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Screening of medicinal plants used by the Garífuna of Eastern Nicaragua for bioactive compounds

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Abstract

As part of a larger study of the plants used by the Garífuna of eastern Nicaragua, the 229 species representing 177 genera and 72 families used for medicinal purposes were assayed for the presence of bioactive compounds. A review of the literature for alkaloids and glycosides showed that 113 species contained at least one of these bioactive compounds. The remaining 116 species not previously cited were tested for alkaloids with Dragendorff's reagent; 51 contained alkaloids. The combined results show that 72% of the species the Garífuna use medicinally have at least one alkaloid or glycoside. Tests to explore pharmacological activity of compounds from selected species represent the next step to determining efficacy and application of these medicinals.

Keywords: Alkaloids; Glycosides; Garífuna; Medicinals; Ethnomedicine; Eastern Nicaragua

1. Introduction

Medicinal plants are the oldest source of pharmacologically active compounds and provided virtually the only source of medicinally useful compounds for centuries (Cordell, 1981). Today it is estimated that more than two-thirds of the world's population relies on plant-derived drugs; some 7000 medicinal compounds used in the Western pharmacopoeia are derived from plants (Caufield, 1991). In the USA, approximately 25% of all prescription drugs used contain one or more bioactive compounds derived from vascular plants (Farnsworth and Morris, 1976; Farnsworth, 1984a).

Few new drugs are being developed from wild sources such as tropical forests because of the high cost and the rigid requirements for their development (Tyler et al., 1988; Principe, 1992). However, no matter how high the dollar cost may be, the loss of the potential for discovery of new treatments for serious human ailments is even greater. The annual rate of tropical deforestation is estimated at 8–11 million hectares (Myers, 1984, 1985). Predictions are that by the year 2050 as many as 25% of tropical plant species will be extinct (Lucas, 1978; IUCN, 1986; Caufield, 1991; Raven, 1988). The destruction of tropical rainforests in eastern

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Nicaragua, as elsewhere in the world, is rampant. By the year 2000, Nicaragua may have lost more than 50% of its 1981 rainforest (Caufield, 1991). With this loss goes the opportunity for discovery of new drug plants. The loss of habitat and the extinction of species in tropical forests is disturbingly rapid, but ethnobotanical information is being lost at an even faster rate. With the diminution, dilution or decimation of traditional plant-use practices goes the opportunity to apply knowledge accumulated during hundreds of generations of human empirical testing of bioactive compounds.

Many pharmaceuticals we use today are of botanical origin and are based on herbal remedies from the folk medicine of native peoples (Tyler et al., 1988). Schultes (1986) suggests that the most important drugs of the past 50 years or so were first isolated from plants used ethnomedically. In fact, 74% of the 119 biologically active plant-derived compounds at present used worldwide were discovered as a result of research on species first identified in ethnobotanical surveys (Farnsworth and Soejarto, 1985; Farnsworth, 1988). Thus, phytochemical screening of plant species of ethnopharmacological use will provide valuable baseline information in the search for new pharmaceuticals. Yet fewer than 10% of tropical plants species have been examined for the presence of bioactive compounds (Myers, 1984).

The pharmacopoeia of the Garífuna of eastern Nicaragua consists of 229 species representing 177 genera and 72 families of vascular plants (Table 1). From these medicinals several hundred remedies are prepared that are used in treating more than 30 human ailments (Coe and Anderson, 1996). The objectives of this study were to survey the literature for alkaloids and glycosides of these 229 species, and to run assays for alkaloids on those not reported. These results are then used to consider the efficacy of these medicinals, and we hope they may lead to more detailed phytochemical and pharmacological analyses.

2. The people

The Garífuna are descendants of Red Carib Islanders and African slaves (Davidson, 1976, 1980; Crawford, 1984). They are relative newcomers to the Atlantic Coast of Nicaragua. They arrived in eastern Nicaragua ca. 1890 to work in the extraction of timber (mahogany) around the Pearl Lagoon in eastern Nicaragua (Hale and Gordon, 1987). The Garífuna communities in the Pearl Lagoon area of Nicaragua (Fig. 1) were founded around the turn of the century (Davidson, 1976, 1980), and are the southernmost site of Garífuna culture. At present there are about 1500 Garífuna living on the Atlantic Coast of Nicaragua (Davidson, 1980; Hale and Gordon, 1987). Most of the Garífuna live in four small villages (Justo Point, La Fé, Marshall Point, and Orinoco), all on the southwest rim of the Pearl Lagoon (Fig. 1). One of the authors has observed that the largest of these settlements is Orinoco with a population of 650, in nearly 100 dwellings (see also Davidson, 1980). The Garífuna practice slash-and-burn agriculture on small plantations of 1–2 ha. in size. Their major sources of income are agriculture and logging, with fishing and hunting done seasonally. They participate in the local market economy, selling some of their goods in regional markets.

3. Study area

Nicaragua is the largest of the Central American republics. It encompasses about 140 000 km^2, of which 41 700 km^2 is tropical forest (Sutton, 1989). The Eastern Lowlands of Nicaragua are the most extensive landform in the country, making up about one third (41 000 km^2) of the national territory. These lowlands run from sea level to an elevation of 200 m. The eastern lowlands have a tropical climate (25–30°C), with a rainy season of 6–8 months. Climatic factors combine to yield a rainforest (average annual rainfall: 3810 mm), the most extensive in Central America.

Due to the density of the rainforest, abundance of rainfall, and regular distribution of rivers, the east coast of Nicaragua remained essentially undeveloped and isolated from the rest of the country until roads were built recently. The primary means of transportation in the eastern lowlands is still by boat or airplane. The largest city is Bluefields (Fig. 1), in which 60% of the lowland population lives. The primary forest type

