ECOLOGY, BEHAVIOR AND BIONOMICS

Host Plants of the Carambola Fruit Fly, *Bactrocera carambolae* Drew & Hancock (Diptera: Tephritidae), in Suriname, South America

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Hospedeiros da Mosca-da-Carambola, *Bactrocera carambolae* Drew & Hancock (Diptera: Tephritidae), no Suriname, América do Sul

RESUMO - Durante um periodo de 12 anos foram coletados frutos para determinar as plantas hospedeiras da mosca-da-carambola, *Bactrocera carambolae* Drew & Hancock, e outras espécies de tefrítidos que ocorrem no Suriname, América do Sul. Mais de 11.000 amostras de frutos foram coletadas de diversas localidades e somaram o total de 20 espécies de frutos tidos como hospedeiros, classificados como infestação entre forte e até ocasional. Mais de 650 amostras de 188 espécies de frutos, incluindo várias espécies selvagens, foram coletadas porém não foram encontradas as moscas nas frutas. Este trabalho, que começou especificamente para obter informações sobre a mosca-da-carambola, resultou também em informações sobre a importância, distribuição e preferência de diferentes espécies de *Anastrepha* para as plantas hospedeiras e a importância de parasitóides de moscas-das-frutas.

PALAVRAS-CHAVE: Levantamento, hospedeiro, *Anastrepha*, infestação, parasitóide, preferência

ABSTRACT - Fruits were collected over a 12-year period to determine the host status for the Carambola fruit fly, *Bactrocera carambolae* Drew & Hancock, and other tephritid species in Suriname, South America. Over 11,000 fruit samples were collected from many locations and the total of 20 fruit species were recorded as host, ranging in infestation from heavy to occasional. Over 650 samples of 188 fruit species, including many wild species, were collected and no fruit flies were reared. This work, which started specifically to obtain information on the Carambola fruit fly, resulted also in detailed information regarding the importance, distribution and host preferences of several *Anastrepha* species, and the status of fruit fly parasitoids.

KEY WORDS: Fruit survey, *Anastrepha*, infestation, parasitoid, host, preference

The Oriental fruit fly, *Bactrocera dorsalis* Hendel as it was known up to a decade ago - now the *Bactrocera dorsalis* complex - had a wide variety of fruits listed as hosts throughout Asia from the Philippines to India and Indonesia when it was originally described. The review of the taxonomic status of this complex resulted in over 52 species (Drew & Hancock 1994) and raised questions on the host status of each 'new' species. Literature referring to host plants of the Oriental fruit fly previous to 1994 is actually referring to fruit flies belonging to what is now known as the OFF complex. Thus no exact information regarding host plants for each fly species is available, as several species are known to occur within a country or region. The distribution of *Bactrocera carambolae* Drew & Hancock, the Carambola fruit fly (CFF) - one of the Oriental fruit fly complex species - is Indonesia, Malaysia and southern Thailand. As an invading species it is found in the northern part of South America: Suriname, Guyana, French Guiana and northern Brazil (White *et al*., 1992).

Fruit production in Suriname is not yet developed; most fruit trees are found in domestic backyards. Citrus orchards are common (ca 1735 ha), but orchards are limited for fruits as guava (*Psidium guajava*) (3 ha), Malay apple (*Syzygium malaccense*) (app. 0.5 ha), carambola (*Averrhoa carambola*) (app. 3 ha) and West Indian Cherry (*Malpighia punicifolia*) (15 ha). The total acreage for mango (*Mangifera indica*) is estimated to be around 157 ha.

CFF has been in Suriname since at least 1975 (van Sauers-Muller 1991). In 1975, several specimens were reared

from fruits and stored unidentified in the insect collection of the Agricultural Experiment Station. Flies were sent for identification to the Smithsonian after new fruit collections showed the presence of this exotic fruit fly in 1986. After its detection in 1986, a host and distribution survey began by collecting wild and cultivated fruits from many locations throughout the country.

Several control options for CFF were considered, but the only relevant one appeared to be an eradication programme. The importance of an eradication program for CFF lies not only within future expansion of the fruit sector of Suriname, but also in the threat which the CFF poses upon expanding its range to the tropical areas of South and Central America and the south of the United States. In 1990 the first control actions were applied. In 1996, this initiative was continued on a larger scale with the Regional Program for eradication of the CFF.

The control program consisted of a detection phase, in which the presence or absence of CFF in a certain area was confirmed using Jackson and McPhail traps baited respectively with methyl-eugenol and food lure, and by the collection of fruits. In the control phase, the Male Annihilation Technique was applied by using fiberboard blocks drenched in methyl-eugenol and malathion.

