The Identity of the African Firebush (*Hamelia*) in the Ornamental Nursery Trade

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Abstract. The neotropical shrub *Hamelia patens* Jacq. has been cultivated as an ornamental in the United States, Great Britain, and South Africa for many years, although only in limited numbers and as a minor element in the trade. Recently, other taxa of *Hamelia* have been grown and evaluated as new flowering shrubs. The relatively recent introduction of a superior ornamental taxon of *Hamelia*, called the african firebush, has propelled this genus to greater prominence as an excellent small flowering shrub or container plant, especially throughout the southeastern United States and in other countries such as South Africa. Initially, this firebush was sold as an African plant. Data from field studies, herbarium specimens, and from DNA analysis of several taxa and populations of *Hamelia* show that the african firebush in southern Florida may have originated from populations of *H. patens* var. *glabra* native to southern Mexico. The original plants were taken to Europe, southern Africa, and southeastern Asia probably in the middle to late 1800s and then recently reintroduced to New World markets as a new African ornamental plant.

The genus *Hamelia* (family Rubiaceae) consists of 16 species of shrubs or small trees native to lowland neotropical areas ranging from southern Florida, the West Indies, and Mexico to Brazil and Argentina (Elias, 1976). The genus is divided into two sections. Section *Hamelia* has strictly tubular red, orange or yellow flowers, and Section *Amphituba* has yellow infundibular or sometimes broadly flaring trumpet-shaped flowers. Species of *Hamelia* have been introduced and cultivated for at least 250 years, with six species grown in England in 1839 (Sweet, 1839). In the United States, the American Exotic Nurseries in Seven Oaks, Fla., offered two species of *Hamelia* for sale in their 1892 catalog: *H. patens* with bright orange flowers, and *H. sphaerocarpa* (Ruiz and Pav.) Pers. with coppery red flowers. Both were promoted as excellent pot plants “growing freely and blooming in great profusion” (American Exotic Nurseries, 1892). In recent years, taxa of *Hamelia* have become important landscape plants in warmer sections of the southeastern U.S. The common and widely ranging neotropical shrub *H. patens* Jacq., commonly known as firebush or scarlet bush, has been cultivated as an ornamental for many years, although only in limited numbers and as a minor element in the trade. Although a long-lived perennial in tropical and subtropical areas, *H. patens* is also recommended and used as an annual bedding

or container plant in more temperate zones. *Hamelia patens* was named a Texas Superstar by the Horticulture Department at Texas A&M University because of its excellent performance during the hot dry Texas summers (www.texas-superstar.com). It has been highly touted by the Mississippi Nursery and Landscape Association for its heat and drought tolerance and adaptation to various soil types (Winter, 2001). *Hamelia patens* is recommended as a low maintenance native shrub in Florida (Gilman and Meerow, 1999), and has been promoted as an attractant for hummingbirds and butterflies to gardeners throughout the southern U.S. as a perennial or annual (Druitt, 2002). The relatively recent introduction of a superior ornamental variety, *H. patens* ‘African’ or african firebush (Fig. 1, top), with primarily yellow to yellow-orange flowers has propelled this genus to greater prominence as an excellent small flowering shrub or container plant throughout the southern U.S. and in other countries such as South Africa.

Hamelia is divided into two sections based on the morphology of the corolla. *Hamelia* section *Hamelia* (eight species) is characterized by a strictly tubular corolla that does not expand noticeably toward the apex, while *Hamelia* section *Amphituba* Elias (eight species) has an infundibular corolla that expands gradually or abruptly toward the apex (Elias, 1976). *Hamelia papillosa* Urb. is the only member from section *Amphituba* used in this study. It is a large shrub or small tree endemic to Jamaica and has yellow broadly campanulate to globose flowers. The african firebush belongs to section *Hamelia* because of its tubular corolla. Species in section *Hamelia* that are phenotypically most similar to the african firebush are *H. chrysantha* Swartz., *H. versicolor* Gray, and *H. patens*. The rare Jamaican *H. chrysantha* has distinctly pedicellate flowers. It has not been seen in recent years,

