

Chapter 13

Learning in Paradise: The Role of Botanic Gardens in University Education

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*Paradise—from the Greek *parádeisos* (παράδεισος), and ultimately from the Persian *pairidaēza*—enclosed spaces where plants grew.*

13.1 Introduction

A garden means different things to different people, and the kinds of gardens run the alphabet from alpine to zoological gardens. The English word “garden” is derived from the Old High German *gart*—an enclosure, particularly an enclosure containing plants. Yard, orchard, and court are cognates. The term garden is also akin to the term paradise. For some, the garden is the yard surrounding a suburban dwelling. For others, the boundaries are less defined. Among rainforest dwellers, their term includes plantings around the house, cultivated field, and even the adjacent forest. Gardens, in the broadest sense, encompass a diverse array of plant collections (Fig. 13.1).

Botanic (or botanical) has a more specific meaning. Warren (1989, cited in Watson et al. 1993) defined a botanic garden as “a place set aside for the collection, cultivation, and study of plants, serving a variety of scientific, educational, and aesthetic purposes.” Wyse Jackson (1999) offered a similar definition: “an institution holding documented collections of living plants for the purposes of scientific research, conservation, display and education.” Of the thousands of gardens in the world (Figs. 13.2 and 13.3), few achieve all four objectives, and seldom are these objectives integrated or considered to be of equivalent importance.

While most would agree on the four primary roles of public display, research, education, and conservation, the latter recently has become a major focus of many botanical gardens (Ballantyne et al. 2008; Chen et al. 2009; Donaldson 2009). Botanic

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Fig. 13.1 a Shuar home garden with pineapple (*Ananas comosus* (L.) Merr.), sweet potato (*Ipomoea batatas* (L.) Lam.), ginger (*Zingiber officinale* Roscoe), and cassava (*Manihot esculenta* Crantz). **b** Garden plaza in Xalapa, Mexico

gardens also offer unique opportunities for the study of ecological restoration (Hardwick et al. 2011), global climate change (Donaldson 2009; Primack and Miller-Rushing 2009), and even the relationship between humans and nature (Heyd 2006). Nonetheless, Watson et al. (1993) noted that the recurrent functions of botanic gardens were research and education and that those two functions differentiated botanic gardens from parks. The authors also questioned use of the moniker “botanic garden” by institutions not engaged in both education and research. Likewise, He and Chen (2012) cited education and research, along with ex situ conservation, as the major roles of botanical gardens. In this chapter, I focus on two of the objectives of botanical gardens—education and research, specifically at the undergraduate and graduate levels. I hope to make three points in this essay: (1) botanical education is crucial (and not merely for botanists), (2) gardens are integral components in comprehensive training, and (3) gardens are underutilized but invaluable resources.

13.1.1 Brief History of Botanic Gardens, Research, and Education

It may surprise many that botanic gardens and universities share a common heritage. The formation of the physic gardens, which often were associated with universities,



Fig. 13.2 **a** Luther Burbank Home and Garden, Santa Rosa, CA. **b** Coker Arboretum, University of North Carolina, Chapel Hill, NC. **c** The New York Botanical Garden, Bronx, NY. **d** Belfast Botanic Garden, Belfast, Ireland

began in the 1540s with the university gardens at Padua and Pisa. Subsequently, botanical inventories of the gardens, often compiled by people holding medical degrees, were published. Many of the compilers also travelled widely, adding exotic plants to the collections (Holmes 1906).

The modern European botanic garden has its roots in the medicinal plant gardens associated with the medical schools of Renaissance universities (Brockway 1979). Hill (1915) suggests that the establishment of gardens by university medical schools was “largely owing to the need of protecting the doctor and apothecaries against the drug sellers.” Dr. Robert Morrison was the first professor of botany at Oxford University. Hill describes Morrison’s inaugural lecture of September 2, 1679. “He translated himself to the Physic Garden where he read in the middle of it (with a table before him) on herbs and plants for five week space.” Botany remained an important part of medical education for at least the next 200 years. The University of Glasgow established a joint professorship in botany and anatomy in 1718 (Olszewski 2011). The use of fresh plant material from associated physics gardens continued at least through the late 1880s. Isaac Bayley, University of Edinburgh, Professor of Botany (1888–1892), covered his lecture table with plants and flowers from the garden and the hothouse (Olszewski 2011).

