



SCIENCE ANNUAL REPORT

2016



MISSOURI
BOTANICAL
GARDEN

"TO **DISCOVER** AND
SHARE KNOWLEDGE
ABOUT PLANTS AND
THEIR ENVIRONMENT IN
ORDER TO **PRESERVE**
AND **ENRICH** LIFE."

—mission of the Missouri Botanical Garden





INTRODUCTION

Since its establishment in 1859, the Missouri Botanical Garden has been dedicated to the study of plants. Today, the Garden is one of the world's leading centers for conserving plant species and their habitats. All of the tools needed for successful plant conservation are available at the Garden. The ability to identify which plant species are threatened, understand their variability, and map their geographic distributions gives the Garden a unique position in the conservation world. The Garden uses this information and associated resources to continue to commit to saving the world's plants through conservation.

Today, the Garden is one of the world's leading centers for conserving plant species and their habitats.



The Garden's Herbarium currently holds more than 7 million dried plant specimens, which scientists use to help identify species that are scarce, have limited geographic distributions, or are at possible risk of near future-extinction. The Garden's Tropicos® plant database utilizes Geographic Information System software to identify the most important places for conservation. Garden conservation geneticists determine how genetic variability may influence the survival of species populations, and Garden conservation biologists work with this data to design species-recovery programs. Garden restoration ecologists are working to restore damaged or degraded habitats in order for the habitats to function again. Long-term survival in the wild is the ultimate goal, but plants are also stored in the Garden's seed banks and maintained in the living collections.



IDENTIFYING CONSERVATION PRIORITIES

1/3

of Earth's known
plant species are at
risk of extinction

13

New protected areas
in Madagascar
managed by
the Garden

One-third of the Earth's 350,000 known plant species are at risk of extinction in the foreseeable future. One of the biggest challenges to conservation is the lack of current, well-supported conservation assessments. The most widely accepted international system for assessment of conservation status is the Red List program supported by the International Union for the Conservation of Nature (IUCN).

In 2016, Garden scientists contributed to completing numerous IUCN Red List assessments. Continuing work on the Global Ebony Assessment led to conservation assessment workshops in New Caledonia with the New Caledonia Plant Red List Authority, Madagascar with the Madagascar Plant Specialist Group, and collaborative work in Rio de Janeiro, Brazil, at the Jardim Botânico with the Centro Nacional de Conservação da Flora (CNCFlora) staff. This work produced modern assessments for numerous species of *Diospyros*.

Dr. George Schatz conducted a workshop on conservation assessment procedures in collaboration with the Panamanian National Parks Authority that produced assessments and trained local staff to continue producing them for plant species endemic to Omar Torrijos and Santa Fé National Parks in central Panama.

Once assessments are available, they can be used to identify geographic areas where large numbers of threatened species co-occur, Priority Areas for Plant Conservation. One such analysis conducted in 2004 has finally seen impact and will save a large number of Madagascar's threatened plant species. In 2015 and 2016, the Priority Areas for Plant Conservation concept led to the establishment of 13 new protected areas in Madagascar managed by the Garden.



DISCOVERY

Discovering new plant species extends our knowledge of the plant world. The majority of species still awaiting discovery and description have very limited geographic distributions, are rare, and are of great conservation concern. If these are not identified and described, they face possible anonymous extinction, gone before they are discovered.

In 2016, Garden botanists discovered and described 128 species of plants that are new to science. Fifty-three new species were from South America and 29 were from Africa and Madagascar. Many of these new species resulted from Garden collecting expeditions to new areas and the subsequent study of the resulting collections. Garden botanists also conducted systematics research, including the use of DNA sequences, to understand how plants are related, and therefore how they should best be classified. As a consequence of these new studies, Senior Vice President for Science and Conservation, Dr. James Miller, coauthored a new plant family, Coldeniaceae, with his German collaborator Dr. Marc Gottschling, from Ludwig-Maximilians-Universität. Also using molecular data, Dr. Rosa Ortiz and collaborators named Spirospermeae, a new subdivision of the moonseed family, Menispermaceae. Dr. Ihsan Al-Shehbaz also used molecular studies to show that three new genera he and colleagues described were not part of the genus in which they had previously been thought to belong, and Dr. Li-Bing Zhang and colleagues reached a similar conclusion for the fern genera *Draconopteris* and *Malafilix*, which they described.