and may be extinct. *Hamelia versicolor* occurs in southern Mexico and partially overlaps with the Mexican populations of *H. patens*. The latter is the most common of all the species and is subdivided into two varieties: *H. patens* var. *patens* and *H. patens* var. *glabra* Oersted. The widespread *H. patens* var. *patens* is found from Florida, the West Indies, and Mexico to Brazil and Argentina. Typically *H. patens* var. *patens* has red to red-orange flowers, large ovate leaves that are moderately to densely pubescent, with large variation in leaf size, degree of pubescence, and flower and fruit size (Fig. 1, middle). *Hamelia patens* var. *glabra* is found in southern Mexico and disjunctly in northern South America, and has smaller, narrowly ovate pubescent leaves, a more compact habit, and yellow to yellow-orange flowers (Fig. 1, bottom).

Specimens of *H. patens* ‘African’ or african firebush were observed in 1998 in Florida at two retail ornamental nurseries and at the Fairchild Tropical Garden in Miami and in South Africa at a retail ornamental nursery and at a large wholesale nursery with a thriving export business near Pretoria, South Africa. All these

Fig. 1. African firebush (top), *Hamelia patens* var. *patens* (middle), and *H. patens* var. *glabra* (bottom).

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Table 2. Comparison of the Mexican populations of *Hamelia patens* var. *glabra* and the southern Florida and Mexican populations of *H. patens* var. *patens*.

Trait	<i>H. patens</i> var. <i>glabra</i>	<i>H. patens</i> var. <i>patens</i>
Growth habit	Compact, dense.	Open, with longer internodes.
Leaves	Small 4.5–9.0 cm long × 1.5–3.6 cm wide, often 3 or 4 per node. Glabrous, shiny, with green petioles.	Large, 6–18 cm long × 3–8 cm wide, usually 2 per node. Pubescent, often densely so, with usually reddish petioles.
Flowers	Inflorescences often with 30–50 flowers.	Inflorescences often with 20–30 flowers.
Corolla tube	Yellow to yellow-orange with narrow basal constriction, glabrous.	Red to red-orange, often without basal constriction, pubescent.

plants appeared phenotypically identical. They were compact shrubs with three to four small, narrowly ovate, glabrous leaves per node. The yellowish flowers were small, narrowly tubular, and with a constriction at the base of the floral tube. The african firebush that is currently grown and sold in the southeastern U.S. is the first reported African taxa of *Hamelia* and could represent a new taxon not previously reported to be in cultivation. Alternatively, like many earlier examples, it could represent a population that was transported far out of its natural range, maintained in cultivation, and later reintroduced to the region of its origin. The objective of our research was to determine the correct identity of the african firebush, its origin, and its affinities to known existing American populations and taxa of *Hamelia* by examining both morphological and molecular characteristics.

Materials and Methods

Field and herbarium specimens. Herbarium specimens were borrowed from institutional collections of the Fairchild Tropical Garden (Miami Fla.), the National University of Mexico National Herbarium (Mexico City), the Herbarium of the National Botanical Institute (Pretoria, South Africa), the National Herbarium of the Smithsonian Institution (Washington, D.C.), and the Herbarium at the U.S. National Arboretum (Washington, D.C.). These specimens were used to determine the variability and the approximate time of introduction and establishment of species and selected cultivated forms in areas out of its native range. Fieldwork to collect herbarium specimens and seeds was conducted in South Africa, southern Florida, and southeastern Mexico in 1998. Plants were grown from seed at the U.S. National Arboretum and maintained outside in pots during the summer and inside in heated greenhouses in the winter. Voucher specimens of each of these samples were deposited in the herbarium of the U.S. National Arboretum.

DNA extraction and amplified fragment-

length polymorphism (AFLP) analysis. Newly expanding leaves were collected from plants and freeze-dried (Table 1). DNA was extracted from two leaves using a CTAB buffer and the QIAamp Tissue Kit (Qiagen, Inc., Valencia, Calif.) following previously published methods (Pooler, 2003). AFLP analysis (Vos et al., 1995; PE Applied Biosystems, 1996) was performed as described previously (Pooler, 2003). Completed selective reactions were analyzed on an ABI310 automated DNA sequencer with POP4 polymer. The sample was prepared by mixing 1 µL of selective reaction, 0.2 µL ROX size standard, and 9.8 µL deionized formamide. The experiments were repeated to ensure reproducibility of results.

