in systematic botany in cooperation with Washington University, Saint Louis University, University of Missouri-St. Louis, and Southern Illinois University-Edwardsville. Students apply to and enroll at one of these universities and complete the degree requirements of that school, but have full access to the staff, facilities, laboratory, GIS facilities, and research opportunities available at the Garden. The exceptional faculties and programs at these universities in conservation, population biology and genetics, ecology, and molecular biology, combined with the excellent herbarium, library, greenhouse facilities, and research staff at the Garden, make this



a unique and stimulating graduate program. The Garden's strong commitment to conservation and tropical research provides students with outstanding opportunities for field-oriented studies. Dr. Peter Wyse Jackson, President of the Garden, is Engelmann Professor of Botany at Washington University, and many of the Curators are adjunct faculty members at one or more of the participating universities. A student can work under the direction of any regular or adjunct faculty member at his/her university. Students may pursue master's or doctoral degrees at University of Missouri-St. Louis, Washington University, and Saint Louis University, and a master's degree at Southern Illinois University-Edwardsville.

Currently, twenty-one graduate students carry out dissertation research with an advisor at Missouri Botanical Garden. Twenty-one Missouri Botanical Garden scientists are adjunct professors at one or more of the area universities. The Garden scientists advise students, direct research, serve on dissertation committees, and teach courses. Reciprocally, fourteen faculty members from the area universities serve as research associates at the Garden.

Dr. Peter Hoch serves as the manager of the Garden's Graduate Program.

Madagascar

The Garden has a sustained research presence in Madagascar since the 1970s and established a permanent base in the 1980s. The program has grown locally and organically, to more than 150 staff members, almost all of whom are Malagasy.



Recent Program Highlights

After more than 25 years of concentrated work in Madagascar, the Garden is more committed than ever to its conservation efforts in region. The program's recent accomplishments include:

- The planting of 155,919 seedlings of fast-growing non-native trees as an industrial alternative to the wood from native trees
- 888 new species collected and recorded for the Garden's herbarium
- Support for 13 Malagasy university and college students, including 2 doctoral students
- 35 new development projects, including the construction of 9 classrooms and 16 wells
- Support for 91 full-time or part-time rangers
- 4 biodiversity festivals, which cumulatively attracted more than 10,000 visitors
- A change of forest structure and flora monitored in 17 permanent plots
- 277 radio broadcasts and 38 film showings designed to increase awareness among villagers of the importance of biodiversity, how it is threatened, and how it can be conserved
- Propagation of 45,727 seedlings of 135 different native tree and shrub species for the restoration of degraded forest
- Installation of 37 km of firebreak to help protect vulnerable forests from wildfires

Monographic Studies



Monographic Studies is a group of senior researchers who focus on preparing comprehensive, extensive, detailed studies of groups of plants in the particular plant families for which they are specialists. Many other Garden researchers also publish monographic studies, but this particular group focuses exclusively on this kind of study. A monograph is a comprehensive summary of the state of our understanding of a circumscribed group of plants that provides a level of detail not found in other publication, like floras, field guides, or checklists.

Monographic studies in botany are the essential basis for all other studies that involve plants, whether they are ethnobotanical, ecological, agricultural, conservation-focused, or used to make decisions about land use or water resource management. Every time a plant name appears anywhere, its correct application is based on an underlying body of information from a monographic study. The monograph provides each species with a unique scientific name and an accurate description/circumscription, as well as the additional information necessary to allow the correct identification of individual plants. Without this fundamental, basic information, no species can be truly studied or discussed.

Some examples of recent contributions from monographic studies are:

- Descriptions of 18 new species of *Ocotea* (Lauraceae, laurel family), mostly from Ecuador and Peru
- Three collecting trips to Bahia, Brazil, that resulted in a much more detailed understanding of the diversity of Lauraceae in this area, including several new species
- Publication of three new genera of mustards (Brassicaceae)
- Completion of a treatment for the 380 species of Brassicaceae found in the area covered by the Pan-Himalayan Flora
- Production of a modern classification with six other researchers for one of the largest groups of flowering plants, the tropical genus *Psychotria* (Rubiaceae, coffee family), with over 1,000 species
- Descriptions of 23 Rubiaceae species that are new to science discovered by Garden flora inventory and conservation projects, particularly in Peru, Bolivia, and Madagascar.

Tropical America

For many years, the Missouri Botanical Garden has conducted comprehensive botanical inventories of selected areas in the Latin American tropics, including intensive, long-term studies of small permanent plots in regions of richest diversity. To the extent funds are available; the Garden will expand the program to include more than a hundred sites of great biological significance.