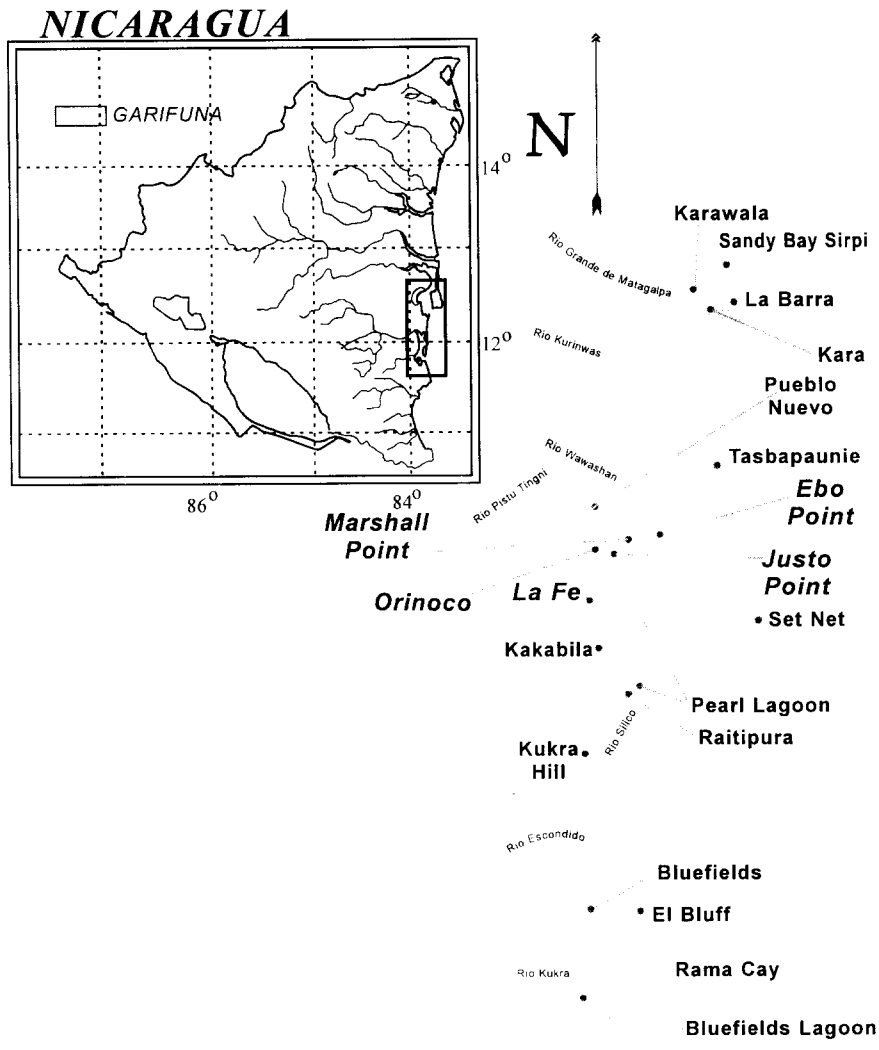

Fig. 1. Present distribution of Garífuna settlements in eastern Nicaragua.

around the Garífuna settlements in the Pearl Lagoon area is lowland swamp forest (Sutton, 1989) characterized by the abundance of mangroves and palms along the shore of the lagoon and river banks.

4. Materials and methods

Interviews of practitioners (shamans, midwives, and others) were conducted and plants were collected for a period of several months in 1992–1993, around the Pearl Lagoon and other settlements along the Wawashan River of eastern Nicaragua (Fig. 1). Further details about this study and the practitioners are published elsewhere (Coe and Anderson, 1996). Voucher specimens were prepared and deposited at the Herbarium of the Atlantic Coast of Nicaragua in Bluefields (established by Coe in 1992), the Missouri Botanical Garden (MO), and the Univer-

sity of Connecticut (CONN). The 229 Garífuna medicinals (Table 1) were surveyed for alkaloids and glycosides. This was determined by doing a literature search, covering the period of 1950–1994, of major compendia, including manual and electronic sources on alkaloids (Karrer, 1958, 1977, 1981, 1985; Willaman and Schubert, 1961; Hegnauer, 1962, 1963, 1964, 1966, 1969, 1973, 1986, 1989, 1990, 1992, 1994; Willaman and Hui-Lin Li, 1970); Chemical Abstracts Services (CAS); and Natural Products Alert (NAPRALERT).

The 116 Garífuna medicinals tested for alkaloids are those species not reported in the literature. Plant parts tested are the same as those used in the preparation of herbal remedies, and included both aerial and underground parts (Table 1). Plant materials were obtained from mature individuals in flower or fruit, and collected and processed according to standard practices (Lawrence, 1951; Bridson and Forman, 1992; Soejarto, 1993; Soejarto et al., 1996). Alkaloid tests were done in the same way in the field and in the laboratory, using Dragendorff's reagent (Harborne, 1988; Stermitz et al., 1989) and thin-layer chromatography (TLC) (Stahl, 1969; Stermitz et al., 1989).

Alkaloids were determined qualitatively by macerating 10–15 mg of plant material in a test tube in 1–2 ml of 1 M Na_2CO_3. Once macerated, 0.5–1.0 ml of 2:1 $CHCl_3$–MeOH was added. The mixture was then mixed with a stirring rod for 3–5 min, then allowed to stand and separate into two phases. The lower phase containing the plant extract in $CHCl_3$ was drawn off with a disposable pipet into a depression in a spot plate. The $CHCl_3$ was allowed to evaporate to about a drop (0.025 ml). This amount was spotted on an aluminum-backed TLC strip 10 mm × 40 mm in size. The strips were developed in $CHCl_3$ and alkaloids were visualized (color ranges are yellow/orange, red/orange, red/black, pink, and even purple depending on the species or genus) by spraying with Dragendorff's reagent. Alkaloids were considered present in a plant part when at least two of three replicates gave positive results; number of spots on the TLC strip was not recorded. Since field alkaloid tests can sometimes produce false-positive reactions, especially in latex-bearing families, e.g. Apocynaceae, Asclepiadaceae, and Moraceae (Farnsworth, 1966), test results, as applicable, for the above families were verified with reports in the literature. However, the method (Stermitz et al., 1989) used includes a purification procedure (adding a base — Na_2CO_3 — and extraction with a water immiscible organic solvent — $CHCl_3$) that helps avoid false-positive reactions. Glycoside tests were not done because of time constraints and the complexity of the testing procedure.

5. Results and discussion

More than 250 plant species are important to the Garífuna as sources of food, fiber, construction and craft materials, and medicine (Coe and Anderson, 1996). Medicinal plant species constitute by far the largest use category (Table 1). Among the 229 medicinal species, 113 contain at least one alkaloid or glycoside reported in the literature (Table 2). Of the remaining 116 species, 51 species, representing 45 genera and 25 families, tested positive for alkaloids (Table 2). Thus, 152 species of the Garífuna medicinals contain alkaloids and an additional 12 contain glycosides (Table 2). About one-half (43%) of alkaloid-bearing species are herbs, and about one-third (28%) are trees (Table 3).

The Fabaceae had the highest number (20) of species with alkaloids (Table 4). As this would lead one to expect, this family contains many medicinals that are highly regarded by Garífuna healers (Coe and Anderson, 1996). Several other families also have a number of genera and species used medicinally that possess alkaloids (e.g. Euphorbiaceae, Rubiaceae, Solanaceae) (Table 4). In most families where a number of species are utilized, one genus or species tends to predominate. For instance, the following are the dominant genera in some of the most important families: Cassia (Fabaceae), Psychotria (Rubiaceae), Jatropha (Euphorbiaceae), Piper (Piperaceae), and Solanum (Solanaceae). In spite of the prominence of some families and genera, the general pattern we observed was a wide taxonomic distribution of medicinals (Table 4).