The major botanical gardens in the USA also were established with university education in mind. Henry Shaw founded the Missouri Botanical Garden (MBG) in 1859. In 1885, Shaw established the Henry Shaw School of Botany at Washington



Fig. 13.3 **a** The Kampong, National Tropical Botanic Garden, Coconut Grove, FL. **b** Kanapaha Botanical Garden, Gainesville, FL. **c** Queen Sirikit Botanical Garden, Mae Rim, Thailand. **d** National Tropical Botanical Garden, Allerton Garden, Kalāheo, HI

University and created the Engelmann Professorship of Botany, which is held by the director of MBG (Rudolph 1991). More than a century ago, the synergistic relation between the two institutions was predicted to become a “leading center for research, experiment, and instruction in pure and applied botany” (Anonymous 1886). Today, MBG has achieved that goal and is one of the world’s leaders in botanical education at the graduate level. Its graduate program has expanded to include other universities in addition to Washington University and graduates from its program span the globe. Walter Lewis (1972), a former MBG director, observed that the MBG consortium permitted students to study plants in “the heart of the living collections” and that the garden had become what it was intended to be—“the classroom and laboratory of the botanical community.”

The New York Botanical Garden (NYBG), founded in 1891 (Britton 1915) launched its Graduate Studies Program with Columbia University in 1896 (Fig. 13.2c). This arrangement continued until the late 1960s (Lentz and Bellengi 1996) and like MBG, the NYBG graduate program now includes other universities. NYBG with its herbaria, library, museum, and laboratories, coupled with its Columbia University’s Department of Botany partnership, created an entity that rivaled any botanical institution in the Old World (Hill 1915). Other major garden–university partnerships, including Arnold Arboretum/Harvard University, University Botanical Garden at Berkeley, and the Botanic Garden of the University of Pennsylvania, were established in response to the needs in teaching and research in botany (Hill 1915).

13.2 University Level Botanical Education and Botanical Gardens

13.2.1 *Botanical Education Is Crucial*

Crane et al. (2009) aver that “at no other point in history has research in botanic gardens and arboreta, been more important.” Society is becoming ever more removed from both the experience of nature and knowledge of the natural world. Green plants are the dominant and the most salient elements of terrestrial ecosystems; yet, they mostly are neglected in both high school and university biology courses. Sundberg (2011) documented the decline of botany courses at universities throughout the USA. Woodland (2007) considers botanists to be the “dinosaurs of biology in the 21st century,” as the number of botany students, botany classes, botany departments, and botanist’s attendance at national meetings continues to diminish in North America. He also provides several suggestions for reversing or slowing the trend, including engaging students outside the laboratory and emphasizing the value of botanical gardens.

Sundberg et al. (2011) surveyed 1,500 academic faculty, graduate students, government employees, and nongovernmental organizations (NGOs). One of their conclusions was the “Critical need for botanically trained professionals.” More than 90% of surveyed government employees indicated that their agencies lacked the botanical expertise to meet their current management or research needs. They also found that among the skills desired by employers were “Field skills, plant identification ability, and general botanical knowledge.” All subjects aptly suited for botanical garden education programs.

13.2.2 *Gardens Are Integral in Comprehensive Training*

Botanic gardens are living laboratories. While a botanical library and herbarium can form the foundation of botanical education, they must be complemented by a garden (Anonymous 1886). The eminent ecologist Frederick Clements (1911) avowed that “beginning botany cannot be properly taught without adequate greenhouses, as well as gardens.” He even argued for the replacement of textbooks and lectures with hands-on experiences with plants.

Botanic gardens are not substitutes for study in natural areas but should be viewed as complementary, and they offer several advantages to the latter. Among the advantages of botanical gardens are the following:

1. **Convenience and accessibility:** University/garden partnerships, especially when gardens are on or near campus, allow students and faculty to readily visit collections. Instruction time is limited and every hour driving to a field site means 1 hour less of study. Moreover, gardens are designed so that the plant collections are easily accessible.