This paper reports the results of the fruit collection, ranking the importance of the different fruit species as host for CFF and the importance of natural enemies attacking CFF.

Materials and Methods

From August 1986 to July 2002, fruit samples were collected in the field to identify and quantify the hosts of CFF and its distribution. The samples were taken before, during and after control techniques were applied. Collections were made in most of the human inhabited areas in Suriname and partly in forested areas. Samples (ranging from 1 to over 100 fruits) were collected by gathering fruits either fallen recently on the ground or picked from the trees. The fruits were brought to the laboratory in buckets and trays with sawdust.

Each fruit sample was identified to plant species, and their weight, number of fruits and location were recorded. Fruits were identified, if not commonly known, to family and species using the information in Ostendorf (1962), Wessels Boer *et al.* (1976), Van Roosmalen (1985), Hoyos (1994) and with the help of experts of the University of Suriname. After a maximum period of 10 days, samples and sawdust were checked for pupae and larvae, which were transferred to smaller jars for emergence. Fruit samples and jars with pupae were screened with cotton cloth, to prevent *Drosophila* from entering and fruit flies from escaping. Samples were discarded, sometimes after a second check, when no more larvae were found in the decomposing fruits or in the sawdust. Adults were identified to genus and either kept for further identification to species in the insect collection or used for training purposes. Numbers and species of emerged flies, and -if present- numbers of parasitoids, were recorded.

Results and Discussion

Table 1 presents a summary of the fruit species infested with fruit flies, the total number of collected samples of each species, number of fruits and their weight; number of samples infested with fruit flies and their parasitoids. Numbers of samples with no fruit flies were recorded and the frequency of non-infested of the total is given. The total number of pupae, emerged *Anastrepha* flies, *Bactrocera* flies and parasitoids is presented, as is the percentage of parasitism. A total of 10,183 samples from 46 plant species belonging to 21 families were collected from August 1986 to July 2002.

Mixed populations of *Anastrepha* and *Bactrocera* have been found in several samples, and sometimes one fruit comprised more than one fruit fly species. From all collected samples, a total of 292 fruits were either collected or reared individually. In nine samples, a mixed population of *Anastrepha* and *Bactrocera* was reared from one fruit. These samples were found in seven different districts, and in the following fruit species: carambola, guava, West Indian cherry, starapple (*Chrysophyllum cainito*) L., grapefruit (*Citrus paradisi*) Macf. and sapodilla (*Manilkara achras*) (Mill.) Fosberg.

Wild and cultivated fruits from over 56 families and belonging to over 187 different species were collected and no fruit flies were reared from them. Locations of sampling and number of collections of all fruits are shown in Fig. 1.

Carambola, *Averrhoa carambolae* L., proved to be the major host plant, with 32% of the samples infested by CFF. The Curacao apple, *Syzygium samarangense* (Blume) Merr. & Perry, is second in this list (20.45%).

Surinam cherry (*Eugenia uniflora* L.), pommeroos (*Syzygium jambos* (L.) Alston), a wild cherry (*Eugenia* cf *patrisii* Vahl), mango (*Mangifera indica* L.), West Indian cherry (*Malpighia punicifolia* L.), moendoe (*Garcinia dulcis* (Roxb.) Kurz.), jujube (*Zizyphus jujuba* Mill.) and tropical almond (*Terminalia catappa* L.) all had infestation rates between 10-19 %. The number of samples collected from both *Eugenia* species, pommeroos and moendoe are very low, as these fruits are not common in Suriname. The wild cherry has been found only in the Para district, mainly in Amerindian communities.

Mango, West Indian cherry, jujube and tropical almond were abundant. Different varieties of mango, guava and carambola were infested differently. Sweet varieties of the carambola were often infested, while sour varieties, even in the immediate surroundings, were free of CFF. Several local varieties of mango, Tité and Cayenne, were found more often infested than other varieties by as well CFF as the West Indian fruit fly (*Anastrepha obliqua*) Macquart. CFF also occurs in some other mango 'varieties', however due to hybridization, description of these mango varieties is difficult.

Several non-described guava varieties also occur, which differ in shape and color of their flesh. One large-sized variety (propagated by seed, local variety) was observed to be more susceptible to CFF infestations, while in the other varieties the local guava fruit fly (*Anastrepha striata*) Schiner

Table 1. Hosts of fruit flies in Suriname.