128

New species of
plants discovered by
Garden botanists

53

New species from
South America

29

New species
from Africa and
Madagascar



CONSERVATION ACTIONS

Garden scientists are engaged in conservation efforts aimed to conserve threatened species and important habitats, taking into account increasing pressures from dynamic issues like climate change.

CONSERVATION IN THE UNITED STATES

Dr. Matthew Albrecht and Dr. Quinn Long are working with the Tennessee Department of Natural Resources to save *Astragalus bibullatus*, Pyne's ground plum. This endangered species is known only from a few remaining populations on the outskirts of the Nashville suburbs. Their research shows plants survive in their glade habitats characterized by thin soil over near-surface bedrock, only in a narrow zone between the shade of junipers that grow on the glade edges and the center of the glade, where surface temperatures often exceed 140 degrees Fahrenheit. This knowledge ensures that plants reintroduced into the glades will be placed in the zone where they can survive.

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Dr. Jan Salick is working in coastal Massachusetts with the Native American Narragansett community. She is helping the Narragansett document the effects of changing climate on local vegetation and working with them to identify ways to mitigate the negative effects of climate change and adapt to new environmental conditions.



CONSERVATION ACTIONS

INTERNATIONAL CONSERVATION

The Garden is partnering with the St. Louis Zoo and the Ivoloïna Zoological Park, Madagascar, in a program financed by the Darwin Initiative to propagate and cultivate threatened plant species from Madagascar's east coast lowlands. Scientists are collecting seeds and cuttings of threatened species in the region and growing them at Ivoloïna, where they serve as a buffer against possible extinction in the wild and will be used in the future to re-establish natural populations.

2/3

of the Priority Areas
in Madagascar have
newly obtained
protected status

In 2004, Garden scientists identified 76 Priority Areas for Plant Conservation in Madagascar in response to the Durban Vision program, an effort to triple Madagascar's protected areas announced at the World Parks Congress in Durban, South Africa. Two-thirds of these important areas have obtained protected status. The Garden was granted management authority in 2015 and 2016 over 13 of the Priority Areas for Plant Conservation that have been designated as protected areas. These protected areas conserve a significant percentage of Madagascar's threatened plant species.

452

Herbarium
collections made in
Lomami National
Park

Lomami National Park, the first new national park in the Democratic Republic of the Congo since 1970, was established in July 2016. The Park is 3,426 square miles and is nearly the size of Yellowstone National Park in the United States. The Park encompasses nearly unexplored moist tropical forests and grasslands that are rich in wildlife. Garden botanist Roy Gereau worked with Dr. Marc Sosef of the Botanic Garden Meise and the Wildlife Conservation Society's Corneille Ewango to inventory the area's biodiversity in support of the Park's creation. During the spring of 2015, they traveled by river and foot to make 452 herbarium collections. The project was supported by Terese and John Hart of the Lukuru Foundation, which helped launch the management of the Park. Gereau and his collaborators are working to secure funding for future fieldwork in the area to enhance further the knowledge of its flora and vegetation and support its continued conservation status as a national park.

The Garden began a new collaboration in Gabon in 2016 with the National Association for National Parks (ANPN). The Garden and ANPN will work together on *in-situ* and *ex-situ* conservation in the Mondah Forest Reserve. The Garden will also provide technical input to the ANPN's program inventorying Gabon's biodiversity, including the floras in 14 protected areas managed by ANPN. Dr. Tariq Stévant, coordinator of the Garden's program in Central Africa, will lead a biodiversity study of the Bas Ogooué wetlands, one of the largest and best-preserved wetland areas in all of Africa, which will help development and implementation of the site's future conservation management plan.



SYSTEMATIC, FLORISTIC, AND MONOGRAPHIC STUDIES

Systematics is the study of the diversity and evolutionary diversification of species, including their relationships and how they have evolved in space and time. Floristic surveys study the plants that occur in a given region. Monographic surveys study all of the members of a given plant group. All are important to the advancement of knowledge of plant diversity, and Garden scientists are active in all three areas.