The project will help focus conservation efforts and accelerate our understanding of these regions. It will generate an invaluable “Plant Inventory of the Western Hemisphere,” which

will serve as a model for preserving biodiversity. This kind of in-depth knowledge – a road map of tropical diversity – can be obtained no other way.

The Garden has been doing research in the Mesoamerica region since the 1920s. Dr. Gerrit Davidse oversees the program. Mesoamerica is defined by the project to include all of the



Central American republics and five Mexican States east of the Isthmus of Tehuantepec (Chiapas, Tabasco, Campeche, Yucatán, and Quintana Roo).

The Garden is collaborating on a vast international project to publish a Flora Mesoamericana in Spanish.

The Missouri Botanical Garden has been conducting research in South America since the 1970s. The research done in the area includes floristic inventories, checklists, training, and conservation.

The Garden works in Costa Rica, Nicaragua, Panamá, and the Andean región: Bolivia, Chile, Colombia, Ecuador, Paraguay, and Perú.

Countries Visited for Research and Conservation Efforts

Australia	Ecuador	Nicaragua
Belgium	France	Panama
Belize	Gabon	Peru
Bhutan	Germany	Republic of Georgia
Bolivia	India	South Africa
Brazil	Iraq	Spain
Cameroon	Madagascar	Tibet
Chile	Mauritius	United Kingdom
China	Nepal	United States
Colombia	New Caledonia	Vietnam
Costa Rica	New Zealand	

Missouri Botanical Garden New Species Described – 2014

- Aphelandra merelloae* T.F. Daniel & McPherson
Braya sichuanica Al-Shehbaz
Bulbophyllum pauwelsianum Stévant & Droissart
Calantica olivacea Appleg., Phillipson & G.E. Schatz
Calantica pseudobiseriata Appleg., Phillipson, & G.E. Schatz
Calantica sphaerocephala Appleg., Phillipson, & G.E. Schatz
Callicarpa qianyiyongii L.B. Zhang
Callicarpa tenuiflora L.B. Zhang & Yi F. Duan
Cardamine hongdeyuana Al-Shehbaz
Chaunanthus torulosus Al-Shehbaz
Cissampelos arenicola M. Nee & R. Ortiz
Coussarea acrensis C.M. Taylor
Coussarea boliviensis C.M. Taylor
Coussarea camposiana C.M. Taylor
Coussarea maranonesis C.M. Taylor
Coussarea mexiae C.M. Taylor
Coussarea pseudopilosa C.M. Taylor
Coussarea vasqueziana C.M. Taylor
Cybianthus pittierianus Pipoly & Ricketson
Dichapetalum coronadoae Arbeláez & W.D. Stevens
Dictyonema coppinsii Lücking, Barrie, & Genny
Distylodon sonkeanum Stévant
Dombeya micrantha Appleg.
Dombeya milleri Appleg. & Bosser
Dombeya pauciflora Appleg.
Dombeya pilosissima Appleg. & T. Andriam.
Dombeya ratovosonii Appleg. & Bosser
Dombeya vohemarensis Appleg.
Draba dongchuanensis Al-Shehbaz
Dryopteris damingshanensis L.B. Zhang & H. M. Liu
Drypetes birkinshawii McPherson
Eobruchia sichuaniana W.Z. Ma, S. He & Shevock
Eremolaena darainensis Nusb. & Lowry
Eritrichium axilliflorum L.B. Zhang & Yi F. Duan
Eritrichium lianyongshanii L.B. Zhang & Yi F. Duan
Eritrichium wangwencaii L.B. Zhang & Yi F. Duan
Euphorbia haevermansii X. Aubriot & Lowry
Euphorbia nusbaumerii X. Aubriot & Lowry
Fleischmannia pinnatifida Pruski
Gaertnera arenarioides C.M. Taylor
Gaertnera breviflora C.M. Taylor
Gaertnera hirsuta C.M. Taylor
Gaertnera laevis C.M. Taylor
Gaertnera littoralis C.M. Taylor
Gaertnera malcomberiana C.M. Taylor
Gaertnera masolana C.M. Taylor
Gaertnera nitida C.M. Taylor
Gaertnera rakovotaoana C.M. Taylor
Gaertnera razakamlala C.M. Taylor
Gaertnera robusta C.M. Taylor
Gaertnera rubra C.M. Taylor
Gaertnera sclerophylla C.M. Taylor
Gaertnera velutina C.M. Taylor
Gaertnera vernicosa C.M. Taylor
Gaertnera xerophila C.M. Taylor
Gladiolus exalatus Goldblatt & Blittersd.
Gouania croatii A. Pool
Gouania ferruginea A. Pool
Gouania guiengolensis A. Pool
Gouania obamana A. Pool
Gouania pubidisca A. Pool
Lowryanthus rubens Pruski
Lycianthes tibetica L.B. Zhang & Yi F. Duan
Matelea corniculata W.D. Stevens & Arbeláez
Minaria praetermissa W.D. Stevens & Arbeláez
Moraea acocksii Goldblatt & J. C. Manning
Moraea geminifolia Goldblatt & J. C. Manning
Moraea quartzicola Goldblatt & J. C. Manning
Moraea niassensis Goldblatt & J. C. Manning
Moraea teretifolia Goldblatt & J. C. Manning
Nesogordonia chrysocarpa Rakotoar. & Callm.
Noccaea germanii Al-Shehbaz
Noccaea iranica Al-Shehbaz
Noccaea meyeri Al-Shehbaz
Ocotea alveata van der Werff
Ocotea caesifolia van der Werff
Ocotea choquetangensis van der Werff
Ocotea condorensis van der Werff
Ocotea cuscoensis van der Werff
Ocotea cuspidate van der Werff
Ocotea fusagasugensis van der Werff