Data analysis. Markers were scored with Genotyper 2.5 software (Applied Biosystems) and assigned a value of 1 (presence of a marker) or 0 (absence of a marker) for each sample. Markers that were not scored the same in both replications of samples were assigned a score of 9 to represent missing data. Markers in which at least six of the 27 samples had missing data points were not used, nor were markers for which all samples were scored as only 0 or 9. Similarity coefficients between each accession were calculated using the SIMQUAL program in NTSYS-pc, version 1.70 (Rohlf, 1992), using the Dice similarity coefficient [$2a/(2a + b + c)$], where a = total number of bands shared by both individuals, b = bands unique to one individual, and c = bands unique to the other individual. These data were subjected to cluster analysis using the UPGMA method in the SAHN program of NTSYS to generate a phenogram. A cophenetic matrix was constructed and compared with the similarity matrix using the MXCOMP program to test the goodness of fit of a cluster. Bootstrap analysis of 1000 replications was performed using WinBoot (Yap and Nelson, 1996) to estimate supports for individual clusters (Felsenstein, 1985).

Results

Specimens of *H. patens* var. *glabra* collected wild in Veracruz and Oaxaca, Mexico

and from cultivated sources in South Africa are virtually identical to those specimens sold in the southeastern U.S. as the african firebush. Field observations in southern Florida confirmed that this plant is distinct from the *H. patens* var. *patens* native to southern Florida (Table 2). Specimens of *H. patens* var. *patens* are also sold by some nurseries; however, *H. patens* var. *glabra* is generally regarded to be a superior ornamental plant due to its compact growth habit, small shiny leaves, drought- and heat-tolerance, and abundant flowering over several months.

Our AFLP analysis using four selective primer pairs (MseACC/EcoCAG, MseACG/EcoCTG, MseAGC/EcoCAC, and MseAGG/EcoCTG) generated 95 polymorphic markers, and UPGMA analysis of these markers resulted in a phenogram with a cophenetic correlation (r) of 0.96 (Fig. 2). Accessions of *H. versicolor* were clustered together (bootstrap value 100%), and were separated from the cluster containing *H. papillosa*, african firebush, *H. patens* var. *patens*, and *H. patens* var. *glabra*. Accessions of african firebush formed a cluster that was sister to the cluster of *H. patens* var. *glabra*.

The clustering clearly groups the african firebush that is sold in the Miami, Fla., region with the Veracruz and Oaxaca populations of *H. patens* var. *glabra*. The Mexican *H. versicolor* and *H. patens* var. *patens* are distinct from *H. patens* var. *glabra*. Based on this data, it is apparent that the african firebush is genetically quite similar to and probably originated from one or more of the populations from southern Mexico. Because we did not study samples of *H. patens* var. *glabra* from South America and therefore do not know how closely related those populations are to the Mexican populations, we cannot rule out the possibility that the plant could have also come from South America.

While there are scattered records of *Hamelia* species cultivated in gardens and plant introduction stations throughout tropical regions of the world, the country of most intense cultivation and known commercialization of *Hamelia* is South Africa. It is unknown when *H. patens* var. *glabra* was first introduced to South Africa. It has

Table 1. Accessions of *Hamelia* used for morphological and molecular comparisons. Voucher specimens of each of these samples are deposited in the Herbarium of the U.S. National Arboretum.