2. **Diversity:** Some natural areas are species rich, especially those closer to the tropics, but few equal the species density of gardens. In most natural systems, a few species dominate the vegetation. In gardens, there is a greater equanimity where fewer individuals of a species per area equate to more total species.
3. **Global perspective:** In a temperate North American garden, students can see *Chusquea* from Chile, *Eupatorium* from Europe, and *Juniperus* from Japan. In a tropical garden, visitors might encounter *Brassavola* from Brazil, *Cola* from Cameroon, or *Veitchia* from Vanuatu. A few hours of strolling through a garden can be the equivalent of a circumnavigation of a global climate belt. Climate-controlled glasshouses can extend the tour to encompass even more of the world's diversity. Many forward thinking gardens now include local plants as well. For example, teaching plant taxonomy at Fairchild Tropical Botanic Garden (FTG) in Miami, permits students to examine species of Fabaceae from the Neotropics, Africa and Asia, Australia as well as southern Florida, in a single afternoon.
4. **Repeat visits:** Owing to their convenient locations and accessibility, students can return to a garden for additional study and review. It is much easier to learn plants when their names and origins are embossed on a metal tag. Serious students return to the gardens long after their final grade has been recorded.
5. **Aesthetics:** An underappreciated aspect of education is the aesthetics of the learning environment. Among the ways to improve learning is to create a physical environment that supports and encourages learning. Teaching about plants makes sense in a botanic garden owing, in part, to the accessibility of living material. Yet the garden environment is more than a source of pedagogic material. Gardens offer a respite from the normal learning environment that can foster concentration, eliminate distractions, and inspire students.
6. **Outdoor learning:** Learning about the outdoors is best accomplished while outdoors. Most people have a limited knowledge about the common organisms, especially the plants that surround them (e.g., Bebbington 2005). Students learn more effectively about living organisms when they encounter those organisms in the field (e.g., Bauerle and Park 2012; Scott et al. 2012; Taraban et al. 2004). Field components in courses allow student to integrate what they have learned in the classroom (Dillon et al. 2006). Moreover, field courses at the college level can enhance student interest and attention in environmental-focused humanities courses—including environmental history, philosophy, and literature (Alagona and Simon 2010).
7. **Human–nature relationship:** Much of the so-called natural world is a result of both ecological and evolutionary processes as well as the intervention of humans, whether intentional or not. Clark (1996) persuasively argues that the commonly used term “virgin forest” is meaningless. Even as early as 1500, most of the world's vegetation had been affected by some form of human activity. Increasing CO₂ levels during the past century have rendered the question moot. All of the world's forests have been affected (Vitousek 1994). During a recent visit to the Chocó Forests of Ecuador, I accompanied three of my indigenous Chachi colleagues on a 3-day trip to visit a waterfall that they considered to be sacred. The trip required a 5-h motorized canoe journey to the village of Loma



Fig. 13.4 **a** Chachi village Loma Linda, Ecuador. **b** Poling canoe up the Rio San Miguel. **c** Base camp in sacred Chachi forest. **d** Metate near trail of sacred forest

Linda, a 2-h trip in a smaller motorized canoe, followed by an hour of poling up the Rio San Miguel in an even smaller canoe. An 11-km hike took us to a base camp. The next morning, after a 2-h hike, we arrived at the waterfall (Fig. 13.4). The view was spectacular (Fig. 13.5). The forest was seldom visited by humans, and our trip was one of the fewer than a dozen that the Chachi had made in the last 100 years. The forest was replete with large trees, diverse epiphytes, and scores of flowering Gesneriaceae. Animal diversity rivaled that of the plants with three species of primates, a 5-m long boa, a 2-m long bushmaster, scores of collared peccaries, and fresh jaguar tracks. Despite the spectacular biodiversity, what impressed me most was a piece of rock. Near our path, we found a large metate, a carved stone used for grinding corn (Fig. 13.4d). Four of us could barely move it and a smaller one found nearby required at least two people to lift it. Why was this interesting? It revealed that the forest, which would have been termed “virgin” by many ecologists, had once been someone’s cornfield. Human impact on most of the world’s vegetation is now widely accepted, ranging from enrichment planting, to protection when clearing field to intentionally planting along trails (Bennett 1992). Over several generations, such activity can significantly alter vegetation composition and structure. Perhaps then, we should consider the Chachi forest to be a kind of garden. David Fairchild (1838) wrote, “The World is My Garden” describing his adventures in plant collecting. One could accurately paraphrase Fairchild’s book title as the “World is a Garden.”



