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Floristic Richness and Affinities in the West Indies

Pedro Acevedo-Rodríguez[1,2] · **Mark T. Strong**[1]

[1] Department of Botany, National Museum of Natural History, Smithsonian Institution, P.O. Box 37012, Washington, DC 20013-7012, USA
[2] Author for correspondence; e-mail: Acevedop@si.edu

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Abstract Comparison of the common floristic elements between the West Indies and the surrounding continents shows a mosaic of affinities that are stronger to Central America and South America as a whole than with either one of them separately or with North America. However, since only 28% of the total West Indian seed plant flora is shared with other geographic regions of the world, the referred exercise is of limited value. Numerous tables are provided to show the distribution of genera throughout the archipelago. The application of phylogenetic studies into the service of biogeography is herein regarded as the next necessary step in elucidating the origins and affinities of the West Indian flora.

Resumen El estudio comparativo de los elementos florísticos que existen en común entre las Indias Occidentales y los continentes circundantes muestran un mosaico de afinidades más cercanas a Centro América y Sur América en su totalidad, que con cualquiera de ellos por separado o con Norte América. Sin embargo, este estudio es de valor limitado ya que solo el 28% del total de la flora de plantas con semillas en las Indias Occidentales es compartido con otras regiones del mundo. En este estudio, se muestran numerosas tablas resumiendo los valores de endemismos, la distribución de los géneros dentro y fuera del archipiélago, así como los géneros más especiosos. La utilización de estudios filogenéticos al servicio de la biogeografía en las Indias Occidentales es considerado como el próximo paso esencial para la elucidación del origen y de las afinidades de la flora Antillana.

Keywords West Indies · Seed Plant Flora · Phylogenetic Studies

Introduction

The West Indies are an archipelago with more than one thousand islands that separate the Atlantic Ocean from the Caribbean Sea and cover a distance of 2,700 km from Barbados to the most western tip of Cuba (Howard, 1973). They are not in contact with the continents although they are relatively close, at about a distance of 150 km between Grenada and South America and 210 km between Cuba and Yucatan. These islands are generally divided into three archipelagos with different topography and independent geological history, i.e., the Lesser Antilles,

Greater Antilles and the Bahamas Archipelago (Bahamas Islands + Turks and Caicos Islands).

The Lesser Antilles belong to a small volcanic arc with about 21 main islands and numerous islets and keys dating from Mid Eocene (about 45 m.y.) with an approximate total area of 8,320 km^2. These islands are commonly referred to as the Windward and the Leeward Islands according to their position relative to the prevailing winds. The Windward Islands in the south are directly exposed to the south to north trade winds, while the Leeward, in the north, are sheltered from these currents. The Windward Islands include: Grenada, The Grenadines, St. Vincent, Barbados, St. Lucia, and Martinique, while the Leeward Islands include: Dominica, Marie Galante, Guadeloupe, La Desirade, Montserrat, Antigua, Nevis, St. Kitts, Barbuda, St. Eustatius, Saba, St. Barthélemy, St. Martin, and Anguilla. In contrast to popular opinion, the islands north of the South American coast do not belong to the Lesser Antilles, these include the Netherlands Antilles (Aruba, Curacao, & Bonaire), the Venezuelan Antilles (Las Aves, Los Roques, La Orchila, La Blanquilla, Tortuga, and Margarita,), and Trinidad and Tobago.

The Greater Antilles, which lie northwest of the Lesser Antilles, comprise the islands of Cuba, Cayman Islands, Jamaica, Hispaniola (Dominican Republic + Haiti), Puerto Rico, and the Virgin Islands, plus hundreds of cays and islets for a total approximate area of 211,108 km^2. Their respective areas are as follows: Cuba: 114,524 km^2, Hispaniola: 76,290 km^2 (Dominican Republic: 48,380 km^2 + Haiti: 27,560 km^2), Jamaica: 10,830 km^2, Puerto Rico 8,959 km^2, Virgin Islands: 505 km^2 (USVI: 352 km^2 + BVI: 153 km^2), and Cayman Islands: 264 km^2. The Virgin Islands are sometimes classified as belonging to the Lesser Antilles, however, geologically (except for St. Croix) they form part of the Puerto Rican insular platform, and therefore they should be considered part of the Greater Antilles. The Greater Antilles posses an extremely complex geological history with its islands made of strata of different geological ages. Western and Central Cuba contain the fragmented remains of the North American tectonic plate (of Precambrian age, i.e., ca. 1,000 m.y.), Cretaceous volcanic rocks and associated oceanic crust, and Jurassic to Lower Cretaceous limestone (Draper et al., 1994). Eastern Cuba, Northern Hispaniola, Puerto Rico, and the Virgin Islands are derived from materials of the Caribbean plate consisting of a Jurassic oceanic basement (ca. 200 m.y.) overlain by Lower Cretaceous to Tertiary island arc deposits (115–60 m.y.). On the other hand, Jamaica and Southern Hispaniola, have a basement of Upper Jurassic to Lower Cretaceous oceanic crust (160–100 m.y.), overlain by Upper Cretaceous volcanic rocks and tertiary sedimentary limestone (Draper et al., 1994).

The Bahamas Archipelago lies north of the Greater Antilles and contains the territories of the Bahamas islands and of Turk and Caicos. This archipelago is formed by thick limestone deposits (6–10 km deep) that date back to the Jurassic (Draper et al., 1994), and is comprised of hundreds of islands for a total approximate area of 10,070 km^2.

There is considerable variation among the islands of the West Indies, these include size, altitude, precipitation, soil types, and mean temperatures. Some of the Caribbean islands are relative flat limestone deposits that slightly emerge from the sea (Fig. 1). Others are large, massive islands, containing large deposits of limestone overlaid by dry to moist vegetations (Figs. 2 and 3), and characterized by the

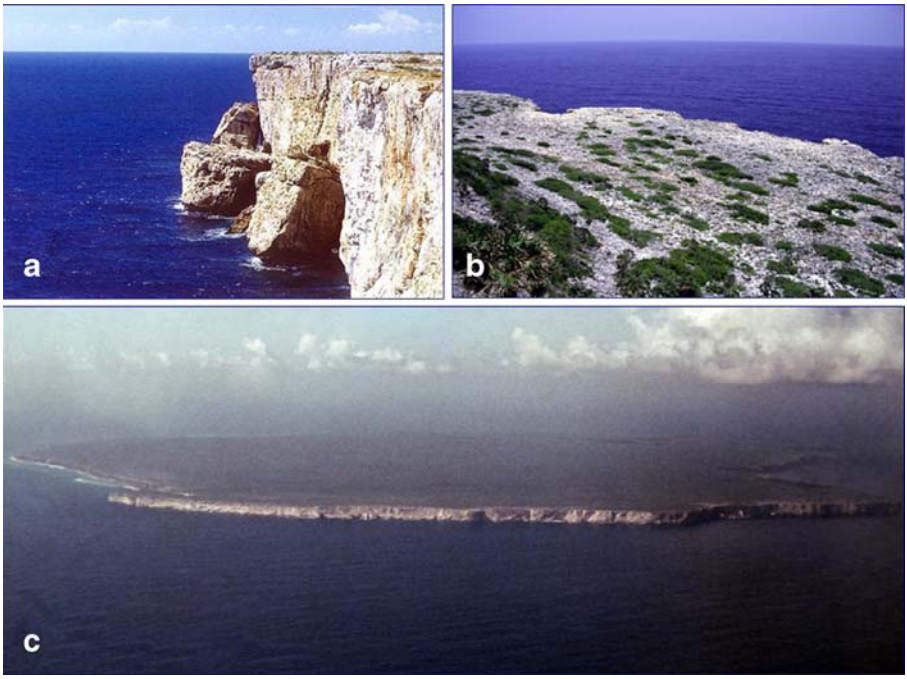

Fig. 1 Exposed limestone deposits. **a** Cabo Rojo, Puerto Rico; **b** Navassa Island; **c** Mona Island, Puerto Rico

presence of a few to several mountain ranges, that reach a maximum elevation of 3,100 m in the Dominican Republic.

The West Indian Vegetation

The West Indies are said to have been covered by forest of various kinds in almost their totality when the Spaniards arrived more than 500 years ago (Labbad y Lasierra,

Fig. 2 Eroded limestone deposits covered by vegetation, Los Haitises, Dominican republic

Fig. 3 Eroded limestone deposits covered by vegetation (mogote formation), Pinar del Río, Cuba

1788). Through time, colonial powers transformed the prevalent natural habitats through logging, and the establishment of large scale plantations, range lands, and permanent dwellings. The European colonization brought about a considerable biotic exchange, bringing in numerous crops and weeds and taking back to the Old World an equal amount of economical and weedy species (Fernández Oviedo, 1535). The destruction of the natural habitats has been extensive, spreading over the whole region. The amount of forest that remains nowadays on these islands varies from 3.2% (in Haiti) to nearly 84% (in the Bahamas) of their total territory, for an average of 25% for the entire West Indies (FAO, 2000). Most islands however, have between of 21% to 30% of their territory covered by trees (Fig. 4), these forming natural forest, secondary forest, or sometimes active or abandoned forest-like plantations.