Overall, the results show that the vast majority

Table 1
Garífuna medicinal plant uses and results of phytochemical screening

Scientific name[a]	Common names[b]	Medicinal applications[c]	Part tested[d]	Mode of preparation[e]	Mode of administration[f]	Alkaloid/ glycoside test[g]	Voucher number[h]
PTERIDOPHYTA							
FILICOPSIDA (Ferns)							
Adianthaceae							
1. *Acrostichum aureum* L.	gaígusi árabu (g)	F,U,Y	L,R	D	O	+	3535
Polypodiaceae							
2. *Pityrogramma calomelanos* (L.) Link	tubána harú (g)	L,R	F,H,L,U	D,I	O,T	–/–	4056
Schizaeaceae							
3. *Lygodium heterodoxum* Kuntze	púntugu (g)	A,B,S	L	D	O,T	–/–	2168
4. *Lygodium venustum* Sw.	withes, witts (c)	A,B,S	L	D	O,T	–/–	4337
CONIFEROPHYTA (Conifers)							
Coniferopsida							
Pinaceae							
5. *Pinus caribaea* Morelet	gúdi (g)	A,L	L,S	D,P	I,O,T	N/–	4430
MAGNOLIOPHYTA (Angiosperms)							
MAGNOLIOPSIDA (Dicots)							
Anacardiaceae							
6. *Anacardium occidentale* L.	úri (g)	A,D,F,S	B,L	D	O,T	+	2725
7. *Mangifera indica* L.	mángu (g)	A,D,F,S	B,L	D	O,T	+	3387
8. *Spondias mombin* L.	sirínguela (g)	D,F,I,S	B,L	D	O	–/–	2275
9. *Spondias purpurea* L.	sirínguela (g)	D,F,S	B,L	D	O	–/–	2959
Annonaceae							
10. *Annona glabra* L.	gasíma (g)	A,C,F,L,O	B,E,L	D,P	O,T	+L	2403
11. *Annona muricata* L.	gurúsulu (g)	A,C,D,F,G,O	B,E,L	D	O	+L	3392
12. *Cananga odorata* L.	lang–a1–lang–a1- (g)	R	B,C,L,R	B,D,I	B,T	+L	3347
13. *Guatteria amplifolia* Triana et Planch.	wild soursop (c)	D,V B,L	D	O	+	2429	
Apiaceae							
14. *Eryngium foetidum* L.	gúlantro (g)	D,G,L,P,R	L	D,I	B,O	-/+L	3515
Apocynaceae							
15. *Allamanda cathartica* L.	dumári raüwa (g)	E,X	F,L,S	D	O	+	2522
16. *Echites umbellata* Jacq.	bean witts (c)	B	R	D	O	+	3487

Table 1 (Continued)

Scientific name[a]	Common names[b]	Medicinal applications[c]	Part tested[d]	Mode of preparation[e]	Mode of administration[f]	Alkaloid/ glycoside test[g]	Voucher number[h]
17. *Odontadenia puncticulosa* (Rich.) Pull.	ámali (g)	B	L	D	O	+	2139
18. *Rhabdadenia biflora* (Jacq.) Muell.-Arg.	tataku (m)	S	L	D	T	–/–	4065
19. *Tabernaemontana chrysocarpa* Blake	cachito (h)	A,I	L	D,P	O,T	+	4193
Aristolochiaceae							
20. *Aristolochia trilobata* L.	cuntríbo (g)	B,G,H,L,T	L,P	D,I	O	+	3923
Asclepiadaceae							
21. *Asclepias curassavica* L.	lamúruhéwe (g)	D,P	B,F,P,S	D,P	O,T	+, +L	3235
Asteraceae							
22. *Bidens pilosa* L.	spanish spade (c)	L	L	D	O	+L	4457
23. *Bidens riparia* HBK.	spanish spade (c)	L	L	D	O	+	3213
24. *Centaurea montana* L.	pressha bush (c)	G	L	D	O	+L	3303
25. *Clibadium pittieri* Greenm.	púntu (g)	S,T	L,P	D	O,T	–/–	2528
26. *Elephantopus mollis* HBK.	cow tongue (c)	L	L	D	O	+	3282
27. *Elephantopus spicatus* Juss. ex Aubl.	iñéñeibágasu (g)	A,D,L,P	L	D	O	+	2271
28. *Matricaria chamomilla* L.	bacháti (g)	A,C,G	P	D	O	+L	4434
29. *Mikania cordifolia* (L.f.) Willd.	guagú (g)	A,B,S	L,M,P	D,P	O,T	+, +L	3246
30. *Neurolaena lobata* (L.) R. Br.	gúye árani (g)	C,F,H,K, M,S,T	L	D	O,T	+L	2513
31. *Synedrella nodiflora* (L.) Gaertn.	node weed (c)	D,L,U	L	D	O	+L	3648
32. *Wedelia trilobata* (L.) Hitchc.	kaisinpata (m)	B,C,F,I	F,L,M	D	*O*	–/–	2166
Bignoniaceae							
33. *Arrabidaea chica* (Humb. et Bonpl.) Verl.	witts (c)	D,Q,S,T	L	D	O	+L	2313
34. *Crescentia cujete* L.	wira (g)	D,F,L	F,L	D,S	O	-/+L	3447
35. *Tabebuia rosea* (Bertol.) DC.	oaka (c)	D,F	B	D	O	N/-	4444
Bixaceae							
36. *Bixa orellana* L.	gusèwe (g)	C,D,K,L,N	E,L	D,I,P	O,T	+L	3267
Bombacaceae							
37. *Ceiba pentandra* (L.) Gaertn.	tídibu maúru (g)	A,E,K,Q	B	D	O	–/–	4445
38. *Pachira aquatica* L.	gumága (g)	D,S,T	B	D	O	–/–	3384

Boraginaceae							
39. *Cordia alliodora* (Ruiz et Pav.) Oken	samwood (c)	S,T	E,L	D,P	O,T	–L/–	4366
40. *Cordia curassavica* (Jacq.) Roem. et Schult.	wild sage (c)	A,C,D,F,H	L	D	B,O,T	+	2046
41. *Cordia spinescens* L.	wild sage (c)	A,C,F,H	L	D	O	+	3409
42. *Heliotropium indicum* L.	tíliáguru (g)	B,D,S,W	L,P	D	O	+L	3946
Burseraceae							
43. *Bursera simaruba* (L.) Sarg.	surúsu wügüri (g)	C,I,S,T	B	D	B,O	–/–	3615
44. *Protium panamense* (Rose) I.M. Johnst.	copal (h)	A,G,P	B	D,P	O,T	–/–	2473
Caricaceae							
45. *Carica papaya* L.	ababaü (g)	P,S,U,Y	F,L,S	D,J	O,T	+L	2723
Caryophyllaceae							
46. *Drymaria cordata* (L.) Willd. ex Roem. et Schult.	sumu marien (m)	A,L	P	D	O,T	+L	4312
Cecropiaceae							
47. *Cecropia peltata* L.	trumpet (c)	A,F,G,W	L	D	O	+L	3345
Chrysobalanaceae							
48. *Chrysobalanus icaco* L.	higágu (g)	D,Q	B,R	D	O	–/–	2838
49. *Chrysobalanus pellocarpus* G. Mey.	siríngüela (g)	Q	B,R	D	O	–/–	2136
Clusiaceae							
50. *Calophyllum brasiliense* Cambess.	guaü (g)	A,L	B,S	D	O,T	–L/–	4371
51. *Garcinia mangostana* L.	mangosteen (c)	A	B,S	N,P	T	+	NV
52. *Symphonia globulifera* L.f.	dumári míligi (g)	A,S	B,S	D,P	T	+	2356
Combretaceae							
53. *Conocarpus erectus* L.	gurúra (g)	D,Q	B,L	D	O	–/–	2023
54. *Laguncularia racemosa* (L.) Gaertn.	harú gurúra (g)	D	B	D	O	–/–	2712
55. *Terminalia catappa* L.	hamánasi (g)	D,L,Q	B,F,L	D	O	–/+L	2708
Connaraceae							
56. *Connarus lambertii* (DC.) Sagot.	toc toc (c)	D,Q	B,L	D	O	+	2119
Convolvulaceae							
57. *Cuscuta americana* L.	caluhuala (g)	S	L,M	D,P	T	+	2129
58. *Ipomoea batatas* (L.) Lam.	bíme mábi (g)	U	L	D	T	+/+L	3637

