Backgrounder

New Developments in Research at the International Plant Science Center

Although the fact may not be very well known outside the academic and conservation communities, The New York Botanical Garden, through its International Plant Science Center, is one of the world's greatest plant research institutions. We have discovered new information about the plants of the world, especially those of the New World tropics, and disseminated that knowledge through publications and teaching since the 1890s. In service of this mission, we have mounted nearly 2,000 expeditions to collect plants in the wild; assembled the world's largest library about plants and the world's fourth largest herbarium, a collection of pressed plant specimens; and built the world's most sophisticated plant information system online, the Virtual Herbarium (visit nybg.org). The Botanical Garden also has an enormous impact on plant science through our Graduate Studies Program, which has granted 246 advanced degrees in conjunction with five premier universities in the Northeast.

Not all plant research is conducted in the field; much of the work is carried out in the laboratory. Eleven years ago, the Botanical Garden created a program in plant molecular systematics, and five years ago a plant genomics program. Today, we have 50 Ph.D. scientists and graduate students working in these new areas, and we are completing the Pfizer Plant Research Laboratory, a state-of-the-art research facility with 28,000 square feet of high-tech labs and DNA storage, which will be the most modern and forward-looking lab in any botanical research center in the world.

Both molecular systematics and plant genomics use DNA data to answer questions about plant biodiversity and evolution. However, molecular systematics explores the relationships and the history of plant species, whereas plant genomics addresses how genes function and their influence on plant growth and structure. The Botanical Garden's molecular research in plant systematics is conducted in the Lewis B. and Dorothy Cullman Program for Molecular Systematics Studies, a collaborative program established in 1994 with the American Museum of Natural History. The plant genomics research is conducted in the newly constituted Plant Genomics Research Program.

Plant genomics came of age about five years ago, when the first plant genome was sequenced. The genome of a little mustard plant, *Arabidopsis*, was completely sequenced almost concurrently with the human genome. As a result, a whole new era in plant science has opened up, with unlimited possibilities. In the New York Plant Genomics Consortium, our formal partners in studying the genomes of plants are New York University and Cold Spring Harbor Laboratory. NYU's strength is mainly in theoretical questions concerning gene function in plants, and Cold Spring Harbor's is in taking the technology their scientists developed to study the human genome and applying it to plants. Our interest, in keeping with our traditional scientific mission, is in biodiversity and the study of plants and fungi as organisms and populations, both in the present day and throughout evolutionary time. Our university and high-tech partners are excited about working with us because our faculty knows plants, where they live, and the differences between one species and another, and because we can grow plants for gene sequencing and lab analysis in our state-of-the-art Nolen Greenhouses for Living Collections. We also possess a collection of 7.2 million plant specimens. We sit atop one of the world's major repositories of information about plants and their habitats.

In keeping with our tradition of providing the world with the most current data on plants, we are now disseminating molecular information as well as other types of plant information. These new developments in plant research represent the modernization of our role as a primary "source" of plant data.

Laboratory Research Projects

Six current research projects in molecular systematics and/or genomics, all of which will take place in the new Pfizer Laboratory, opening in May, are listed below as examples of our work in these important areas:

l. Dr. Ken Cameron has done extensive work analyzing the DNA of orchids, re-thinking the evolutionary tree, or "family tree," of orchids. His work has revealed that orchids of Australia and South America are related. They share a common ancestor, which indicates an ancient land-mass connection.

2. Cameron is now also identifying segments of plant DNA that can serve as "DNA barcodes," working with species from various groups of plants. The New York Botanical Garden is working in partnership with 12 international institutions to develop this new molecular capability, which is well underway in animals but not yet in plants.

3. Dr. Amy Litt is interested in the genes from within a plant's whole genome that determine the shape of a flower. Will it have the form of a tulip or that of an iris?

4. Litt is also looking at the plant family to which both tomatoes and petunias belong. She is trying to find genes for fruit development—will the fruit be juicy like a tomato or dry like a petunia seed pod? Her aim is to shed light on the evolutionary history of this economically important group of plants.

5. Dr. Roy Halling is looking at another kind of food—fungi. He is studying the boletes, a group that includes the well-known porcini mushrooms. Molecular systematics and fieldwork are combining in his research to fill in large gaps in the scientific understanding of these fungi.

6. Dr. Dennis Stevenson is directing a project identifying the genetic mechanism by which neurotoxins are produced in certain plants. He is studying the action of these compounds within the plants themselves, which may help understand how neurotoxins induce nerve disease in humans.

Field Research Projects

Primarily based in the field rather than in the laboratory, the following investigations represent other areas of The New York Botanical Garden's research:

1. Dr. Bill Buck is documenting the lichens of the Ozarks as part of an effort to preserve their habitats. Right here in our own country, a surprising number of new species are being discovered. Out of an estimated 750 lichen species that occur in the Ozarks, 100 may be new to science.

2. Dr. Charles Peters, a forest ecologist, is collaborating with Dr. Andrew Henderson, an authority on palms, to study rattans, plants in the economically important palm family. Rattans are essential to the huge Asian furniture-making industry. These scientists will be applying their research toward conservation and the sustainable harvesting of rattans in Vietnam, Laos, Cambodia, and Myanmar.

3. Peters is also providing expert scientific guidance to a collaborative community forestry project in southern Mexico. He is advising local artisans and landowners in Oaxaca on the sustainable harvest of wood and marketing of eco-certified handicraft products known as

alebrijes. Dr. Peters and his collaborators have already developed a management plan for the project, and this plan is now in use.