Fig. 13.5 a Old growth forest view near site where metate was found. **b** View from Chachi sacred waterfall

Janzen (1998) takes this view when he argues for considering wild nature as a garden to change the prevailing philosophy of conservation. Some forests have a relatively small human footprint. Others are mostly human artifacts (e.g., *apê* in Brazil, Anderson and Posey 1989) or Quichua-enriched trailside gardens (Fig. 13.6). Instead of natural and anthropogenic, all humans live somewhere along a continuum of vegetation types from “natural,” with a small human footprint, to the urban and suburban landscape, which is almost completely defined by human activity (Fig. 13.7). The botanic garden, therefore, becomes an ideal venue for examining the human–nature relationship.

13.2.3 Gardens Are Underutilized

Despite their potential for both teaching and research, most botanic gardens are underutilized. This is not a recent trend. Avery (1957) wrote, “Most people have the idea that a botanic garden or an arboretum is a park without a place to play games”, a place where plants bear labels with unpronounceable names—something like an old-fashioned museum. These are sometimes the ‘outdoor laboratories’ of colleges and universities, generally little used except for a few class field trips each year or for student recreation.”

Fig. 13.6 Trail near Cashinua along Rio Napo Ecuador. Quicha plant edible fruit species along trail to provide snacks for their children who use the trail to walk to school



The reasons for the underuse of botanic garden as teaching resources are myriad. Proximity nurtures collaboration and utilization. Unless a garden is situated within a college campus, logistical problems, such as transportation and parking, ensue. Gardens need to provide adequate classrooms (both indoor and outdoor) and facilities to support education. Interpretation and labels are lacking or inaccurate in many gardens. Most botanic gardens struggle to balance the four primary tasks of research, conservation, display, and education. Research and education often are the losers. Yet, when properly planned, each task can benefit the others.

Gardens should be a primary venue for teaching from K–12 to the graduate level. Most organismal botany courses from taxonomy, morphology, anatomy, physiology, economic botany, and ethnobotany could be better taught in a garden than in a standard classroom, especially if the garden provides some classroom/lab space. At the very least, garden excursions should supplement on-campus activities.

Besides teaching, accessioned, vouchered, and properly identified garden collections are excellent sources of research material. Too often students now study plants exclusively in the lab, with no conception of the plant in natural environment. Two graduate students strolling through a college campus were discussing their research projects. One of them, studying the phylogenetic position of a particular species confessed of never having seen the plant that was the focus of her doctoral



Fig. 13.7 **a** Suburban yard landscaped with native trees from southern Florida. **b** Tropical hardwood hammock, southern Florida. Both sites have a similar species composition. The first is completely anthropogenic, the latter is dominated by natural processes

dissertation. Her companion quickly pointed to the plant, a common weed growing in the brick pathway on which they walked. Dr. Mark Chase, one of the premier plant molecular phylogeneticists, wrote of the inspiration that comes from looking at both the DNA and seeing living specimens of the species that he studies, a process he called “reciprocal illumination” (cited in Marris 2006). Many phylogenetic, morphological, anatomical, phytochemical, and reproductive biology studies would not be possible with garden-grown plants. A researcher could collect material from any reasonably sized botanical garden and discover new plant compounds and new types of biological activity, for example. Studies of seasonal variation in plant natural products is another topic well suited for gardens.

Yet, gardens may be even better suited for studying the people–plant relationships. Every garden visitor interacts with the garden as a whole as well as with individual species. Why do they visit gardens? Do they have a home garden? Do any species have particular significance for them? Scores of other questions remain unanswered. In ethnically diverse cities such as London, Miami, or New York, garden visitors come from around the world and they bring their own unique knowledge and lore about many of the plants. This collective knowledge is an untapped goldmine.