Table 1 (Continued)

Scientific name[a]	Common names[b]	Medicinal applications[c]	Part tested[d]	Mode of preparation[e]	Mode of administration[f]	Alkaloid/ glycoside test[g]	Voucher number[h]
59. *Ipomoea pes-caprae* (L.) R. Br.	beach morning glory (c)	F,X	L	D	O	+/+L	2003
60. *Operculina pteripes* (G. Don) O'Donell	bitta tataku (m)	B,U	L	P	T	+	4102
Crassulaceae							
61. *Kalanchoe pinnata* (Lam.) Pers.	tiába laífu (g)	A,C,L,N	L	D,P	O,T	−/+L	3429
Cucurbitaceae							
62. *Fevillea cordifolia* L.	antidote bush (c)	A,B,E,G	E	I,P	O,T	−/−	4432
63. *Lagenaria siceraria* (Molina) Standl.	sísira (g)	G,S,X	L,R	D	O,T	−/−	2732
64. *Luffa cylindrica* (L.) M. Roem.	pataste (h)	A,P	L	D,P	O,T	+	3400
65. *Momordica charantia* L.	sorosí (g)	A,C,F,H,I,J, L,M,S,T	L,M	D	O,T	+/+L	3633
Dilleniaceae							
66. *Davilla kunthii* A. St. Hil.	yájal (g)	D,Q	B,L,M	D	O	+L	2702
Euphorbiaceae							
67. *Acalypha arvensis* Poepp. et Endl.	worm bush (c)	B,S	L,P	D	O,T	−/+L	3607
68. *Amanoa potamophila* Croizat	worm bush (c)	X	F	D	O	−/−	N
69. *Euphorbia hyssopifolia* L.	sagádi gáyu (g)	A,C,I	L,P	D	O	−/−	4040
70. *Euphorbia thymifolia* (L.) Millsp.	míliqi-míliqi (g)	A,C,I,V	L,P	D	O	+L	2224
71. *Jatropha curcas* L.	purging physic (c)	D,F,N,P,V,X	L,S	D	O	+L	2749
72. *Jatropha gossypiifolia* L.	parroty grass (c)	D,G,I,J,S,U, X,Y	L	D	O	+L	3593
73. *Jatropha hastata* Jacq.	physic (c)	F,X	L	D	O	+L	3518
74. *Jatropha urens* L.	wild physic (c)	C,I,U	L,R	D	O	+L	2789
75. *Manihot esculenta* Crantz	añaha (g)	A,D,F	L,R	D	O	−/+L	3269
76. *Pedilanthus tithymaloides* (L.) Poit.	yauhra (m)	O,X	L,R,S	D,N	O	−L/−	2783
77. *Phyllanthus acidus* (L.) Skeels	jambalin (c)	F	L	D	O	+L	2751
78. *Ricinus communis* L.	higuero (h)	A,F,X	E,L	D,P	O,T	+L	3507
Fabaceae							
79. *Andira inermis* (Wright) HBK.	dogwood (c)	F,P,X	B	D	O	+L	2747

80. *Bauhinia guianensis* Aubl.	kaléra mégu (g)	C,S,T	B,M	D	O,T	–/–	2800
81. *Cajanus cajan* (L.) Millsp.	pigeon pea (c)	L,S	F,L	D	O,T	+/+L	3361
82. *Canavalia maritima* (Aubl.) Thouars	barana aifi (g)	F,X	E,L,R	D	O	+/+L	2003
83. *Cassia alata* L.	christmas blossom (c)	D,F,G,H,I, P,S,T,X	F,L	B,D,J,P	B,O,T	+/+L	3202
84. *Cassia fistula* L.	abúrucha gániesi (g)	L	F	D,N	O	+L	2787
85. *Cassia grandis* L.f.	stinking toe (c)	L,P,S,T,X	F,L	D,J,S	O,T	–/+L	3438
86. *Cassia occidentalis* L.	ganíbisi (g)	A,C,F,G,I, L,M	L,P,R	D,J	O,T	+/+L	3625
87. *Cassia reticulata* Willd.	sorocontil (h)	A,B,I,S,W,X	L,R	D	O	+	2799
88. *Cassia tora* L.	frijolillo (h)	F,X	L	D	O	+L	3403
89. *Cassia undulata* Benth.	poloborajero (h)	F,X	L,R	D	O	–/–	3287
90. *Crotalaria longirostrata* Hook. et Arn.	lamúruhéwe (g)	E,X	L	D	O	+	3335
91. *Dalbergia brownei* (Jacq.) Urb.	red fowl (c)	D,Q,S	B,L,M	D	O,T	–/–	2177
92. *Desmodium adscendens* (Sw.) DC.	burbur (c)	A,D,G,I,S,V	L,P,R	D,I	O	+/+L	4117
93. *Desmodium barbatum* (L.) Benth. et Oerst.	wild peanut (c)	A,I,M,S,V	L,R	D	O	–/–	3307
94. *Desmodium canum* (J.F. Gmel.) Schinz et Thell.	hére anágani (g)	A,F,I,M,S,V	L,R	D	O	+	3359
95. *Desmodium triflorum* (L.) DC.	burbur (c)	A,F,I,M,V	L,R	D	O	+/+L	2767
96. *Dioclea megacarpa* Rolfe	kuakua (g)	A,S	L	D,P	T	+	3238
97. *Dipteryx oleifera* (Benth.) Taub.	ebo (c)	A,Z	B,F	D,P	O,T	+L	2321
98. *Entada gigas* (L.) Fawc. et Rendle	quaqua (c)	A,N,S	F	P	T	+L	2860
99. *Hymenaea courbaril* L.	tídibu chagágaru (g)	A,C,D,F,L	B,S	D,P	O,T	–/–	3417
100. *Mimosa pudica* L.	gúsu nebénene (g)	A,F,G,O,P,W	F,L,M,P	D	O	+/+L	2252
101. *Mucuna urens* DC.	quaqua (c)	A,B,G,S	S	D,P	T	+L	2870
102. *Pentaclethra macroloba* (Willd.) Kuntz	pigeon bush (c)	B,E,F,L,S	B	D	O,T	+	2441
103. *Pithecolobium dulce* (Roxb.) Benth.	roosta (c)	D,Q	B	D	O	+L	3764
104. *Tamarindus indica* L.	támparanu (g)	I,X	B,F	D	O	+L	2783
Flacourtiaceae							
105. *Casearia aculeata* Jacq.	birdberry (c)	S	L	D,P	T	+	3852
Gentianaceae							
106. *Coutoubea spicata* Aubl.	worm bush (c)	A,F	L	D	O	–/–	2587
Lamiaceae							
107. *Hyptis verticillata* Jacq.	baríorúma (g)	A,H,I,L,S	L,P,R	D,I	O,T	+	2667
108. *Ocimum micranthum* Willd.	barsley (c)	A,F,G,H,I,L, N,R,S	L	D,I	O,T	+L	2229