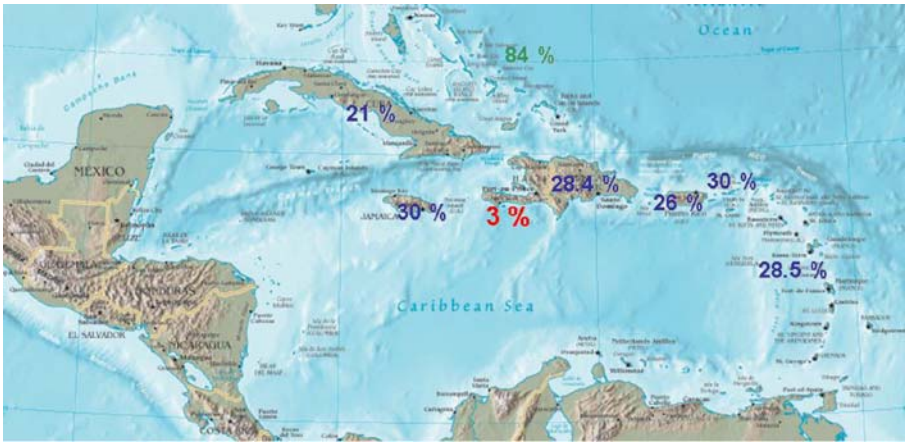

Fig. 4 Percent of forest remaining in the West Indies according to FAO estimates, 2000

Fig. 5 Palm forest ecosystem, prevalent on moist mountain slopes, Puerto Rico

The geography of the West Indies is highly variable with numerous habitats and microclimates capable of sustaining numerous vegetation types with an extremely high diversity of plants. This fact is illustrated in a recent publication by Areces-Mallea et al. (1995) where 104 vegetation types are recognized for the Caribbean islands. Their classification includes numerous types of forests (Figs. 5, 6, 7, 8), woodlands, scrublands (Fig. 9), and herb-dominated vegetations. Within these formations, they recognize numerous alliances and associations based on floristic dominance that mostly pertains to specific islands.

Floristic Studies

Early Studies

Because of the generalized destruction and degradation of habitats in the West Indies we do not know with certainty how many plant species may have been lost in the

Fig. 6 Moist, broad-leaved forest dominated by Dacryodes exelsa, Puerto Rico

Fig. 7 Cloud forest dominated by arborescent ferns, Puerto Rico

past. The base line for conservation studies in the region comes from the early botanical surveys carried out by French and British naturalists, nearly 200 years after the discovery of the Americas. These include the work of Plumier (1693, 1703, 1755–1760) in the French colonies, and the work of Plukenet (1691), and Sloane (1696, 1707–1725) in the British colonies. These early publications contained numerous illustrations and although based on polynomial (phrase) names (later to be replaced by the simpler binomial system of Linnaeus), they opened a window into the vast richness of Neotropical plants, depicting plants never seen by the Europeans. The work of Plumier, who mostly worked in Haiti, has been a particularly important source of generic and specific names for Linnaeus, Jacquin,

Fig. 8 Pine forest (Pinus occidentalis) in central Hispaniola

Fig. 9 Cactus scrub on limestone subtrate, Guánica, Puerto Rico

Swartz, and posterior botanists. Likewise, the work of Sloane in Jamaica (and other British colonies) has been a corner stone for Caribbean botany.

Linnaeus and the Species Plantarum

The adoption of the binomial system devised by the Swedish botanist Linnaeus (1707–1778) and consistently applied since his *Species Plantarum* of 1753 (Linnaeus, 1753), marked a revolution in the nomenclatural system of classification of living organisms. A simpler, binomial (genus + species) name came to replace the cumbersome phrase-name system of previous centuries. The Species Plantarum of Linnaeus has pivotal importance as it has been declared the starting point of modern nomenclature in flowering plants. The Species Plantarum was an attempt to described the known plants of the world, where approximately 7,700 species where described and named under the new binomial system of classification. Of these, 239 species where described from plants collected in the West Indies as follows:

- JAMAICA: 135 species. e.g., *Cyperus elegans*, *Piper aduncum*, *Piper amalago*, *Rivina humilis*, *Sapindus saponaria*, *Tragia volubilis*, *Passiflora rubra*, *Theobroma cacao*, *Conocarpus erectus*, *Plumeria rubra*, *Plumeria alba*, *Cestrum nocturnum*, *Melothria pendula*, *Cucumis anguria*.
- LESSER ANTILLES: 75 species. e.g., *Phaseolus unguiculatus*, *Plukenetia volubilis*, *Gossypium barbadense*, *Solanum mammosum*.
- HISPANIOLA: 20 species. e.g., *Cupania americana*, *Paullinia pinnata*, *Hippocratea volubilis*, *Mammea americana*.
- CUBA: 7 species. e.g., *Phaseolus vexillatus*, *Cestrum diurnum*.
- PUERTO RICO: 2 species. e.g., *Guaiacum sanctum*.

Although the number of Caribbean species listed in Linnaeus' Species Plantarum is very low, its contribution to Neotropical botany is substantial, due to the fact that most of these species are either wide-spread in the Neotropics or are economically important. In posterior publications (Linnaeus, 1756, 1762, 1767), Linnaeus described several additional dozens of plants based on West Indian collections.

Linnaeus Contemporaries

The Dutch born Austrian botanist, N.J. Jacquin (1727–1817) is one of the most important early contributors to the Caribbean flora. As opposed to Linnaeus, who never visited the West Indies, Jacquin spent nearly 5 years (1755–1759) in the Caribbean region (West Indies and the north coast of South America) collecting plants and seeds for the first official Austrian botanical expedition (D'Arcy, 1970). Jacquin described numerous new species of West Indian origin in some of the lavishly illustrated botanical treatments prepared by him (Jacquin, 1763; 1800–1809).

Late 18th and 19th Centuries

At the turn of the 18th century, the work of the Swedish botanist, O. Swartz (1760–1818) is among the most important early work in the region. Swartz explored the islands of Jamaica, Cuba, and Hispaniola and published several books on various subjects of Caribbean botany. Among the most important one is his *Florae India Occidentale* (1797–1806) the first attempt of a synthetic flora for the whole Caribbean region, where 1,005 species of plants were accounted for (Urban, 1898).

Although many workers contributed to expanding the knowledge of Caribbean botany during the first half of the 19th century, the most comprehensive of all, is the work of A.H.R. Grisebach (1814–1879). In 1857 Grisebach published a checklist for the plants of the Caribbean region where he listed 1,486 species (Urban, 1898). This publication was followed by his *Flora of the British West Indian Islands,* published from 1859–1864 where 3,409 species were treated, being the most comprehensive Caribbean floristic treatment at the time (Grisebach, 1859–1864).

Late 19th and 20th Centuries

At the turn of the 19th century, botanical studies in the Caribbean acquired a new dimension with the work of I. Urban (1848–1931). His *Symbolae Antillanae,* published from 1898 to 1928, is extremely important as numerous genera and species from the West Indies were therein described for the first time. In particular, this work constitutes the first attempt to describe the flora of Hispaniola, thanks to the exceptional contributions of the Swedish botanist, explorer and plant collector Erik Ekman. Urban and Ekman coauthored more than 600 taxa of seed plants, either described in Urban's Symbolae Antillanae or in various scientific journals.

Contemporary to the work of Urban, is that of N.L. Britton (1859–1934), founder of the New York Botanical Garden, who substantially contributed to the study of Caribbean botany. In his *Botany of Porto Rico and the Virgin Islands* (Britton & Wilson, 1923–1926), he described numerous endemic species and refined many of the generic concepts applied to the region.

The second half of the 20th century, received the contributions of Bro. León (1871–1955), H.A. Liogier [(also known as Bro. Alain) 1916-], R.A. Howard (1917–2003) , C. D. Adams (1920–2005), and G.R. Proctor (1920-) among others. The most important floristic publications of these and other workers are summarized in Table 1.

Table 1 Summary of Floristic Studies

Location	Study
Bahamas	Britton & Millspaugh, 1920; Correll & Correll, 1982 (illustrated flora)
Cuba	Richard, 1845a, 1845b, 1850; Grisebach, 1860, 1866; León, 1946; León & Alain, 1951–1957; Alain (Liogier), 1962, 1969; Flora de la República de Cuba, 1992-present
Cayman Islands	Hitchcock, 1893; Proctor, 1984
Jamaica	Browne, 1756; Linnaeus, 1759; Macfadyen, 1837–50 (incomplete work); Fawcett & Rendle, 1910–36 (incomplete work); Adams, 1972; Proctor, 1985 (ferns); Proctor, 1967, 1982
Hispaniola	Liogier, 1982–1996; Liogier & Martorell, 2000, Dicotyledons (Cactaceae, monocotyledons, gymnosperms and ferns to be completed). Haiti: Barker & Dardeau, 1930. Dominican Republic: Moscoso, 1943; Jiménez, 1967
Puerto Rico	Stahl, 1883–1888; Britton & Wilson, 1923–26 (the most complete floristic treatment for Puerto Rico and the Virgin Islands); Liogier, 1985–1997 (dicotyledons); Little & Wadsworth, 1964; Little et al., 1974 (trees); Proctor, 1989 (ferns); Ackerman, 1995 (orchids); Acevedo-Rodríguez, 2003, 2005 (vines); Acevedo-Rodríguez & Strong, 2005 (gymnosperms & monocotyledons); Peterson (in prep., grasses)
Virgin Islands	Britton, 1918; Anegada: D'Arcy (1971); St. Croix: Eggers (1879); St. Croix.: Millspaugh (1902); St. John: Acevedo-Rodríguez & collaborators, 1996. Tortola: D'Arcy (1967)
Lesser Antilles	Flora of the Lesser Antilles (Howard, 1974–1989); Flora of the Netherlands Antilles (Stoffers, 1962–1966); Flore illustree des phanerogames de Guadeloupe et de Martinique (Fournet, 1978); Flora phanerogamique des Antilles Françaises (Duss, 1897); Flora of Barbados (Gooding et al., 1965), Flora of Dominica (Hodge, 1954; Nicolson, 1991); St. Bartholomew (Questel, 1941); The Grenadines (Howard, 1952); St. Vincent (Royal Botanic Gardens, Kew, 1893); and St. Eustachius, Saba & St. Martin (Boldingh, 1909)

The above summary table shows the abundance of single islands floristic treatments. While the flora of most islands has been studied, a floristic assessment of the entire region is still lacking.