Fig. 13.8 Fairchild
Tropical Botanic Garden,
Coral Gables, FL



13.3 Personal Observations

I have taught courses in botanical gardens for more than 30 years. As an M.S. student at Florida Atlantic University, I first visited FTG, then known as Fairchild Tropical Garden, as a plant taxonomy teaching assistant. As a Ph.D. student at the University of North Carolina, I frequently taught local flora and plant taxonomy labs at the North Carolina Botanical Garden. Since 1992, I have taught a variety of Florida International University (FIU) botany courses at the National Tropical Botanical Garden's Kampong Garden, Montgomery Botanical Center, University of Miami's Gifford Arboretum and especially at Fairchild (Fig. 13.8). I also have taught field courses in southern Florida, the Bahamas, Ecuador, Panama, and Peru, which has given me a perspective on the merits and pitfalls of both field and garden-based teaching.

FIU and FTG have a long history of collaboration. From 1992 until 2006, my colleague Dr. Scott Zona and I taught at FTG's Botanical Research Center, located about a mile away from the garden (Fig. 13.9a). Space issues lead to the loss of the classroom for a 6-year period. During this time, FIU classes visited the garden on field trips but did not spend the entire semester in the garden. That changed in the fall of 2012, when Fairchild opened the Burns Building within the DiMare Science Village. The Burns Building includes a classroom/teaching lab located within the garden, and it should be a model for other gardens (Fig. 13.10). The classroom overlooks the Richard H. Simons Fairchild Rainforest, an ideal backdrop for teaching about tropical plants (Fig. 13.11). Prior to its completion, we would lecture at the offsite research center, travel with students to the garden to collect, and then ultimately return to the research center to study the plant material. The new venue alleviates the logistics of transporting students between the research center and the garden. But it does more than save time. At any point during a class, instructors and students can step outside to gather material and quickly return to the classroom/lab. Florida's notoriously frequent thunderstorms no longer disrupt schedules. Students

Fig. 13.9 Dr. Scott Zona and FIU graduate taxonomy class examining *Furcraea* sp. at Fairchild Tropical Botanic Garden



Fig. 13.10 Newly opened Joyce and M. Anthony Burns Building in Fairchild Tropical Botanic Garden's DiMare Science Village. The classroom/lab overlooks the Richard H. Simons Rainforest



enrolled in the FTG courses also are granted semester-long passes to the garden, allowing them to return for reviews as needed.

FTG has an active K–12 program, and teaching in the garden allows college students to interact and serve as mentors to the younger students. Undergraduates

Fig. 13.11 View of the Richard H. Simons Rainforest from the Fairchild Tropical botanic Garden's new classroom/lab



and graduate students also can easily attend the garden's research seminars. For teaching taxonomy, there is no better venue than a botanical garden. The diversity is unrivaled in natural areas, and most garden collections are developed to insure that there are at least some plants in fruit or flower during all seasons. And, unlike in most natural areas, student and professor usually can collect plant material, with the permission of the director of horticulture. Gardens are also excellent venues for teaching about useful plants. It matters little where economic plant collections are labeled in the garden. Any competent instructor can visit a garden and soon discover the interesting people–plant stories to engage students. Nonetheless, ethnobotanical displays are useful for both education and interpretation. Chang et al. (2008) found that the incorporation of traditional wooded canoes in an ethnobotanical display produced more positive influence on visitor learning and perceptions of attractiveness than any other measured factor.

The diversity within a garden is a two-edged sword. While it offers the potential to expose students to a breadth of plant forms, families, and functions, it can also prove overwhelming. Whatever the subject, the optimal teaching philosophy is not to cover every topic, but rather to teach students how to learn on their own—a lesson I learned in a garden. In 1986, I enrolled in Dr. Barry Tomlinson's Harvard Tropical Botany Course, which he taught at Fairchild (Fig. 13.9b). Midway through the course, we visited the nearby USDA Chapman Field. Half the class went with Dr. Tomlinson and the other half toured the collections with a Harvard colleague, who co-taught that year. I wisely opted for Dr. Tomlinson's group. After 4 h we re-convened and someone from the second group asked how many plants we had seen. The Tomlinson students conferred, and then replied "four." The second group was incredulous. "How can you spend 4 hours and see only four plants?" It was a result of Tomlinson's teaching style. For each of the four species, we began by looking at plant architecture, and then moved on to morphology and anatomy. Next, we dissected flower and fruits. We concluded with a discussion of the plant's taxonomy and biogeography. The hour we spent with each species seemed to pass quickly.