Table 1 (Continued)

Scientific name[a]	Common names[b]	Medicinal applications[c]	Part tested[d]	Mode of preparation[e]	Mode of administration[f]	Alkaloid/ glycoside test[g]	Voucher number[h]
Lauraceae							
109. *Cinnamomum zeylanicum* Blume	cinnament (c)	D,G,T	B,M	D	O	–/–	2763
110. *Persea americana* Mill.	wagádi (g)	D,J,L,O,W	B,E,L	D	O	+L	3356
Loganiaceae							
111. *Spigelia anthelmia* L.	worm bush (c)	P	P	D	O	+/+L	2830
Loranthaceae							
112. *Struthanthus cassythoides* Millsp. ex Standl.	scani growd (c)	A,F,L,S	L,P	D	O	+	3829
Malpighiaceae							
113. *Banisteriopsis argentea* C.B. Rob. ex Small	witts (c)	S	B,L,M	D	T	+L	2384
114. *Banisteriopsis cornifolia* C.B. Rob. ex Small	witts (c)	B,S	B,L,M	D	T	+	3305
115. *Byrsonima crassifolia* (L.). HBK.	mureí (g)	A,D,G,Q,S	B,L	D	O	+	2857
116. *Heteropteris multiflora* (DC.) Hochr.	iñéñei (g)	L,Q	L	D	O	+	3476
117. *Hiraea quapara* (Aubl.) Morton	babú (g)	S,U	L	D	T	+	2333
118. *Stigmaphyllon pseudopuberum* Nied.	snakeroot (c)	Q,V,Z	L	D	O,T	–/–	3789
Malvaceae							
119. *Abelmoschus esculentus* (L.) Moench	néhu (g)	L,Y	C	D,J	O	+L	4440
120. *Hibiscus bifurcatus* Cav.	amapola (h)	F,L	F,L	D	O	+	3470
121. *Hibiscus sabdariffa* L.	hamaíga (g)	K,L,T	F,L	D	O	–/–	2745
122. *Hibiscus tiliaceus* L.	maíñu (g)	C,F,Y	B,L	D	O	+	2185
123. *Kosteletzkya pentasperma* (Bertol.) Griseb.	malva mulata (h)	S,U	L	D,P	T	+	3527
124. *Pavonia rosea* Schltr.	mozote (h)	I,V,W	R	D	O	+	4150
125. *Sida acuta* Burm. f.	sagádi abuídagülei (g)	A,C,L,V,W	L,P	D	O	+L	3232
126. *Sida rhombifolia* L.	sagádi abuídagülei (g)	A,C,F,I,L,V	L	D	O	+L	3587
127. *Sida spinosa* L.	white broom weed (c)	D,I,S	L	D	O,T	+L	2249

Melastomataceae							
128. *Miconia albicans* (Sw.) Triana .	blueberry (c)	S	L	D	T	–/–	2053
Meliaceae							
129. *Carapa guianensis* Aubl.	saba (s)	D,Q	B	D	O	+/+L	4369
130. *Cedrela odorata* L.	hibúari (g)	A,F,Q,T	B	D	O	–L/–	4365
131. *Swietenia macrophylla* King	gaúbana (g)	F	B	D	O	+L	4413
Menispermaceae							
132. *Cissampelos pareira* L.	tamasás, alcotán (h)	B,F,S,V	L,R	D	O,T	+L	2532
Moraceae							
133. *Artocarpus altilis* (Parkinson)	breadfruit (c)	A,H	L,S	D,P	T	–/–	3423
Fosberg							
134. *Ficus insipida* Willd.	higo (g)	A,G	S	I,P	O,T	+	3483
Myristicaceae							
135. *Myristica fragrans* Houtt.	misgádu (g)	G	F	D	O	+L	2753
136. *Virola koschnyi* Warb.	banak (m)	A,D,F,Q	B,L,S	D,P	O,T	+L	2398
Myrtaceae							
137. *Calyptranthes chytraculia* var. americana McVaugh	wild lime (c)	G,L	L	D	O	–/–	4071
138. *Eugenia acapulcensis* Steud.	mansána (g)	F,G	L	D	O	–/–	3913
139. *Eugenia axillaris* (Sw.) Willd.	white bush (c)	D,T	L	D	O	–/–	3988
140. *Psidium guajava* L.	waríafa (g)	D,F,G,H,I, M,P,S	B,F,L	D,I	B,O	+L	3441
141. *Syzygium aromaticum* (L.) Merr. et Perry	cloves (c)	A,C,G,O	C	D	O	+L	4442
142. *Syzygium malaccensis* (L.) Merr. et Perry	mansána (g)	A,S	B,L,S	D,P	T	+	3452
Onagraceae							
143. *Ludwigia octovalvis* (Jacq.) Raven	wild cloves (c)	C,F,G,L	F	D	O	–/–	3220
Oxalidaceae							
144. *Averrhoa bilimbi* L.	mimbro (h)	D,F	F,L	D,J	O	–L/–	2784
Passifloraceae							
145. *Passiflora quadrangularis* L.	drap (m)	F,M,S	L	D,J	O,T	+L	3513
Phytolaccaceae							
146. *Petiveria alliacea* L.	fitsy bush (c)	A,L,R	L,P,R	I,P	O,T	+L	3566
147. *Phytolacca rivinoides* Kunth et Bouché	yukutu (c) calalu, yocoto	E,X	L,R	D	O	+L	3259

Table 1 (Continued)