Floristic Richness

In spite of the long tradition of botanical studies in the West Indies, much work remains to be done. There are abundant floras for individual islands or for groups of islands, but a comprehensive flora for the whole region or for the Greater Antilles is still missing. Plant endemism in the West Indies has never been calculated with certainty due to the lack of reliable floristic information for the whole region. Centuries after the treatments of Swartz (1797–1806) and of Grisebach (1857) we still do not have an absolute number of the taxa occurring in the West Indies, as there are numerous problems to be solved. These include taxonomical, nomenclatural, bibliographical, place of origin and distribution issues to evaluate.

In the last few decades, there have been some attempts to further characterize the West Indian flora and its relationship to other areas of the globe. In 1973, Howard discussed the origins, relationship and distribution of the Antillean vegetation, presenting accounts for generic diversity and endemism values for the different islands. More recently, Myers et al. (2000), and Mittermeier et al. (2004), have identified the Caribbean region as one of the biodiversity hotspots with high priority for conservation. In fact, Myers et al. (2000), based on biodiversity richness (endemism) and loss of habitat, declared the Caribbean region the third most important global biodiversity hotspot. A recent paper by Santiago-Valentín and

Olmstead (2004) presents an excellent review of the historical biogeography of Caribbean plants. They compared the West Indies floristic diversity to other archipelagos of the world and provided estimates of diversity and endemism for the Caribbean as a whole and for the individual islands.

In spite of the recent progress in understanding the origins and composition of the West Indian flora, much work lies ahead. The referred works contain only approximations of the total flora and levels of diversity, as a comprehensive analysis of the flora has never been possible. In more recent years, at our lab at the Smithsonian Institution, we have been compiling and analyzing the various floristic and monographic accounts for the seed plants of the region. Although our work is not final, our numbers substantially differ from previous estimates of total diversity and endemism in the West Indies. In the next paragraph we are providing a summary of our work, which will soon be posted in its totality on our website and printed in book form by the end of 2008.

Families

The West Indies contain a total of 231 families of seed plants. However, only 205 of these are indigenous to the region, all of which are shared with other areas of the Neotropics. Of these, there are 17 families (out of 35) that are endemic to the Neotropics (Gentry, 1982) showing the West Indian flora to belong to the Neotropical floristic province as defined by Good (1974) and Takhtajan (1986). There are no endemic families of seed plants in the West Indies, although in the past, Picrodendraceae and Goetzeaceae were considered endemic. However, molecular phylogenetic studies have showed them to be nested within Euphorbiaceae and Solanaceae respectively, and therefore not meriting recognition at the family level.

Family values are shown for individual islands in Table 5, while the ten largest families of seed plants in terms of number of taxa and generic diversity are shown in Tables 2 and 3. Howard (1973), in a previous analysis on family diversity of the Antilles, did not show particular values, but his top families are for the most part consistent with the current analysis.

Table 2 Ten Families with Most Taxa Diversity in the West Indies

Family	No. of taxa	No. of endemic taxa
Rubiaceae	903	769
Asteraceae	715	536
Orchidaceae	677	441
Fabaceae	631	353
Myrtaceae	542	494
Euphorbiaceae	538	433
Melastomataceae	451	391
Poaceae	430	133
Cyperaceae	333	88
Urticaceae	260	237

Table 3 Ten Families with Most Generic Diversity in the West Indies

Family	No. of genera	No. of endemic genera
Asteraceae	147	39
Orchidaceae	111	12
Poaceae	96	8
Rubiaceae	89	27
Fabaceae	89	10
Euphorbiaceae	56	11
Scrophulariaceae	31	4
Malvaceae	31	2
Melastomataceae	28	3
Apocynaceae	23	2

Genera

There are a total of 1,945 genera of seed plants reported for the West Indies, 1,447 of which are considered indigenous, and 181 endemic (+ 10 nearly endemic), accounting for 13.2% of generic endemism. The endemic genera are represented by 984 species, these contributing only close to 9% of the total native seed plant diversity in the region. On the other hand, the most diverse genera in the West Indies are those with wide distributions, ranging throughout the Neotropics. A list of the ten most speciose indigenous genera is provided in Table 4 in order to illustrate this point. For the most part, the taxa in these genera are endemic and correspond to the most diverse families in the West Indies.

Taxa

The current estimate for total number of seed plant taxa (species and infra species level) in the West Indies is 12,847, a number that includes exotics and commonly cultivated plants. The total number of indigenous taxa however, is ca. 10,948 of which 7,868 are endemic to the archipelago or part of it, contributing to nearly 72% endemism for the West Indies. Table 5 contains diversity estimates for different taxonomical levels of native seed plant flora on the different islands, groups of islands and for the whole West Indies.

Table 4 Ten Most Speciose Genera in the West Indies

Genus	Native taxa	Endemic taxa	Endemism
Eugenia	239	218	91%
Pilea	219	205	93.6%
Psychotria	146	118	80.8%
Rondeletia	145	145	100%
Calyptranthes	128	123	96%
Miconia	125	95	76%
Lepanthes	119	117	98%
Peperomia	113	76	67%
Cordia	108	92	85%
Rhynchospora	103	30	29%

Table 5 Floristic & Endemism Estimate of Seed Plants

Island (s)	Family	Genera	G End	Total Taxa	Native taxa	T End
Bahamas	127	507 (0)	0%	1,381	1,102 (113)	10.4%
Cuba	195	1,210 (65)	5.3%	6,601	5,991 (3,187)	53%
Hispaniola	185	1,102 (32)	2.9%	5,586	4,612 (2,032)	43.9%
Jamaica	164	810 (6)	0.7%	3,218	2,540 (874)	34%
Pto Rico & VI	163	792 (1)	0.1%	3,270	2,221 (305)	13.6%
Lesser Antilles	163	765 (1)	0.1%	2,543	2,083 (312)	14.6%
Total	205	1,447 (191)	13.2%	12,847	10,948 (7,868)	71.8%

Values in parenthesis represent number of endemic taxa
G End = Generic endemism; T End = Taxa endemism

Endemism Structure

Generic Endemism

The diversity pattern exhibited by the endemic genera in the West Indies is shown in Fig. 10. Nearly 48% of these genera are represented by a single species; 22% by 2–5 species; 11.5% by 6 to 10 species, and only about 10% of them with more than 10 species. Similar values have been presented in a recent paper by Francisco-Ortega et al. (2007), where only a small percentage of the endemic genera have numerous species. An analysis of the generic distribution by island shows that 105 of the 181

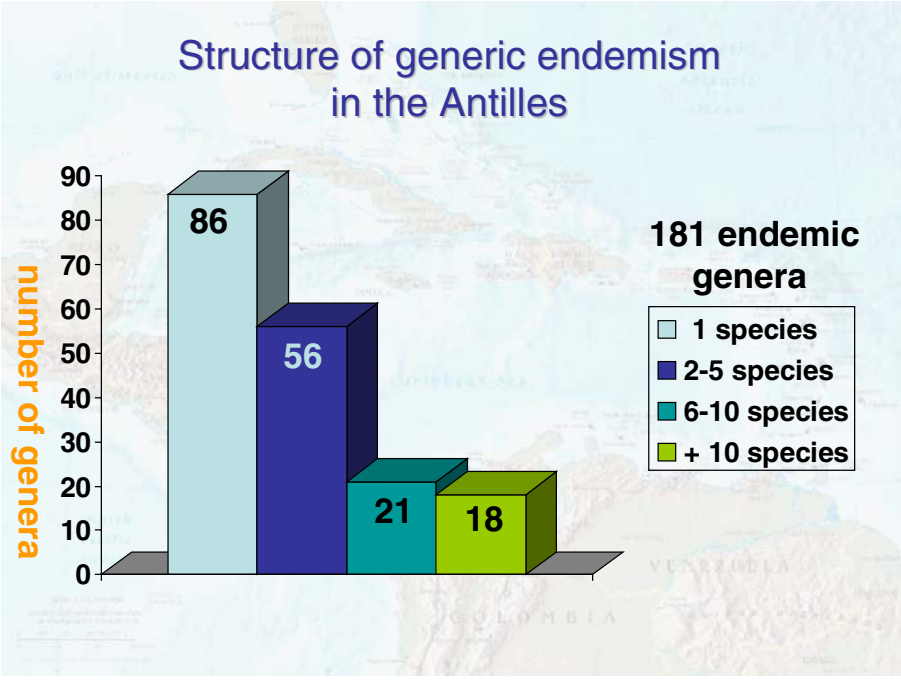

Fig. 10 Graph showing size of West Indian endemic genera

endemic genera are distributed on a single island (Fig. 11) and 80% of these are unispecific; a condition that makes the genera vulnerable to extinction due to habitat destruction.