Accession no.	<i>Hamelia</i> species	Collection notes
1	<i>patens</i> var. <i>patens</i>	Fairchild Tropical Garden, Accession #90-475A
2	African firebush	Fairchild Tropical Garden, Accession #96-1151A
3	<i>papillosa</i>	Fairchild Tropical Garden, Accession #95-1489A
4	<i>patens</i> var. <i>patens</i>	Seed from accession #1
5	African firebush	Seed from accession #2
6	<i>patens</i> var. <i>patens</i>	Seed collected Oct. 1998 in Veracruz, Lake Catemaco, Mexico. 18°26'03"N, 95°05'23"W. 370 m. Disturbed tropical forest.
7	<i>patens</i> var. <i>glabra</i>	Seed collected Oct. 1998 in Veracruz, Alvarado, Mexico. 18°52'52"N, 95°55'26"W. 0.5 m. Stabilized coastal dune.
8	<i>versicolor</i>	Seed collected Oct. 1998 in Oaxaca, Mexico. 16°18'43"N, 95°26'43"W. 400 m. Tropical dry forest.
9	<i>versicolor</i>	Seed collected Oct. 1998 in Oaxaca, Mexico. 16°18'50"N, 95°26'41"W. Tropical dry forest.
10	<i>patens</i> var. <i>glabra</i>	Seed collected Oct. 1998 in Oaxaca, Mexico. 16°57'13"N, 95°00'45"W. 120 m. Tropical forest elements.
11	<i>patens</i> var. <i>patens</i>	Seed collected Oct. 1998 in Veracruz, Xico, Mexico. Dense mixed tropical forest.

Fig. 2. UPGMA-derived phenogram of genetic similarity of *Hamelia* accessions based on 95 characters from four AFLP primer pairs. Accessions are as listed in Table 1, with hyphenated accessions representing individual plants from the same seed source. Cophenetic correlation coefficient (r) = 0.96. Bootstrap values for clusters are indicated above branches.

been documented from herbarium specimens in a park in Pretoria in 1955. By the middle to late 1960s, it was being cultivated in many regions including Richards Bay, Durban, and Sandton, and was sold by Malans Nursery near Pretoria. Now it is widely sold by commercial nurseries in South Africa and available as an export product. Based on herbarium records, similar small-leaved forms of *H. patens* are known to have existed as far away as Java in 1924 and in Bangkok, Thailand in 1899.

Discussion

The identification of a new plant in the ornamental nursery trade is sometimes complicated by human activities. In some cases deliberate selection or hybridization can produce specimens that are phenotypically different from known wild taxa, making accurate identification more difficult. Likewise, the transport of plants from one continent to another can obscure the true origin of a plant. Misidentification and mistakes in attributing the correct country of origin of plants in the nursery trade is common. For example the california pepper tree (*Schinus molle* L.) is actually native to Chile. Likewise, the introduction of a Mexican population of *H. patens* var. *glabra* via South Africa created the impression that a new African species of *Hamelia* with superior horticultural traits had been found.

Our finding that the african firebush is probably *H. patens* var. *glabra*, most likely from Mexico, is not surprising considering the historical trade routes for plants. Early English, Spanish, Dutch, and Portuguese explorers and horticulturists took hundreds of tropical American plants to Europe for cultivation in gardens and conservatories. Many of the plants were then taken to stations in southeast Asia via Africa in the search for new food, fiber, medicinal, and ornamental plants. The West Indies became a critical staging area to hold living plants until they could safely make the trans Atlantic voyage. Other major ports such as Veracruz, Mexico, served as important points of embarkation of goods including plants and seeds for Spanish ports. Many New World plants, both temperate and tropical, were taken to more suitable climates and staging areas for reestablishment, testing and evaluation. The Cape region of South Africa, for example, served as a major transfer point and reprovisioning center for trade between the Orient and Europe from the 1650s through the 1950s (Karsten, 1951). Thus, it is easy to see how the origin of the african firebush could have become obscured.

Living material of *H. patens* var. *glabra* from northern South America was not available for DNA evaluation; thus, the relationship of the plants from this region to the african firebush and the Mexican *H. patens* var. *glabra* populations is unknown. Further studies of the highly vari-

able *H. patens* complex is needed to ascertain if this taxa is a highly variable species or if *H. patens* was too broadly prescribed in the 1976 monograph (Elias, 1976) and actually constitutes two or more taxa. While that question will not be answered here, it is apparent from these studies that the small-leaved, yellow flowered plants in the commercial trade are more closely related, if not identical, to populations sharing the same characters in southern Mexico.

Other species of *Hamelia* have potential merit as medium-sized to large ornamental flowering shrubs, including the species of section *Amphituba* with large, flaring yellow flowers. *Hamelia* specimens are easy to propagate, grow readily, and tolerate a variety of soils. Further selections and introductions of *Hamelia* taxa are anticipated.

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