Scientific name[a]	Common names[b]	Medicinal applications[c]	Part tested[d]	Mode of preparation[e]	Mode of administration[f]	Alkaloid/ glycoside test[g]	Voucher number[h]
Piperaceae							
148. *Peperomia pellucida* (L.) HBK.	sumu mairen (m)	B,I,V,W	P	D	O	–/–	3744
149. *Peperomia peltata* C. DC.	man-to-man (c)	B,I,V,W	P	D	O	–/–	2225
150. *Piper auritum* HBK.	ugúdi bágasu (g)	A,C,F,G,N	L	I,J,P	O,T	+/+L	2719
151. *Piper hispidum* Sw.	spanish ela (c)	A,F,G	L	B,I	B,O	+	2457
152. *Piper jacquemontianum* (Kunth) DC.	spanish ela (c)	A,F,G	L	B,I	B,O	+	3326
153. *Piper peltatum* L.	ugúdi bágasu (g)	A,C,F,G,N	L	D,P	B,O,T	+	3210
Polygonaceae							
154. *Antigonon leptopus* Hook. et Arn.	kuráli púntugu (g)	V	R	D	O	–/+L	2766
155. *Coccoloba uvifera* (L.) L.	barána baíbai (g)	D,G,S	B,L	D	O	–/–	3444
Rhizophoraceae							
156. *Rhizophora mangle* L.	gurúra (g)	D,G,S	B	D	O	–/–	2096
Rubiaceae							
157. *Cinchona pubescens* Vahl	quina (h)	D,F,G,M,T	B,M	D	O	+L	3544
158. *Coffea arabica* L.	gáfe (g)	F,U	E	D,N	O,T	+L	NV
159. *Morinda citrifolia* L.	yeíawa haráchan (g)	A,N	L	P	T	+L	2769
160. *Morinda panamensis* Seem.	buíruhu manzána (g)	D,X	B,L	P	T	–/–	2596
161. *Posoqueria latifolia* (Rudge) Roem. et Schult.	urágu (g)	D,Q	B,L	D	O	+	4313
162. *Psychotria elata* (Sw.) Hammel	red scholars (c)	B,F,I,J,N,O,S	F,L,M,R	D	O,T	+	2472
163. *Psychotria ipecacuanha* (Brot.) Stokes	raizcilla (h)	D,E,F,L,S	R	D	O	+L	4447
164. *Psychotria poeppigiana* Muell.-Arg.	sore mouth bush (c)	B,F,I,J,N, O,S,U	F,L,M	D	O,T	+	2010
Rutaceae							
165. *Citrus aurantiifolia* (Christm.) Swingle	líma (g)	C,D,F,G,I,L, M,P,S	F,L,R	D,J	O	+L	3677
166. *Citrus aurantium* L.	aránsu garühü (g)	D,F,G,H	F,L,R	D,I,J	B,O	+L	4449
167. *Citrus paradisi* Macfad.	charígi, torónha (g)	D,F,H	F	J	O	+L	3681
168. *Citrus sinensis* (L.) Osbeck	aránsu (g)	D,F,H,L	F,L	D,J	O	+L	4450

Sapindaceae							
169. *Melicoccus bijugatus* Jacq.	kinep (c)	D,Q	E,L	D	O	–/–	3435
Sapotaceae							
170. *Chrysophyllum cainito* L.	star apple (c)	D,F,Q,V	F,L	D,N	O	+L	3350
171. *Manilkara zapota* (L) P. Royen	sagadú (g)	A,S	S	P	T	+L	2792
172. *Pouteria sapota* (Jacq.) H.E. Moore et Stearn	sabúdi (g)	A,D,G,S	B,E,L	D,P	O,T	+L	2710
Scrophulariaceae							
173. *Bacopa procumbens* (Mill.) Greenm.	yellow bird (c)	A,X	L	D,J	O,T	–/–	2707
174. *Lindernia diffusa* (L.) Wettst.ex Dugand et Jacks.	bird bush (c)	X	P	D	O	+	2709
175. *Scoparia dulcis* L.	ri haráchan (g)	B,C,I,M,N, T,V,W	L,P,R	D	O	+/+L	2236
Simarubaceae							
176. *Quassia amara* L.	wéwe gífi (g)	A,B,F,M,P, Q,T	M	D	O	+/+L	3540
177. *Quassia simarouba* L.f.	leskuéla (g)	D,F,M,T,W	B	D	O	–/+L	4404
Solanaceae							
178. *Capsicum annuum* var. glabriusculium (Dunal) Heiser et Pickersgill	áti (g)	A,L,S	E,F,L	D,N	O,T	+L	4330
179. *Capsicum chinensis* Jacq.	áti (g)	A,L,S	E,F,L	D,N	O,T	+	3605
180. *Capsicum frutescens* L.	áti (g)	F,I,K,L	F,L	D,J	O,T	+L	2748
181. *Nicotiana tabacum* L.	iúri (g)	A,B,S	L	N	O,T	+L	NV
182. *Physalis angulata* L.	dumádu haráchan (g)	F,S	L,P	I	O	+L	2259
183. *Physalis cordata* Mill.	turtle egg (c)	K	L,P	I	O	+	3695
184. *Solanum asperum* Rich.	susul (m)	S	L	D	T	+L	3255
185. *Solanum lycopersicum* L.	dumádu (g)	S	L	J	T	+L	2831
186. *Solanum mammosum* L.	gañé gadáru (g)	A,L,S	E,F,L	D,P	O,T	+L	3664
187. *Solanum torvum* Sw.	mirámira furúda (g)	A,B,F,S	L,R	D,P	T	+L	4361
188. *Solanum tuberosum* L.	mábi (g)	G	R	J	O	+L	NV
Sterculiaceae							
189. *Melochia villosa* (Mill.) Fawc. et Rendle	tea bush (c)	G,L	L	D	O	+	2750
190. *Theobroma cacao* L.	gábu (g)	N,S,U	E,L	P	T	+L	2815
Tiliaceae							
191. *Apeiba aspera* Aubl.	fáñeimégu (g)	L,S	B,L	D	O,T	–/–	2369
192. *Luehea seemannii* Triana et Planch.	guácimo (h)	Q	B,L	D	O	–/–	2283

Table 1 (Continued)

Scientific name[a]	Common names[b]	Medicinal applications[c]	Part tested[d]	Mode of preparation[e]	Mode of administration[f]	Alkaloid/ glycoside test[g]	Voucher number[h]
Turneraceae							
193. *Turnera ulmifolia* L.	ram goat dash along (c)	A,F,L,X	L	D	O	+L	3885
Verbenaceae							
194. *Avicennia germinans* (L.) L.	würí gurúra (g)	D,Q	B	D	O	–/–	2824
195. *Lippia alba* (Mill.) N.E. ex Britton et Wilson	catnip (c)	C,F,G,L,W	L	D,I	O	–/+L	3495
196. *Lippia micromera* Schauer	wild thyme (c)	A,C,G,K,L,W	L	D,I	O	–/+L	2247
197. *Stachytarpheta cayennensis* (Rich.) Vahl	vorvine (c)	C,F,G,L,P,V, X,Y	L	D	O	+L	3551
198. *Stachytarpheta jamaicensis* (L.) Vahl	vorvine (c)	C,F,L,P,V,X	L	D	O	+L	3628
199. *Tamonea spicata* Aubl.	wild thyme (c)	F,G,L	L	D	O	+	4333
LILIOPSIDA (Monocots)							
Aloeaceae							
200. *Aloe vera* L.	sábila (g)	B,N,S,X	L	J	O,T	+L	2743
Araceae							
201. *Montrichardia arborescens* (L.) Schott	chinchin banana (c)	F	F	D	O	+	3538
202. *Philodendron scandens* K. Koch et Sello	snake vine (c)	B	L,M	D,P	O,T	+/+L	2155
203. *Xanthosoma mexicanum* Liebm.	wild coco (c)	S	L	D	T	–/–	2151
Arecaceae							
204. *Acoelorraphe wrightii* (Griseb. et. H. Wendl.) H. Wendl. ex Becc.	harádan (g)	D	R	D	O	–/–	2782
205. *Bactris gasipaes* Kunth	pejibáyu (g)	G	F	D	O	–/–	2772
206. *Bactris major Jacq.*	coyúl (g)	P,X	R	D	O	–/–	3725
207. *Cocos nucifera* L.	fáluma (g)	D,P	F	D,I	O	+L	NV
208. *Elaeis oleifera* (Kunth) Cortés	batana, murísi (g)	C,G,S,X	F	D	O	N/–	NV
Bromeliaceae							
209. *Ananas comosus* (L.) Merr.	yeíawa (g)	B,I,U	F,L	D	O	+L	2727
210. *Bromelia pinguin* L.	tídibu yeíawa (g)	B	L	D,P	O,T	–L/–	2737