Taxa Endemism

Data for the analysis of endemism structure at the species or sub-species level is not currently available for the Greater Antilles due to unresolved taxonomic and nomenclatural issues. However, a preliminary analysis of the Lesser Antilles endemic taxa shows that nearly one third of them (98 out of 305) are single island endemics. Endemic taxa present on two or three islands, account for another third, while the remaining third correspond to taxa that are distributed on 4 or more islands (Fig. 12). The vulnerability of the Lesser Antillean endemics becomes evident, as many of these taxa have restricted distributions. Habitat destruction due to human activity or natural catastrophic events could jeopardize the existence of these species.

Origins of the West Indies and its Flora

The geologic history of the West Indies is extremely complex; as a result several models have been proposed to explain the tectonic evolution of the Caribbean region. In general, the Greater and the Lesser Antilles are volcanic islands, which

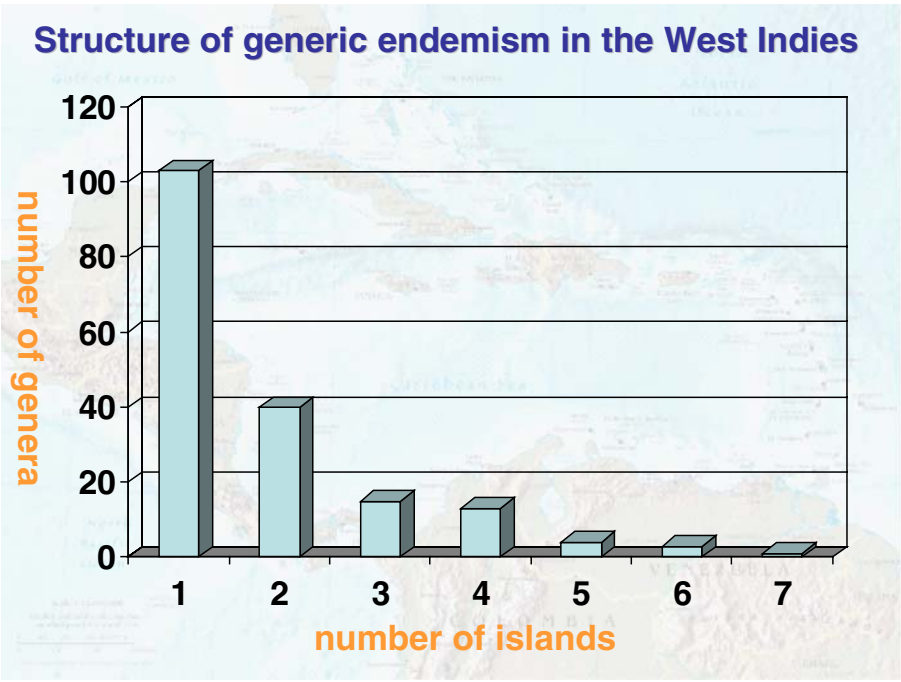

Fig. 11 Graph showing distribution of West Indian endemic genera

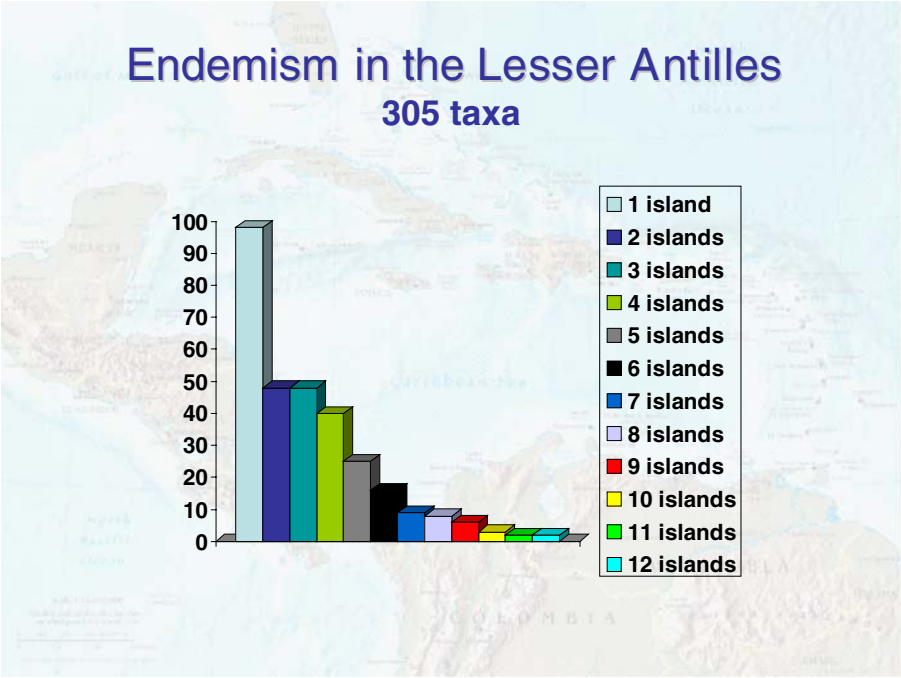

Fig. 12 Graph showing distribution of Lesser Antillian endemic taxa

never were joined with the continents (Draper et al., 1994). On the other hand, western and central Cuba, and the Bahamas belong to the North American tectonic plate (Draper et al., 1994; Pindell, 1994).

The Greater Antilles in general are much older than the Lesser Antilles but only became emergent since the middle Eocene [(ca. 49 Ma), Graham, 2003; Iturralde-Vinent and MacPhee, 1999], and therefore available for colonization by biotic elements from the surrounding continents, which at the time had a well developed modern biota. There is still debate whether colonization occurred through dispersal or through temporary land bridges connecting the islands to the continents. Faunal elements in the West Indies are rather poor, suggesting strong barriers between the islands and the continent (Hedges, 1996).

Models that explain the tectonic evolution of the region fall into two broad categories, depending on whether a stationary or a mobilist view is emphasized (Graham, 2003). The mobilist view portraits a dynamic scenario, where the West Indies have moved eastward (relative to North and South America) more than a thousand kilometers after their formation within the Caribbean plate. During the last several decades, this view has gained support from modern tectonic studies through the aid of global satellites. This subject has been covered at length by Williams (1989), Donovan and Jackson (1994), Iturralde-Vinent and MacPhee, 1999, and Graham (2003, 2003a) and therefore, no attempt is made in the present work to review the existing literature on the subject.

Floristics Affinities

Floristic affinities of the West Indies have been looked at from three different perspectives. The more traditional approach has come through floristic inventories, comparing the West Indian flora to the surrounding continents and to other areas of the world. Commonality of taxa is interpreted as evidence of floristic affinity, and the larger the number of shared taxa, the greater the affinity. Other lines of evidence come from paleontological studies and more recently from molecular phylogenetics. Paleobotanical studies are rather fragmentary and are in need of modern interpretation (Graham, 2003), while molecular studies cover only a small fraction of the West Indian genera of plants (Francisco-Ortega et al., 2007).

Although there is no comprehensive flora of the West Indies as to allow an in-depth analysis of their floristic affinities, there have been some efforts conducive to the formulation of general patterns of floristic affinities. Howard (1973) identified five main patterns or units based on generic distribution. These are as follows: 1) Pan-Caribbean: all islands and surrounding continents; 2) Western Continental: Central America, northern South America and the Greater Antilles; 3) Southern Continental: Central America, northern South America and the Lesser Antilles; 4) Antillean: restricted to the West Indies but better developed in the Greater Antilles; 5) Greater Antillean: endemic to one or more islands of the Greater Antilles.

Recent efforts in reviewing the taxonomy of West Indian plants at the Smithsonian have allowed us to further evaluate the affinity patterns or traits as proposed by Howard. Progress on floristic knowledge of the West Indies has improved during the last decades, allowing further comparative floristic studies to take place.

The analysis of the distribution of the Antillean flora can provide some general guidelines regarding the floristic affinities and events responsible for development and evolution of the West Indian flora. The West Indies contain 1447 genera of seed plants indigenous to the region. Of these, 77 have a worldwide distribution, being present in the surrounding continents as well as in the Old World tropics; 38 are only shared with the American continents and Africa; 316 are endemic and widely distributed throughout the Americas; and 181 (plus 10 nearly endemic) are endemic to the West Indies or to portions of them. To the effect of elucidating more recent floristic relationships between the West Indies and the American continents (given the lack of phylogenetic studies), the above genera are of limited value, since they are either too widely or too narrowly distributed. Only genera that are present in the West Indies and in some of the surrounding continents are useful for the current analyses. From the analysis of the genera shared with any of the surrounding American continents emerge the following distribution patterns:

Affinities to the Continents

North America-West Indies

Twenty six genera are exclusively shared between the West Indies and North America (including northern Mexico). These genera are assumed to be of North American origin and to have spread to the West Indies because they are better

developed in North America, and because their presence diminishes as the distance from North America to the islands increases. The distribution of these genera seems to be the result of southward migration. Out of these 26 genera, 11 reach the Bahamas, 16 Cuba, 8 Hispaniola, 2 Jamaica, 2 Puerto Rico, and 0 the Lesser Antilles. (Fig. 13, Appendix, Table 6). This pattern is rather insignificant when compared to the total number of genera in the region. However, at the species level, there are additional elements that are shared exclusively between North America and the West Indies.