Fig. 13.12 Chachi House exhibit at Fairchild Tropical Botanic Garden



Professor Tomlinson knew that there was far too much for a neophyte or even an expert to grasp during a single visit. His objective was broader—to teach us how to learn on our own. I still remember the four plants that we saw, and I doubt that students in the second group could name a single species or a single fact about the myriad of species they encountered that day. I try to employ Professor Tomlinson’s approach with my students, but I must confess that I am seldom as successful as he was. Gardens are wonderful places to teach about plants. They are better places to teach students how to learn on their own.

Another thing that gardens offer that cannot be duplicated in natural areas is the ability to destructively sample material. During the Harvard course, the class dissected a banana plant, a ginger relative (including roots), a large cycad, and a coconut palm among many others. While observing slabs we cut from the trunk of the palm, I was struck by how effective living material is for teaching. Every botany student has sat in a lab looking through a microscope at a cross section of a lily stem. Yet, we could learn just as much about monocot anatomy by examining the coconut palm stems. Moreover, observing the palm sections was a visceral experience. We had collected them and knew how they related to the whole organism.

The four functions of a botanic garden—research, conservation, display, and education (Wyse Jackson 1999)—are often viewed as competing for limited resources. They should be seen as mutually beneficial. In 1996, I planned an ethnobotanical display for Fairchild. In October, we shipped an entire Chachi house, four dugout canoes, and scores of traditional crafts down the Rio Cayapas to the town of Borbón, Ecuador. From there, the material was transported by truck to the port city of Esmeraldas and packed in large shipping containers. A few weeks later, the material arrived in Miami, soon followed by three of my Chachi colleagues: Pedro Añapa, Manuel Añapa, and Miguel Chapiro. During their 2-month stay in Miami, we erected the Chachi House at Fairchild, with help from my graduate students and garden volunteers (Fig. 13.12). During its 5-year span, the Chachi House and adjacent garden proved to be one of the most popular exhibits in the garden (display). Interpretive material and interactions with the Chachi were an invaluable experience for my students and for garden visitors (education). The project contributed to

my long-term study of Chachi ethnobotany (research) and helped publicize the loss of the Chocó forests of Ecuador as, well as the threats to the Chachi culture (conservation). Artifacts from the exhibit continue to be used in Fairchild's education program, which reaches 50,000 K–12 students each year.

13.4 Conclusion

Botanic gardens have a long and well-established relationship with university educations and were especially important in the development of medical education, beginning in the 1500s. Today, with a shift away from organismal biology, gardens often play a minor or nonexistent role in collegiate education. Ironically, the kinds of skills many employers seek, such as plant identification, are the kinds of skills best taught with living plant and not with preserved classroom material. Visits to natural areas are important and cannot be replaced by visits to gardens. Nonetheless, gardens offer several advantages over natural areas with respect to teaching. These include accessibility, diversity of collections (including species from around the world), and the ease of repeat visits for review. The respite from frenetic college campuses and the aesthetics of gardens foster an environment conducive to learning and creativity. Spending class time outdoors also is a refreshing change and allows students to ponder the human–nature relationship.

FTG's new classroom/lab and its collaborative relationship with Florida International University serve as a model to foster university education. It has allowed the garden, in the words of Walter Lewis, to become "the classroom and laboratory of the botanical community." Fairchild's new facilities include office space for faculty and graduate students and four research labs in addition to the classroom/teaching lab. It was a multimillion-dollar venture that is beyond the dreams of many gardens in today's tough financial times. The FTG accoutrements are wonderful, but they are not essential. All that is needed is classroom space and a few good dissecting microscopes. Even the latter may not be absolutely necessary. Much can still be learned about the botanical world with a good hand lens and a razor blade. Thus, with simple cutting implements, magnification devices, and a modest teaching space, any botanical garden can become a valuable venue for teaching and research. We should not miss the opportunity to teach in botanic gardens, to teach in a paradise.

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