The Garden plays an important role in organizing and working to achieve the World Flora Online (WFO), an internet-available database with information on all of the world's known plant species, their relationships, tools for their identification, descriptions, images, and conservation assessments. The WFO consortium now includes nearly 40 member institutions that have joined the council and participate in regular meetings to advance the work. Garden President, Dr. Peter Wyse Jackson, co-chairs the council with Dr. Pierre-André Loizeau, the Director of the City of Geneva Conservatory and Botanical Garden.

In 2016, the Garden's major effort to support large regional floras continued with the publication of Volume 12 of the *Flora of North America*.

In 2016, the Garden's major effort to support large regional floras continued with the publication of Volume 12 of the *Flora of North America*. This volume, which covers the families Vitaceae to Garryaceae, is another major step toward having a comprehensive compendium of the plants of North America north of Mexico.

Floristic studies at a smaller scale included the *Flora del Páramo del*

Cajas by Dr. Carmen Ulloa and her Ecuadorian colleagues. They also contributed to an illustrated field guide for identifying páramo plants. Together the two significantly add to our knowledge of the open grasslands dotted with numerous plant species of unusual form that have evolved high in the Andes. Dr. Ulloa was recently inducted into the Ecuadorian Academy of Sciences in recognition of her contributions to Ecuadorian botany.

Dr. Charlotte Taylor is one of the world's leading experts on the coffee and quinine family, Rubiaceae, the fourth largest family of flowering plants. She has been leading efforts to complete a review of the Neotropical members, to form the basis for a high-quality treatment in the World Flora Online. In 2016, she published numbers 35 and 36 in her serial monographic review of New World tropical Rubiaceae, including 16 species new to science. These types of studies help us to have an accurate understanding of all plant groups, but are most difficult to achieve in the largest families.

Dr. Ihsan Al-Shehbaz is one of the world's authorities on the mustard family, Brassicaceae. In 2016, he completed systematic revisions of *Anzhengxia*, *Asta*, *Metashangrilaia*, and *Rudolf-kamelinia*. These contributions contribute directly to the World Flora Online.



RESOURCES

THE HERBARIUM

The Garden maintains one of the largest and fastest growing herbarium collections including bryophytes, ferns and allies, gymnosperms, and flowering plants. Currently 6.7 million mounted and accessioned specimens are in the collection, but there are in excess of 7 million specimens when unprocessed specimens are included. There is still an unknown number of un-accessioned specimens in the Herbarium, including many early acquisitions from Europe and North America. The Garden also recently acquired the Dunn-Palmer Herbarium from the University of Missouri, Columbia, which contains an additional yet-to-be accessioned 200,000 specimens.

6.7

Million mounted and accessioned herbarium specimens

THE LIBRARY

The Peter H. Raven Library, with more than 250,000 volumes, including 6,550 rare books published before 1810, is one of the world's most complete botanical libraries. In 2016, efforts to make research material available online continued. The Garden's library has contributed millions of pages representing more than 8,000 titles to the Biodiversity Heritage Library, a consortium of natural history research libraries.

BOTANICAL DATABASES

The Garden has built and continues to maintain the Tropicos database, the world's most extensive collection of information about plants. Tropicos is the most authoritative source of basic information for systematic research. The database currently contains information for nearly 1.3 million plant names, 4.6 million records of herbarium specimens, more than 500,000 images of both living plants and dried specimens, 140,000 bibliographic references, and nearly 2.4 million pages in the literature portal, *Botanicus*.

1.3

Million plant names in TROPICOS

4.6

Million records of herbarium specimens in TROPICOS

2.4

Million pages in the literature portal, *Botanicus*

2016 HIGHLIGHTS

HERBARIUM

61,816

Newly mounted
and accessioned
specimens

Tropicos received more
than **65 MILLION** hits,
with an average of 178,175
queries per day.

LIBRARY

1,160

New books
accessioned

1,163

Reference
queries
answered

530

Interlibrary
loans to 20
countries

OVER

2,500

Electronically
accessible
journals



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