Central America-West Indies

Similarly, the presence of 23 genera exclusive to nuclear Central America (north of Costa Rica) and the West Indies decreases as the distance from Central America increases (Fig. 14, Appendix, Table 7). Of these 23 genera, 12 are found in Jamaica, 21 in Cuba, 15 in Hispaniola, 10 in Puerto Rico, and only 2 are found in the Lesser Antilles. This distribution pattern seems to suggest a route of active dispersion that could date to ancestral times, perhaps when the Greater Antilles were closer to nuclear Central America.

South America-West Indies

The genera shared exclusively between South America and the West Indies display a pattern similar to the one mentioned above, where fewer genera are present as we

Fig. 13 Genera exclusively shared between North America and the West Indies

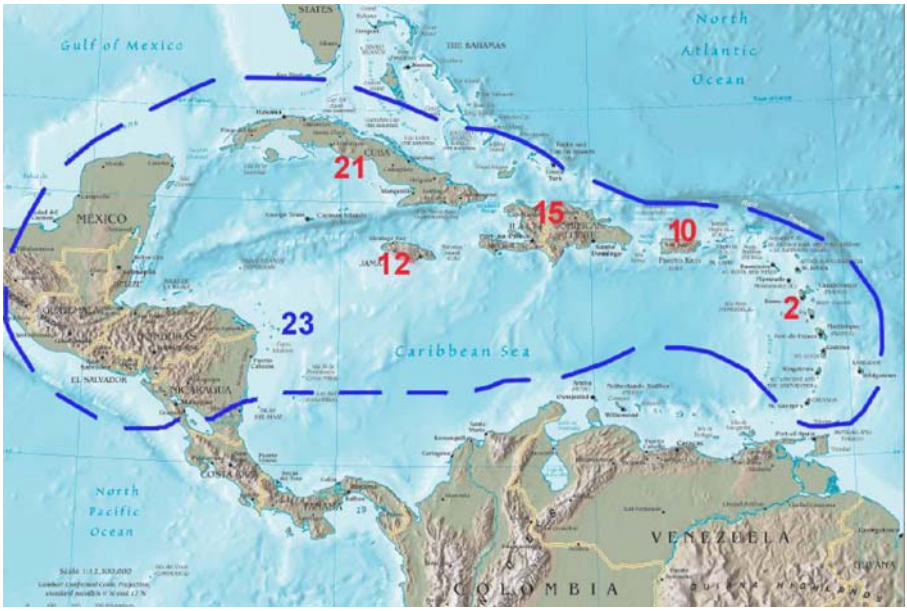

Fig. 14 Genera exclusively shared between Central America and the West Indies

move away from the South American continent into the West Indies. A total of 8 genera are exclusively shared between South America and the West Indies. All of which are in the Lesser Antilles, 7 in Puerto Rico, 6 in Hispaniola, 5 in Cuba, 4 in Jamaica, and 4 in the Bahamas (Fig. 15; Appendix, Table 8). This pattern again suggests dispersal from South America north into the West Indies.

South America-Lesser Antilles

Another distribution pattern that seems to respond to the recent dispersion from South America towards the Antilles is the presence of 10 genera in the Lesser Antilles that are predominantly South American (Appendix, Table 9). This pattern is more restricted than the previous pattern (South America-West Indies) and therefore is here interpreted as an early stage of colonization of the West Indies before reaching the Greater Antilles.

South America-Greater Antilles

Our analysis also shows disjunction patterns, where 21 South American genera are in some or on all of the Greater Antilles but not present on any of the Lesser Antilles. (Fig. 16, Appendix, Table 10). This pattern could be explained as the result of ancestral migrations when South America was presumably closer to the proto-macro-Antilles and therefore easier to migrate from South America into the territories that now constitute the Greater Antilles.

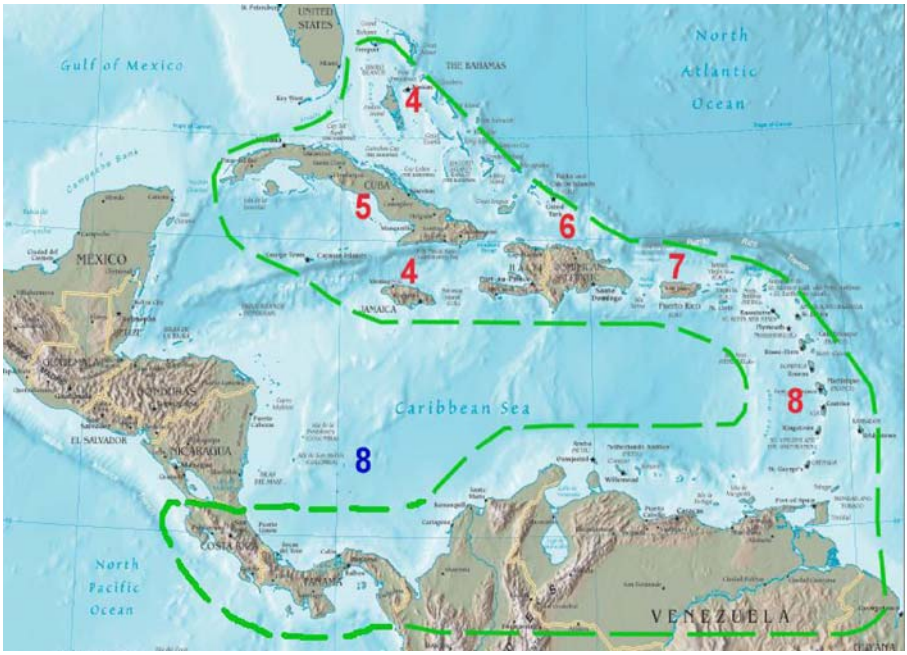

Fig. 15 Genera exclusively shared between South America and the West Indies

South America-Central America-Greater Antilles

In addition to the mentioned patterns of distribution, there are 111 genera that are distributed in South America, Central America, and the Greater Antilles that are

Fig. 16 Genera disjunct between South America and the Greater Antilles

missing from the Lesser Antilles, in spite of their proximity to South America (Fig. 17, Appendix, Table 11). This pattern suggests that migration into the Greater Antilles occurred before the Lesser Antilles were formed. This hypothesis is to be tested by phylogenetic data of the involved genera.

Affinities within the West Indies

In addition to the mentioned genera, there are 77 genera that are exclusively shared between the Antillean islands. Of these, only *Dendropemon* (Loranthaceae), *Rajania*[1] (Dioscoreaceae) and *Tetramicra* (Orchidaceae) are present on all the islands of the West Indies and therefore they can be used to define the West Indian flora. The Greater Antilles on the other hand, have 4 endemic genera that are present on all islands of the Greater Antilles, therefore characterizing their flora. Theses are: *Calocogonium*, (Melastomataceae), *Dilomilis* (Orchidaceae), *Lucya* (Rubiaceae) and *Mecranium* (Melastomataceae). The presence of genera shared exclusively between different groups of islands seems to suggest common biogeographical history among different islands. Examples of this are the presence of 28 exclusive genera to the islands of Cuba and Hispaniola (Appendix, Table 12) and the presence of 7 genera exclusively shared between Jamaica and Cuba (Appendix, Table 12). The distribution of shared endemic genera among various islands of the West Indies tends to mirror the most recent scenarios of geological evolution of the West Indies, with islands (or portions of them) proposed to be closely derived, sharing many endemic genera.

Disjunctions

There are disjunctions reported for the putative native West Indian flora at different taxonomic levels. Some of these may respond to collection or taxonomical artifacts, while others may be the result of ancient distributions or dispersal coupled with extinctions. The following disjunctions are worth highlighting to stimulate further research on their taxonomy and distribution.

West Indian Disjunctions

In the past, *Gaussia* (Arecaceae), was considered to be disjunct between the eastern portion of Cuba and Puerto Rico, but recently has been discovered on eastern Hispaniola (García et al., 2002). The other three endemic genera that presently show a disjunction in their distribution are: *Phlebotaenia* and *Auerodendron*, *both* disjunct between Puerto Rico and Cuba but absent in Hispaniola, and *Gyrotaenia* disjunct between the Lesser Antilles and Hispaniola-Cuba-Jamaica (absent in Puerto Rico). It is possible that some of these disjunctions reflect the lack of knowledge on the flora of the region, especially those missing from Hispaniola, whose flora is the least

[1] Pending the treatment of *Rajania* as a distinct genus from *Dioscorea.*

Fig. 17 Genera exclusively shared between Centra America, South America and the Greater Antilles

known of the Greater Antilles. The absence of *Gyrotaenia* from Puerto Rico could well correspond to ancestral extinctions, since this genus has never been found in Puerto Rico, and given the excellent knowledge of the Puerto Rican flora today, it is very unlikely that *Gyrotaenia* would ever be found in Puerto Rico.

West Indies-Continental Disjunctions

Generic disjunctions:

1. Cuba-South America (3): *Bonnetia* (Theaceae), *Neja* (Asteraceae), and *Votomita* (Melastomataceae).
2. Hispaniola-South America (2): *Cyrtocymura* (Asteraceae) and *Dactylaena* (Capparaceae).
3. Jamaica-South America (1): *Leptothrium* (Poaceae).
4. Puerto Rico-South America-Central America (1): *Piptocarpha* (Asteraceae).