Commelinaceae							
211. *Commelina erecta* L.	bluebird (c)	S	L,M	J	T	–/–	3593
212. *Tradescantia zebrina* Bosse	purple grass (c)	D,G,L	P	D	O	–/–	NV
Cyperaceae							
213. *Kyllinga tibialis* Ledeb.	béya sagádi (g)	F	R	D	O	+L	4111
Liliaceae							
214. *Allium cepa* L.	sebúya (g)	L,P	R	J	O	N	NV
215. *Allium sativum* L.	lai (g)	A,C,H,P	R	J	O	+L	NV
Musaceae							
216. *Musa* sp.	gasíbu (g)	B,D,U	F,S	N,P	O,T	+L	NV
217. *Musa paradisiaca* L.	barúru (g)	B,D,N,U	F,S	N,P	O,T	+L	NV
218. *Musa paradisiaca* var. sapientum (L.) Kuntze	bímena (g)	B,D,N,U	F,S	N,P	O,T	+L	NV
Poaceae							
219. *Bambusa vulgaris* Schrad. ex Wendl.	bámbu (g)	D,F,I,N,S	R	D,P	O,T	+L	2711
220. *Coix lacryma-jobi* L.	sagádi, agúsa (g)	I,S	E,R	D	O	+L	2646
221. *Cymbopogon citratus* (Nees) Stapf	sagádi, sagádi abíruaü (g)	F,G,L	L,R	I,P	O,T	+L	3682
222. *Eleusine indica* (L.) Gaertn.	sagádi (g)	C,F,I,W	R	D	O	+L	2273
223. *Gynerium sagittatum* (Aubl.) P. Beauv.	gániesiharáchan (g)	B,I,K,S,V	R	D	O	–/–	3870
224. *Olyra latifolia* L.	sagádi (g)	S	L,R	D	T	–/–	3323
225. *Oryza sativa* L.	ri (g)	D,S	E	B,I	B,O	+L	2756
226. *Saccharum officinarum* L.	gániesi (g)	D,I,L,P,S	L,M	D,J	O,T	–L/–	2764
227. *Zea mays* L.	awási (g)	I	C	D	O	+L	2766
Smilacaceae							
228. *Smilax spinosa* Mill.	ílagülei güríngüri (g)	B,C,S,T	R	D	O	–/–	2161
Zingiberaceae							
229. *Zingiber officinale* Roscoe	chichámbara (g)	A,C,F,G,L	R	D	O	–/+L	2826

Table 1 (Continued)

[a]Scientific name of the angiosperm families follows Cronquist (1981); the order of families, genera, and species within dicots and monocots is alphabetical.
[b]Common names used by the Garífuna: c, Creole English; g, Garífuna; h, Spanish; m, Miskitu; s, Sumu; spelling follows CIDCA (1986, 1989), Hadel (1975) and Smutko (1985).
[c]Medicinal applications: A, aches and pains; B, bites and stings (snake, scorpion, insects); C, childbirth and pregnancy; D, diarrhea; E, emetic; F, fever; G, digestive (stomachache, ulcers, etc.); H, hypertension; I, infections; J, diabetes; K, diuretic; L, respiratory and pulmonary disorders (cold, coughs, etc.); M, malaria; N, burns; O, abortifacient; P, worms and intestinal parasites; Q, astringent; R, rituals; S, skin rashes and sores; T, tonic and anemia (blood fortifier); U, cuts and hemorrhage; V, venereal diseases; W, female disorders (menstruation, hemorrhage); X, purgative and laxative; Y, constipation; Z, tooth extraction.
[d]Part tested: B, bark; C, flower; E, seed; F, fruit; L, leaf; M, stem; P, whole plant; R, root; S, sap.
[e]Mode of preparation: B, bath; D, decoction; I, infusion; J, juice of crushed parts; N, none; P, poultice; S, syrup (see Materials and methods for further explanation).
[f]Mode of administration: B, bath; I, inhalation; O, oral; T, topical (see Materials and methods for further explanation).
[g]Alkaloid/glycoside test. Alkaloid tests: N, not tested and no literature search; −L, none in literature; +L, alkaloids reported in the literature; + (present) or − (absent) in Coe's tests (see Methods and materials). Glycoside tests: a limited literature search for glycosides was conducted only for those species that tested negative for alkaloids; /+L, present; /−, none reported.
[h]Voucher number: N, common, native, only one voucher collected for all groups; NV, no voucher; number, F.G. Coe's accession numbers.

Table 2
Occurrence of alkaloids and glycosides in major taxa: numbers represent species

Bioactive compound/source	Filicopsida	Magnoliopsida (Dicots)	Liliopsida (Monocots)	Total
Alkaloid				
Literature	0	86	15	101
Lab/field Test	1	49	1	51
Total	1	135	16	152
Glycoside				
Literature	0	11	1	12
Total	0	11	1	12
Grand total	1	146	17	164

of the 229 Garífuna medicinal plants contain bioactive compounds. Another sub-sample of the entire list also makes this point. The most commonly used 15 medicinal plant families include some 125 species; more than three-quarters of these species contain alkaloids (Table 4). Cox et al. (1989) and Farnsworth (1984a, 1984b) also report a strong correlation between medicinal plant use and their bioactive compounds. To make this point even clearer, the most popular medicinal species in the Garífuna pharmacopoeia was analyzed. As Table 5 shows, all these 13 'most popular' species (representing 11 families) tested positive for alkaloids. In fact, they have presumably been recognized in other studies, because all but two were already reported in the literature as alkaloid bearing. Another way of making this point is a comparison of the 25 most popular medicinal species with the 25 that are least used (Table 6). This is obviously a subjective ranking, but telling nonetheless. More than 95% of the popular medicinals (24/25) bear alkaloids or glycosides, compared with only 68% (17/25) of the less popular species (this difference is highly significant; $/X/^2 = 4.878$; $P = 0.027$).