- Ocotea gymnoblata* van der Werff
Ocotea hammeliana van der Werff
Ocotea latipetiolata van der Werff
Ocotea limiticola van der Werff
Ocotea longipetiolata van der Werff
Ocotea moliivoilosa van der Werff
Ocotea pedanomischa van der Werff
Ocotea pichichensis van der Werff
Ocotea smithii van der Werff
Ocotea solomonii van der Werff
Ocotea vergelensis van der Werff
Palicourea andina C.M. Taylor
Palicourea diminuta C.M. Taylor
Palicourea madidiensis C.M. Taylor
Palicourea sanluisensis C.M. Taylor
Pandanus bernardii H. St. John ex Callm.
Philodendron alanbrantii Croat
Philodendron arbelaezii Croat
Philodendron bayae Croat
Philodendron bernardoii Croat
Philodendron bomboizoense Croat
Philodendron brantii Croat
Philodendron camarae Croat
Philodendron candamoense Croat
Philodendron fosteri Croat
Plagiomnium guizhouense Y.-J. Yi & S. He
Polystichum hagiangense L.B. Zhang, N.T. Lu
 & Liang Zhang
Premna cordiformis L.B. Zhang & Yi F. Duan
Premna emarginata L.B. Zhang & Yi F. Duan
Prockiopsis grandis G.E. Schatz & Lowry
Prockiopsis razakamalalae G.E. Schatz & Lowry
Pteris barklyae L.B. Zhang, X.F. Gao & Liang
 Zhang
Quipuanthus epipetricus Michelang. & C.
 Ulloa
Rhizonema interruptum Lücking & Barrie
Romulea alticola J.C. Manning & Goldblatt
Romulea monophylla J.C. Manning &
 Goldblatt
Ruellia quartziticola Callm., E.A. Tripp &
 Phillipson
Schizolaena capuronii Lowry, G.E. Schatz, J.-F.
 Leroy & A.-E. Wolf
Schizolaena charlotteae Lowry & G.E. Schatz
Schizolaena parvipetala Randrian. & Hong-Wa
Selaginella wangpeishanii L.B. Zhang, H. He &
 Q.W. Sun
Socratina phillipsoniana Callm. & Luino
Solanum brevipedunculata L.B. Zhang & Yi F.
 Duan
Solanum membranisepalum L.B. Zhang & N.T.
 Lu
Sparaxis calcicola Goldblatt & J. C. Manning
Stenanona migueliana Ortiz-Rodr. & G.E.
 Schatz
Vitex lowryi Callm., Phillipson & G.E. Schatz
Xanthosoma nodosum Croat & V. Pelletier
Xyris labatii Rakoton., Callm. & Phillipson
Xyris marojejyensis Lock, Rakoton., Callm. &
 Phillipson
Zuloagocardamum jujuyensis Salariao & Al-
 Shehbaz
Zygotritonia beneshangulana Goldblatt &
 Sebsebe
Zygotritonia teretifolia Goldblatt & J.C.
 Manning

Missouri Botanical Garden Research Publications – 2014

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