Taxa disjunctions:

1. Cuba-South America (31): *Abutilon mollissimum* (Cav.) Sweet (Malvaceae), *Acianthera rubroviridis* (Lindl.) Pridgeon & M.W. Chase (Orchidaceae), *Aloysia citriodora* Palau (Lamiaceae), *Andropogon macrothrix* Trin. (Poaceae), *Psychotria bahiensis* DC. (Rubiaceae), *Bauhinia bauhinioides* (Mart.) Britton & Rose (Fabaceae),. Caesalpinia spinosa (Molina) Kuntze (Fabaceae), *Canna pedunculata* Sims (Cannaceae), *Casearia mollis* Kunth (Salicaceae), *Coccocypselum aureum* (Spreng.) Cham. & Schltdl. (Bignoniaceae), *Cyperus aggregatus* (Willd.) Endl. var. *gigas* (Lindm.) Guagl. (Cyperaceae), *Eriocaulon melanocephalum* Kunth (Eriocaulaceae), *Gonzalagunia panamensis* K. Schum. (Rubiaceae), *Hyptis microphylla* Benth. (Lamiaceae), *Lagenocarpus rigidus* (Kunth)

Nees ssp. *tremulus* (Nees) T. Koyama (Cyperaceae), *Melochia arenosa* Benth., *Melochia parvifolia* Kunth (Malvaceae), *Mesosetum loliiforme* (Hochst. ex Steud.) Chase (Poaceae), *Mitracarpus scaberulus* Urb. (Rubiaceae), *Octomeria tridentata* Lindl. (Orchidaceae), *Pfaffia sericea* (Spreng.) Mart. (Amaranthaceae), *Pfaffia tuberosa* (Spreng.) Hicken (Amaranthaceae) *Ponthieva diptera* Linden & Rchb. f. (Orchidaceae), *Rhynchospora cephalotes* (L.) Vahl var. pseudocomata Kük. (Cyperaceae), *Sacciolepis vilvoides* (Trin.) Chase (Poaceae), *Senna robiniifolia* (Benth.) H.S. Irwin & Barneby (Fabaceae), *Scleria scabra* Willd. (Cyperaceae), *Serjania adusta* Radlk. (Sapindaceae), *Spigelia humilis* Benth. (Loganiaceae), *Tabebuia billbergii* (Bureau & K. Schum.) Standl. ssp. billbergii (Bignoniaceae), *Utricularia breviscapa* C. Wright ex Griseb. (Lentibulariaceae),*Wedelia calycina* Rich. var. *caracasana* (DC.) Alain (Asteraceae), *Xylopia aromatica* Baill., *X. frutescens* Aubl. (Annonaceae),

2. Hispaniola-South America (11): *Aspidosperma cuspa* (Kunth) Pittier (Apocymaceae), *Cardamine jamesonii* Hook. (Brassicaceae), *Heterosperma diversifolium* Kunth (Asteraceae), *Leucaena trichodes* (Jacq.) Benth. (Fabaceae), *Lobelia longibracteata* Boeck. (Campanulaceae), *Rhynchospora longibracteata* Boeck. (Cyperaceae), *Sclerothrix fasciculata* C. Presl (Loasaceae), *Smilax longifolia* Rich. (Smilacaceae), *Syngonanthus umbellathus* (Lam.) Ruhland (Eriocaulaceae), *Triumfetta abutiloides* A. St.-Hil (Malvaceae), and *Trixis antimenorrhoea* (Schrank) Baker (Asteraceae).
3. Jamaica-South America (13): *Aechmea paniculigera* (Sw.) Griseb. (Bromeliaceae), *Columnea repens* (Hook.) Hanst. (Gesneriaceae), *Croton micans* Sw. (Euphorbiaceae), *Epidendrum bifarium* Sw. (Orchidaceae), *Guettarda argentea* Lam. (Rubiaceae), *Henriettea sessilifolia* (L.) Alain (Melastomataceae), *Leptothrium rigidum* Kunth (Poaceae), *Liparis neuroglossa* Rchb. f. (Orchidaceae), *Melochia crenata* Vahl (Malvaceae), *Miconia theaezans* (Bonpl.) Cogn. (Malvaceae), *Pleurothallis discoidea* Lindl., *P. uncinata* Fawc.(Orchidaceae), and *Sagrea plumosa* (Desr.) Naudin (Melastomataceae).
4. Puerto Rico-South America-Central America (2): *Paspalum parviflorum* Rhodé ex Fluegge and *Pouzolzia occidentalis* (Liebm.) Wedd. (Urticaceae).

Conclusions

The origin of the West Indian flora is still an incipient line of research. The traditional biogeographic approach based on the commonality of taxa is of limited value in answering our question on the origins of its flora, since most taxa (72%) are endemic to the West Indies. The West Indian flora is clearly related to the flora of the surrounding continents as their families and genera are common elements of the Neotropics, with only a 6.5% endemism at the generic level. Thus, the West Indian flora can be regarded as a subset of the Neotropical flora. Comparison of the common floristic elements between the West Indies and the surrounding continents shows a mosaic of affinities that are stronger to Central America and South America as a whole than with either one of them separately or with North America. Individual

islands or groups of islands show affinities with neighboring continental landmasses. For instance, the flora of the Lesser Antilles is strongly related to South America, while numerous elements of Western Cuba can be found in the Yucatan Peninsula. The larger picture on the origin of the West Indian flora requires a detailed floristic knowledge not only of the West Indies but also of the surrounding landmasses. The application of phylogenetic studies is herein regarded as the next necessary step in elucidating the origins and affinities of the West Indian flora.

Acknowledgments This paper is based on the data compiled for the project *Checklist of the Seed plants of the West Indies.* Numerous people at the National Museum of Natural History have contributed in one way or another to the completion of this project since its inception several years ago. Marilyn Hansel began the first database entering several thousand records for names extracted from major Caribbean floristic treatments. Chris Tuccinardi helped on numerous occasions with the merging and migration of database files, as well as in the creation of various queries to proofread the data or to obtain importance values of taxa. Likewise Ellen Farr helped with database structure and the development of efficient models on which to collect floristic and bibliographical data. Fiona Wilkinson added numerous recent taxonomic records to the database. Jamie Whitacre created various database forms that allowed us to proofread the database tables. Dr. Dan Nicolson answered numerous questions regarding nomenclature and Araceae literature.

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Appendix

CA= Central America, CU= Cuba, HI= Hispaniola, JA= Jamaica, LA= Lesser Antilles, NA= North America, PR= Puerto Rico, SA=South America.

Table 6 Genera Exclusive to North America and the West Indies (26)

Family	Genus	na	Ba	cu	hi	ja	pr	la
Rubiaceae	Casasia	x	x	x	x	x		
Poaceae	Distichlis	x	x	x	x			
Haloragaceae	Proserpinaca	x	x	x		x		
Apiaceae	Oxypolis	x	x	x				
Asteraceae	Sachsia	x	x	x				
Anacardiaceae	Toxicodendrum	x	x	x				
Orchidaceae	Calopogon	x	x					
Lamiaceae	Piloblephis	x	x					
Lamiaceae	Trichostema	x	x					
Rubiaceae	Stenaria	x	x					
Scrophulariaceae	Seymeria	x	x					
Apiaceae	Ptilimnium	x		x	x		x	
Melastomataceae	Rhexia	x		x	x		x	
Apocynaceae	Haplophyton	x		x				
Berberidaceae	Mahonia	x		x				
Caryophyllaceae	Stipulicida	x		x				
Eriocaulaceae	Lachnocaulon	x		x				
Haemodoraceae	Lachnanthes	x		x				
Nymphaeaceae	Nuphar	x		x				
Oleaceae	Fraxinus	x		x				
Portulacaceae	Claytonia	x		x				
Onagraceae	Epilobium	x			x			
Amaranthaceae	Tidestromia	x			x			
Caryophyllaceae	Sagina	x			x			
Cistaceae	Helianthemum	x			x			
Poaceae	Sphenopholis	x			x			

Table 7 Genera exclusive to Central America (nuclear) and the West Indies (23)

Family	Genus	ca	cu	ja	hi	pr	la
Salicaceae	Samyda	x	x	x	x	x	x
Anacardiaceae	Comocladia	x	x	x	x	x	x
Apocynaceae	Pinochia	x	x	x	x	x	
Arecaceae	Calyptrogyne	x	x	x	x	x	
Capparaceae	Forchhammeria	x	x	x	x	x	
Icacinaceae	Mappia	x	x	x	x	x	
Rubiaceae	Rachicallis	x	x	x	x		
Simaroubaceae	Alvaradoa	x	x	x	x		
Stegnospermaceae	Stegnosperma	x	x	x	x		
Arecaceae	Gaussia	x	x		x	x	
Polygalaceae	Badiera	x	x		x	x	
Sapindaceae	Thouinia	x	x		x	x	
Sapindaceae	Thouinidium	x	x		x		
Myrtaceae	Calyptropsidium	x	x		x		
Annonaceae	Desmopsis	x	x				
Arecaceae	Colpothrinax	x	x				
Solanaceae	Schwenckia	x	x				
Cucurbitaceae	Cionosicys	x	x	x			
Orchidaceae	Coelia	x	x	x			
Orchidaceae	Pseudogoodyera	x	x				
Canellaceae	Pleodendron	x			x	x	
Orchidaceae	Dinema	x		x			

Table 8 Genera Exclusive to South America and the West Indies (8)

Family	Genus	sa	la	pr	hi	cu	ja	ba
Amaranthaceae	Lithophila	x	x	x	x	x		x
Asteraceae	Gundlachia	x	x	x	x	x		x
Cactaceae	Pilosocereus	x	x	x	x	x	x	x
Melastomataceae	Sagraea	x	x	x	x	x	x	
Myoporaceae	Bontia	x	x	x	x	x	x	x
Myrtaceae	Siphoneugena	x	x	x				
Orchidaceae	Cyrtochilum	x	x	x	x		x	
Rubiaceae	Rosenbergiodendron	x	x				?	