4. Dr. Christine Padoch, an expert in sustainable land management, is studying the genetic diversity of rice in a collaborative project in Thailand. This is an on-the-ground project involving scientists and local farmers.

5. Dr. Michael Balick, an authority on traditional plant-based health care, is leading a collaborative project that is studying healing practices and medicinal plant use in Dominican immigrant communities in New York City. The results of this research are being applied toward cultural competency training for medical practitioners to improve health care for urban immigrant communities.

Why the Botanical Garden Conducts this Research

These research initiatives are important to humankind in many ways. The main reasons that the new molecular systematics and genomics work is pursued at The New York Botanical Garden are the following:

1. The plants and animals on Earth are highly endangered because of the complexity and drive of economic development and human "progress." It is essential to learn everything possible about all aspects of plants—including their ecology, their relationships to animals, their habitats (and habitat destruction), their usefulness for food or other economic purposes, and their biology at every level—and apply this knowledge toward urgent needs in environmental conservation. The newest type of inquiry is at the level of plant genes, about which science knows very little at this early stage in the discipline of genomics. We feel it is the responsibility of a comprehensive research institution such as The New York Botanical Garden to conduct investigative work at all levels of biology.

2. The positive, fool-proof identification of plants used for human food and medicine is critical to consumers, industry, and government agencies the world over. Useless, ineffective, or dangerous plant-based products are being marketed because the wrong species were used in their manufacture.

3. Understanding the evolutionary history or "family tree" of a plant group, especially the species at the node from which new species branch off, contributes to our knowledge of the natural world. Genomic studies are revealing the genes that are responsible for the differences among plant species.

4. Most current plant genomics research is being conducted in commercial settings. The New York Botanical Garden is a biodiversity organization, not primarily concerned with agricultural questions or commercial applications, and not focused on the genetic modification of economically valuable species. We look at the rest of the plants of the world. This sets us and our partners apart, and we believe too few resources are being invested in understanding wild plants (rather than cultivated plants) at the level of their genes. All of our discoveries are disseminated free of cost to the non-profit research community, as is all of the other information we uncover.

5. Today, the most motivated young university students in the life sciences want to pursue molecular systematics and genomics approaches to research questions. It is the way of the future, and The New York Botanical Garden has always wanted the best and the brightest, and we have always wanted to be on the cutting edge.

The Pfizer Plant Research Laboratory

The Pfizer Plant Research Laboratory, the Botanical Garden's new research facility opening on May 16, 2006, will enable scientists to pursue fascinating research agendas such as those detailed earlier in this paper, using the latest and most powerful tools for molecular systematics and plant genomics research. The massive amounts of gene-sequence data that these new technologies enable scientists to analyze are revolutionizing all fields of biology. The 28,000-square-foot Laboratory, designed by Polshek Partnership Architects, will also house the Botanical Garden's large Graduate Studies Program. The building will serve approximately 70 people. It will provide working quarters for scientists, graduate students, and technical staff and accommodate visiting research scientists from around the world. Visitors will also include school groups and undergraduate students.

The Pfizer Plant Research Laboratory is a $23 million project. Principal funding has been provided by the federal government through the leadership of Congressman José E. Serrano; Pfizer Inc and The Pfizer Foundation; the State of New York through the leadership of Governor George E. Pataki; and Lewis B. and Dorothy Cullman.

The International Plant Science Center

The Pfizer Laboratory will complete the Botanical Garden's unique science campus, the heart of its International Plant Science Center. Twenty-three acres dedicated to science and education, the resources and programs of the science campus position the institution at the forefront of international botanical science. In addition to the Laboratory, the campus includes the William and Lynda Steere Herbarium, a collection of 7.2 million specimens used by scientists worldwide to identify species and to determine their characteristics, relationships, and potential uses; and the LuEsther T. Mertz Library, the largest and most active botanical and horticultural library in the world.

With the opening of the Pfizer Laboratory, the Botanical Garden will be the only botanical garden in the world to have opened major new library, herbarium, and research laboratory facilities all within the last four years. The Laboratory also marks the final major addition in a comprehensive 15-year renaissance at the Botanical Garden.

The Staff

The scientific staff at the Botanical Garden, comprising 200 scientists, staff, graduate students, and honorary research associates and curators, is known for its depth and range of expertise in the plant sciences. Botanical Garden scientists are globally recognized authorities on plant diversity. They provide leadership in professional organizations in the plant sciences, including national, international, and United Nations-based organizations, and contribute to wide-scale collaborations in biodiversity research and conservation. Furthermore, they train a new generation of botanical scientists in developing countries, in the United States, and around the world. At the Botanical Garden itself, the Graduate Studies Program trains Ph.D. candidates in joint programs with five leading universities in the region.

The New York Botanical Garden is a museum of plants, a National Historic Landmark with 50 gardens and plant collections on 250 beautiful acres. The Botanical Garden is dedicated to the documentation and preservation of plant biodiversity on Earth through education and research. It has one of the most accomplished, intensive, and distinguished botanical science programs in the world. Located at Bronx River Parkway (Exit 7W) and Fordham Road in the Bronx, the Botanical Garden is open year-round, Tuesday through Sunday and on Monday federal holidays, from 10 a.m.–6 p.m. April through October, and 10 a.m.–5 p.m. November through March. For more information, visit www.nybg.org or call 718.817.8700.

Contacts: Karl Lauby or George Shakespear 718.817.8616

4/18/06