Table 3
Presence of alkaloids in relation to habit of plant

Habit	Number of alkaloid bearing species	%
Herb	66	43
Vine	25	17
Shrub	18	12
Tree	43	28
Total	152	100

The Garífuna are not alone in claiming the healing properties of certain medicinals. For example, *Momordica charantia* (plant no. 65 in Table 1) is also the most popular medicinal among the Miskitu, Sumu, and Rama of eastern Nicaragua. It is also widely used in Mexico, Belize, Honduras, Costa Rica, Panama and the Caribbean (Duke, 1972, 1994; Morton, 1981; Martínez, 1991; García, 1992; Balick and Arvigo, 1993; Duke and Vasquez, 1994). In China, *M. charantia* is used to treat more than 10 ailments (Yang and Walters, 1992). In Fiji (Cambie and Ash, 1994) and in Sri Lanka (Tennekoon et al., 1994) it is used to treat diabetes. *Cassia occidentalis* (plant no. 86 in Table 1) is another popular medicinal used by the Garífuna and other indigenous groups of both the Old World and New World tropics. In the New World, this species is widely used from Mexico to Colombia and in the Caribbean (Duke, 1972, 1994; Morton, 1981; Martínez, 1991; García, 1992; Balick and Arvigo, 1993; Duke and Vasquez, 1994). In Fiji, *C. occidentalis* is used as a pediatric anticonvulsive and sedative (Cambie and Ash, 1994). This species is also used medicinally in the Philippines, China, and Guam (Perry, 1980; Concha, 1982). In

Table 4
Plant families of Garífuna medicinals with the largest number of alkaloid-bearing species

Family	Number of species used	Reported in literature	Lab/field results		Total alkaloid-bearing species	% with alkaloids
			Positive	Negative		
Annonaceae	4	3	1	0	4	100
Apocynaceae	5	0	4	1	4	80
Asteraceae	11	6	3	2	9	82
Boraginaceae	4	1	2	1	3	75
Convolvulaceae	4	2	2	0	4	100
Curcurbitaceae	4	1	1	2	2	50
Euphorbiaceae	12	7	0	5	7	58
Fabaceae	26	15	5	6	20	77
Malpighiaceae	6	1	4	1	5	83
Malvaceae	9	4	4	1	8	89
Piperaceae	6	1	3	2	4	67
Poaceae	9	6	0	3	6	67
Rubiaceae	8	4	3	1	7	87
Solanaceae	11	9	2	0	11	100
Verbenaceae	6	2	1	3	3	50
Total	125	62	35	28	97	

Thailand, *C. occidentalis* is used to treat malaria, digestive disorders, urinary problems, bladder stones, and as a tonic and diuretic (Anderson, 1993). The independent uses of *M. charantia* and *C. occidentalis* and other species by many people across such a broad range of geographic regions supports the assumption that bioactive compounds of some value may be present.

Another simple analysis of the data was to look at the distribution of alkaloids and glycosides in relation to mode of application. By considering the primary mode of application (obviously, many medicinals have multiple uses and more than one mode of application), all but nine of the medicinals could be classified. Table 7 shows that most are primarily administered orally; most (75%) such medicines bear bioactive principles. However, most (70%) of those applied topically also bear such substances. Thus, there is no difference ($/X/^2 = 0.111$, $P = 0.739$) in the possible physiological impact of medicinals used in either way. Perhaps one would not expect any such differences because many topical applications are associated with wounds or skin diseases where bioactive compounds get through the skin even without a penetration enhancer.

Overall, baseline alkaloid screening as done in this survey is an important starting point for more detailed investigations of the pharmacological activity of bioactive principles of medicinals. Our results and those of others (Farnsworth, 1984a, 1984b; Schultes, 1986; Cox et al., 1989; Balick, 1990), show that screening of the ethnobotanical lore of indigenous people provides a rapid and effective means of examining a flora for bioactive compounds. We found that more than 70% of the plant species used by the Garífuna of eastern Nicaragua as medicinals contained alkaloids or glycosides. It is unlikely that a random screening of the local flora would have resulted in such a high success rate. In several studies the percentage of species identified as alkaloid-bearing is considered higher in ethnobotanical screening than would have been found in a random survey (Arthur and Cheung, 1960; Kiang et al., 1961; Amarasingham et al., 1964; Hultin and Torssell, 1965; Farnsworth, 1988).

What about the remaining 25%–30% of the medicinals that tested negative for alkaloids? Our tests may not have detected alkaloids present, but that seems unlikely. These species may contain other biologically active secondary compounds

Table 5
Significant Garífuna medicinals (based on number of ailments treated and subjective interpretation of their importance)

Scientific name	Number of ailments treated	Rating[a]	Alkaloid tests[b]
ASTERACEAE			
Neurolaena lobata	7	H	L
CUCURBITACEAE			
Momordica charantia	10	H	L
EUPHORBIACEAE			
Jatropha gossypiifolia	8	M	L
FABACEAE			
Cassia alata	9	H	L
Cassia occidentalis	7	H	L
LAMIACEAE			
Ocimum micranthum	9	M	L
MYRTACEAE			
Psidium guajava	8	M	L
RUBIACEAE			
Psychotria elata	7	H	+
Psychotria poeppigiana	8	H	+
RUTACEAE			
Citrus aurantiifolia	9	H	L
SCROPHULARIACEAE			
Scoparia dulcis	8	H	L
SIMARUBACEAE			
Quassia amara	7	H	L
VERBENACEAE			
Stachytarpheta cayenensis	8	M	L

[a]H, high; M, medium; L, low; based on F. Coe's interviews and field experience.
[b]L, alkaloid reported in the literature; + present in Coe's tests.

that together with essential fatty acids, mineral nutrients, and vitamins present, may be of value. Johns (1990) argues that many medicinals are of value not because they are antagonistic to disease organisms, or act as stimulants to organ systems, but because they provide some essential fatty acids, mineral nutrients, or vitamins that are in low supply in the regular food system. For example, *Smilax spinosa* (plant no. 228 in Table 1) is rich in essential fatty acids, and *Bromelia pinguin* (plant no. 210 in Table 1) is a good source of minerals and vitamins. Of course, not all the medicinals will have either traditional medicinal value or supply the missing nutrients. Some will be valueless, and others of importance psychologically — certain 'prescriptions' provide healing power simply because a respected practitioner in the community prescribed them (just as in Western medicine).

Nonetheless, the presence of bioactive compounds in the vast majority of Garífuna medicinals may explain their therapeutic use. These extensive field-based studies are a necessary first step in the search for new biologically active molecules from natural products. Tests to explore the pharmacological activity of the compounds are the required next logical steps in determining the efficacy and application of the Garífuna pharmacopoeia.

Table 6
Alkaloids/glycosides and extent of application

Popularity of medicinals	Alkaloids/glycosides[a]	
	Present	Absent
Leading 25 species	24	1
Least used 25 species	17	8

$\chi^2 = 4.878$; $P = 0.0272$.
[a]Data on glycosides are based on literature reports.

Table 7
Alkaloids/glycosides and mode of administration (nine species could not be placed in either the oral or the topical category)

Mode of administration	Alkaloids/Glycosides[a]	
	Present	Absent
Oral	128	45
Topical	33	14
Other	3	6

$\chi^2 = 0.111$; $P = 0.7395$.
[a]Data on glycosides are based on literature reports.

Another goal of this work has been to document the use of plants in traditional Garífuna culture — a culture that, like many, is disappearing rapidly with acculturation. The next step in that effort is the translation and dissemination of these studies to the Garífuna communities. That effort is underway and, although less sophisticated than the pharmacological trials, is equally important.

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