Table 9 Genera Exclusive to South America and the Lesser Antilles (9)

Family	Genus	sa	la
Arecaceae	Syagrus	x	x
Bromeliaceae	Glomeropitcairnia	x	x
Cucurbitaceae	Ceratosanthes	x	x
Gesneriaceae	Crantzia	x	x
Gesneriaceae	Nautilocalyx	x	x
Marcgraviaceae	Ruyschia	x	x
Marcgraviaceae	Schwartzia	x	x
Myrtaceae	Blepharocalyx	x	x
Myrtaceae	Pseudanamomis	x	x

Table 10 Genera Exclusive to South America and the Greater Antilles (19 + 1*) [* = Extending into Bahamas]

Family	Genus	sa	cu	hi	ja	pr
Acanthaceae	Pachystachys	x			x	
Arecaceae	Copernicia	x	x	x		
Asteraceae	Conocliniopsis	x	x	x		
Asteraceae	Cyrtocymura	x		x		
Asteraceae	Neja	x	x			
Asteraceae	Piptocoma	x		x		x
Bromeliaceae	Mezobromelia	x	x			
Canellaceae	Cinnamodendron	x	x	x	x	
Capparaceae	Dactylaena	x		x		
Lamiaceae	Eriope	x	x			
Loranthaceae	Eubrachion	x		x	x	x
Malvaceae	Bastardiopsis	x				x
Martyniaceae	Craniolaria	x	x	x		x
Melastomataceae	Votomita	x	x			
Orchidaceae	Ida	x	x	x	x	x
Orchidaceae	Lankesterella	x	x	x		
Poaceae	Reimarochloa	x	x	x		
Rutaceae	Spathelia*	x	x		x	
Staphyleaceae	Huertea	x	x	x	x	
Theaceae	Bonnetia	x	x			

Table 11 Genera Exclusive to Central America, South America, and Greater Antilles (111)

Family	Genus	ca	sa	cu	hi	ja	pr
Alstromeriaceae	Bomarea	x	x	x	x		
Annonaceae	Xylopia	x	x	x		x	
Apocynaceae	Anechites	x	x	x	x	x	x
Apocynaceae	Aspidosperma	x	x		x		
Apocynaceae	Forsteronia	x	x	x	x	x	x
Apocynaceae	Mesechites	x	x	x	x		
Apocynaceae	Stemmadenia	x	x	x	x		
Araceae	Dracontium	x	x		x		x
Araliaceae	Dendropanax	x	x	x	x	x	x
Araliaceae	Sciadodendron	x	x		x		
Arecaceae	Scheelea	x	x	x			
Asclepiadaceae	Fischeria	x	x	x		x	
Asclepiadaceae	Oxypetalum	x	x	x	x	x	x
Asteraceae	Baltimora	x	x	x			
Asteraceae	Liabum	x	x	x	x	x	
Asteraceae	Otopappus	x	x			x	
Asteraceae	Pacourina	x	x	x	x		
Asteraceae	Pentacalia	x	x	x		x	
Asteraceae	Piptocarpha	x	x				x
Asteraceae	Trichospira	x	x	x			
Bignoniaceae	Distictis	x	x	x	x		x
Bignoniaceae	Jacaranda	x	x	x	x		
Bignoniaceae	Pithecoctenium	x	x	x		x	
Bignoniaceae	Tynanthus	x	x	x	x		x
Combretaceae	Combretum	x	x	x	x	x	
Cucurbitaceae	Sicana	x	x	x		x	
Cyperaceae	Lagenocarpus	x	x	x			x
Dilleniaceae	Curatella	x	x	x	x		
Dilleniaceae	Davilla	x	x	x		x	
Dilleniaceae	Doliocarpus	x	x	x	x		x
Dilleniaceae	Tetracera	x	x	x		x	
Ericaceae	Befaria	x	x	x			
Eriocaulaceae	Tonina	x	x	x			
Euphorbiaceae	Acidoton	x	x		x	x	
Euphorbiaceae	Pera	x	x	x	x		
Euphorbiaceae	Tetrorchidium	x	x			x	
Fabaceae	Ateleia	x	x	x	x		
Fabaceae	Barbieria	x	x	x	x		x
Fabaceae	Cynometra	x	x	x	x		x
Fabaceae	Eriosema	x	x	x	x		
Fabaceae	Mora	x	x		x		
Fabaceae	Phaseolus	x	x	x	x	x	x
Fabaceae	Piptadenia	x	x		x		x
Fabaceae	Poiretia	x	x	x	x		x
Fabaceae	Prioria	x	x			x	
Flacourtiaceae	Banara	x	x	x	x		x
Flacourtiaceae	Zuelania	x	x	x	x	x	
Gentianaceae	Schultesia	x	x	x	x	x	x
Gesneriaceae	Phinaea	x	x	x	x		
Hydrophyllaceae	Wigandia	x	x	x	x		
Iridaceae	Cipura	x	x	x			
Lecythidaceae	Grias	x	x			x	
Lemnaceae	Spirodela	x	x	x	x		x
Loganiaceae	Strychnos	x	x	x	x		
Loranthaceae	Oryctanthus	x	x			x	
Malpighiaceae	Banisteriopsis	x	x	x			
Malpighiaceae	Tetrapterys	x	x	x	x	x	x
Mayacaceae	Mayaca	x	x	x	x	x	
Melastomataceae	Acisanthera	x	x	x	x	x	x
Melastomataceae	Adelobotrys	x	x			x	
Melastomataceae	Arthrostemma	x	x	x		x	
Melastomataceae	Ossaea	x	x	x	x	x	x

Table 11 (continued)

Family	Genus	ca	sa	cu	hi	ja	pr
Meliaceae	Swietenia	x	x	x	x	x	
Menispermaceae	Disciphania	x	x		x		
Moraceae	Pseudolmedia	x	x	x	x	x	x
Myrtaceae	Plinia	x	x	x	x		x
Nyctaginaceae	Guapira	x	x	x	x	x	x
Nyctaginaceae	Neea	x	x	x	x		x
Orchidaceae	Arpophyllum	x	x			x	
Orchidaceae	Cochleanthes	x	x	x	x	x	x
Orchidaceae	Comparettia	x	x	x		x	x
Orchidaceae	Cryptarrhena	x	x			x	
Orchidaceae	Laelia	x	x	x			
Orchidaceae	Platysteles	x	x	x			
Orchidaceae	Trichopilia	x	x	x	x	x	
Poaceae	Chaetium	x	x	x			
Poaceae	Chusquea	x	x	x	x	x	x
Poaceae	Eriochrysis	x	x		x		x
Poaceae	Mesosetum	x	x	x			
Poaceae	Zeugites	x	x	x	x	x	
Podocarpaceae	Podocarpus	x	x	x	x	x	x
Podostemaceae	Maranthrum	x	x	x			
Podostemaceae	Tristicha	x	x	x			
Quiinaceae	Quiina	x	x	x		x	
Rhamnaceae	Rhamnus	x	x	x	x	x	x
Rubiaceae	Alibertia	x	x	x			
Rubiaceae	Amaioua	x	x	x			
Rubiaceae	Coccocypselum	x	x	x	x	x	x
Rubiaceae	Coussarea	x	x	x			
Rubiaceae	Declieuxia	x	x	x			
Rubiaceae	Hemidiodia	x	x	x	x	x	x
Rubiaceae	Manettia	x	x	x	x	x	
Rubiaceae	Randia	x	x	x	x		x
Rutaceae	Esenbeckia	x	x			x	
Rutaceae	Galipea	x	x	x			
Rutaceae	Ravenia	x	x	x	x	x	x
Sapindaceae	Matayba	x	x	x	x		x
Sapindaceae	Serjania	x	x	x	x	x	x
Scrophulariaceae	Russelia	x	x	?			
Solanaceae	Jaltomata	x	x		x	x	x
Solanaceae	Melananthus	x	x	x			
Solanaceae	Witheringia	x	x		x		
Sterculiaceae	Helicteres	x	x	x	x	x	x
Theophrastaceae	Clavija	x	x		x		
Tiliaceae	Luehea	x	x	x			
Tiliaceae	Trichospermum	x	x	x			
Ulmaceae	Ampeloceras	x	x	x	x		
Ulmaceae	Phyllostylon	x	x	x	x		
Urticaceae	Pouzolzia	x	x				x
Urticaceae	Rousselia	x	x	x	x	x	x
Alstromeriaceae	Bomarea	x	x	x	x		

Table 12 Genera Endemic to the West Indies (181 + 7[b] + 1[c] + 2[a])

Family	Genus	Ba	cu	hi	ja	pr	la
Loranthaceae	Dendropemon	x	x	x	x	x	x
Orchidaceae	Tetramicra	x	x	x	x	x	x
Gesneriaceae	Gesneria[a]		x	x	x	x	x
Gesneriaceae	Rhytidophyllum[a]	x	x	x	x	x	x
Sapindaceae	Hypelate[b]	x	x	x	x	x	x
Orchidaceae	Broughtonia	x	x	x	x	x	
Rubiaceae	Phialanthus	x	x	x	x	x	
Rubiaceae	Scolosanthus	x	x	x	x	x	
Lamiaceae	Petitia	x	x	x	x	x	
Aizoaceae	Cypselea[b]	x	x	x		x	x
Melastomataceae	Tetrazygia[b]	x	x	x		x	x
Myrsinaceae	Wallenia		x	x	x	x	x
Euphorbiaceae	Grimmeodendron	x	x	x	x		
Euphorbiaceae	Lasciocroton	x	x	x	x		
Euphorbiaceae	Picrodendron	x	x	x	x		
Lamiaceae	Nashia	x	x	x		x	
Orchidaceae	Basiphyllaea[b]	x	x	x	x	x	
Rhamnaceae	Auerodendron	x	x	**d**	x	x	
Rubiaceae	Lucya		x	x	x	x	
Orchidaceae	Tolumnia [b]		x	x	x	x	x
Rubiaceae	Catesbaea[b]		x	x	x	x	x
Urticaceae	Gyrotaenia		x	x	x	**d**	x
Fabaceae	Poitea		x	x		x	x
Melastomataceae	Calycogonium		x	x	x	x	
Melastomataceae	Mecranium		x	x	x	x	
Orchidaceae	Dilomilis		x	x	x	x	
Euphorbiaceae	Bonania	x	x	x			
Lamiaceae	Pseudocarpidium	x	x	x			
Euphorbiaceae	Acidocroton		x	x	x		
Euphorbiaceae	Leucocroton		x	x	x		
Fabaceae	Brya		x	x	x		
Poaceae	Reynaudia		x	x	x		
Poaceae	Scutachne		x	x	x		
Thymeliaceae	Lagetta		x	x	x		
Acanthaceae	Barleriola		x	x		x	
Asteraceae	Berylsimpsonia		x	x		x	
Cactaceae	Leptocereus		x	x		x	
Celastraceae	Torralbasia		x	x		x	
Euphorbiaceae	Ditta		x	x		x	
Fabaceae	Pictetia		x	x		x	
Oleaceae	Haenianthus		x	x		x	
Orchidaceae	Domingoa		x	x		x	
Rubiaceae	Colleteria		x	x		x	
Orchidaceae	Psychilis			x		x	x
Lythraceae	Ginoria[b]		x	x		x	
Apocynaceae	Neobracea	x	x				
Asteraceae	Thymopsis	x	x				
Apocynaceae	Asketanthera		x	x			
Asteraceae	Lantanopsis		x	x			
Asteraceae	Leonis		x	x			
Asteraceae	Lundinia		x	x			
Asteraceae	Phania		x	x			
Asteraceae	Pinillosia		x	x			
Bignoniaceae	Ekmanianthe		x	x			
Bignoniaceae	Spirotecoma		x	x			
Euphorbiaceae	Bonania		x	x			
Euphorbiaceae	Chascotheca		x	x			
Euphorbiaceae	Cubanthus		x	x			
Euphorbiaceae	Platygyna		x	x			
Gentianaceae	Bisgoeppertia		x	x			
Gesneriaceae	Bellonia		x	x			
Melastomataceae	Pachyanthus[c]		x	x			

Table 12 (continued)

Family	Genus	Ba	cu	hi	ja	pr	la
Myrtaceae	Mitranthes		x	x			
Orchidaceae	Antillanorchis		x	x			
Orchidaceae	Fuertesiella		x	x			
Piperaceae	Verhuellia		x	x			
Poaceae	Saugetia		x	x			
Rubiaceae	Cubanola		x	x			
Rubiaceae	Isidorea		x	x			
Rubiaceae	Margaritopsis		x	x			
Rubiaceae	Micrasepalum		x	x			
Rubiaceae	Ottoschmidtia		x	x			
Rubiaceae	Picardaea		x	x			
Rutaceae	Plethadenia		x	x			
Sterculiaceae	Neoregnellia		x	x			
Lamiaceae	Pseudocarpidium		x	x			
Apocynaceae	Strempeliopsis		x	x			
Asteraceae	Urbananthus		x		x		
Gesneriaceae	Pheidonocarpa		x		x		
Poaceae	Achlaena		x		x		
Rubiaceae	Acrosynanthus		x		x		
Scrophulariaceae	Cheilophyllum		x		x		
Polygalaceae	Phlebotaenia		x	**d**		x	
Fabaceae	Stahlia			x		x	
Solanaceae	Goetzea			x		x	
Asteraceae	Tetranthus			x	x		
Myrtaceae	Calyptrogenia			x	x		
Orchidaceae	Neocogniauxia			x	x		
Acanthaceae	Ancistranthus		x				
Acanthaceae	Dasytropis		x				
Acanthaceae	Sapphoa		x				
Amaranthaceae	Woehleria		x				
Apiaceae	Asciadium		x				
Arecaceae	Hemithrinax		x				
Asteraceae	Antillanthus		x				
Asteraceae	Antillia		x				
Asteraceae	Ciceronia		x				
Asteraceae	Ekmania		x				
Asteraceae	Feddea		x				
Asteraceae	Grisebachianthus		x				
Asteraceae	Harnackia		x				
Asteraceae	Heptanthus		x				
Asteraceae	Herreranthus		x				
Asteraceae	Koehneola		x				
Asteraceae	Lachnorhiza		x				
Asteraceae	Lescaillea		x				
Asteraceae	Oldfeltia		x				
Asteraceae	Rhodogeron		x				
Asteraceae	Shafera		x				
Asteraceae	Spaniopappus		x				
Asteraceae	Tetraperone		x				
Scrophulariaceae	Synapsis		x				
Commelinaceae	Sauvallea		x				
Cycadaceae	Microcycas		x				
Fabaceae	Behaimia		x				
Fabaceae	Hebestigma		x				
Gentianaceae	Zonanthus		x				
Malpighiaceae	Henleophytum		x				
Myrsinaceae	Solonia		x				
Nyctaginaceae	Caribea		x				
Poaceae	Ekmanochloa		x				
Poaceae	Lepturidium		x				
Poaceae	Mniochloa		x				
Poaceae	Piresiella		x				

Table 12 (continued)

Family	Genus	Ba	cu	hi	ja	pr	la
Poaceae	Triscenia		x				
Rhamnaceae	Doerpfeldia		x				
Rubiaceae	Acunaeanthus		x				
Rubiaceae	Ceratopyxis		x				
Rubiaceae	Ceuthocarpus		x				
Rubiaceae	Eosanthe		x				
Rubiaceae	Mazaea		x				
Rubiaceae	Nodocarpaea		x				
Rubiaceae	Phyllacanthus		x				
Rubiaceae	Phyllomelia		x				
Rubiaceae	Roigella		x				
Rubiaceae	Schmidtottia		x				
Rubiaceae	Shaferocharis		x				
Rubiaceae	Siemensia		x				
Rubiaceae	Suberanthus		x				
Rubiaceae	Thogsennia		x				
Rutaceae	Kodalyodendron		x				
Sapindaceae	Euchorium		x				
Scrophulariaceae	Encopella		x				
Scrophulariaceae	Seymeriopsis		x				
Solanaceae	Espadaea		x				
Solanaceae	Henoonia		x				
Theophrastaceae	Neomezia		x				
Thymelaeaceae	Linodendron		x				
Tiliaceae	Tetralix		x				
Turneraceae	Adenoa		x				
Acanthaceae	Samuelssonia			x			
Apiaceae	Pedinopetalum			x			
Arecaceae	Zombia			x			
Asteraceae	Ekmaniopappus			x			
Asteraceae	Elekmania			x			
Asteraceae	Eupatorina			x			
Asteraceae	Herodotia			x			
Asteraceae	Ignurbia			x			
Asteraceae	Mattfeldia			x			
Asteraceae	Nesampelos			x			
Asteraceae	Osmiopsis			x			
Asteraceae	Salcedoa			x			
Asteraceae	Sellophytoum			x			
Bombacaceae	Neobuchia			x			
Cucurbitaceae	Anacaona			x			
Cucurbitaceae	Penelopia			x			
Fabaceae	Arcoa			x			
Fabaceae	Rhodopis			x			
Flocourtiaceae	Priamosia			x			
Loasaceae	Fuertesia			x			
Lythraceae	Haitia			x			
Myrsinaceae	Vegaea			x			
Myrtaceae	Hottea			x			
Orchidaceae	Braasiella			x			
Orchidaceae	Quisqueya			x			
Orchidaceae	Tomzanonia			x			
Polygonaceae	Leptogonum			x			
Rubiaceae	Stevensia			x			
Rubiaceae	Tortuella			x			
Solanaceae	Coeloneurum			x			
Theophrastaceae	Theophrasta			x			
Urticaceae	Sarcopilea			x			
Acanthaceae	Salpixantha				x		
Asteraceae	Acanthodesmos				x		
Asteraceae	Odontocline				x		
Asteraceae	Zemisia				x		

Table 12 (continued)

Family	Genus	Ba	cu	hi	ja	pr	la
Celastraceae	Tetrasiphon				x		
Euphorbiaceae	Dendrocousinsia				x		
Rubiaceae	Portlandia				x		
Fabaceae	Neorudolphia					x	
Melastomataceae	Charianthus						x

d = disjunct
[a] Essentially endemic, extending to South America
[b] Essentially endemic, extending to North America
[c] Essentially endemic, extending to Central America