Plant family, scientific name and common name	Origin	Number of		Sample weight (g)	Number of				Infestation rates		% parasitism
		samples	fruits		Pupae	*Anastrepha*	*Bactrocera*	Parasitoids	pupae. 100 g^{-1}	% infested samples	
Anacardiaceae											
Anacardium occidentale L. (cashew)	Trop. America	160	839	47,523	109	8	76	0	0.23	1.9	0.0
Mangifera indica L. (mango)	India, Burma	401	1888	385,488	1,075	91	566	0	0.28	14.0	0.0
Spondias cytherea Sonn. (golden apple, pomme de cythere)	Polynesia	67	441	21,209	117	5	33	0	0.55	1.5	0.0
Spondias mombin L. (hog plum)	S. America	197	4,813	41,678	4,514	2,123	10	844	10.83	1.5	18.7
Spondias purpurea L. (red mombin)	Trop. America	7	108	778	67	40	0	7	8.61	0.0	10.5
Apocynaceae											
Ambelania acida Aubl. (batbati)	S. America	13	62	5,716	7	0	0	0	0.12	0.0	0.0
Bromeliaceae											
Ananas commosus Merr. (pine apple)	S. America	13	17	8,610	1	0	0	0	0.01	0.0	0.0
Caricaceae											
Carica papaya L. (papaya)	S. America	50	137	33,110	4	0	0	0	0.01	0.0	0.0
Combretaceae											
Terminalia catappa L. (tropical almond)	Indonesia	84	1087	19,706	156	1	132	0	0.79	10.7	0.0
Euphorbiaceae											
Amanoa guianensis Aubl. (swampoe-goejaba)	S. America	6	413	4,705	43	28	0	0	0.91	0.0	0.0
Manihot esculenta Crantz (cassava)	trop. America	34	3516	10,022	211	158	0	4	2.11	0.0	1.9
Flacourtiaceae											
Casearia mariquitensis H.B.K. (oema-odoe)	S. America	6	475	739	1	0	0	0	0.14	0.0	0.0
Flacourtia jangomas (babydruif)	India	16	309	1,760	1	0	0	0	0.06	0.0	0.0
Guttiferae											
Garcinia dulcis (Roxb.) Kurz (moendoe)	T. Asia	18	155	10,285	5	0	2	0	0.05	11.1	0.0
Lecythidaceae											
Couratari sp. (ingipipa)	S. America	7	66	1,184	8	0	0	0	0.68	0.0	0.0
Malpighiaceae											
Malpighia punicifolia L. (West-Indian cherry)	Trop. America	904	22,407	124,911	2,747	1,045	694	120	2.20	11.2	4.4
Melastomataceae											
Bellucia grossularoides (L.) Triana (mispel)	S. America	47	1,354	11,951	338	127	0	32	2.83	0.0	9.5
Loreya mespiloides Miq. (mispel)	S. America	2	62	112	4	0	0	0	3.57	0.0	0.0
Mouriria collocarpa Ducke (spikri-oedoe)	S. America	1	36	802	1	0	0	0	0.12	0.0	0.0
Mispel, species unknown	S. America	33	1470	6,523	235	35	0	18	3.60	0.0	7.7
Mimosaceae											

Cont.

Table 1. Continuation

Plant family, scientific name and common name	Origin	Number of		Sample weight (g)	Number of				Infestation rates		% parasitism
		samples	fruits		Pupae	*Anastrepha*	*Bactrocera*	Parasitoids	pupae. 100 g^{-1}	% infested samples	
Inga acrocephala Steud. (swit-bonki, kala-weko)	S. America	5	148	2,110	10	7	0	0	0.47	0.0	0.0
Inga alba (Sw.) Willd. (swit-bonki)	S. America	7	281	2,694	10	1	0	1	0.37	0.0	10.0
Inga leiocalycina Benth. ? (swit-bonki)	S. America	1	70	400	15	0	0	4	3.75	0.0	26.7
Inga sp. *waiki* (swit-bonki)	S. America	1	20	100	10	0	0	0	10.00	0.0	0.0
Inga spp. (swit-bonki)	S. America	60	1018	12,611	219	108	0	0	1.74	0.0	0.0
Myrtaceae											
Eugenia cf *patrisii* Vahl (boskers)	S. America	7	143	581	58	38	5	5	9.98	14.3	8.6
Eugenia uniflora L. (Surinam cherry, pitanga)	Brazil	21	250	1,753	66	22	8	19	3.76	19.1	28.8
Psidium guajava L. (guava)	Trop. America	849	4,831	339,681	12,071	7,062	509	134	3.55	8.4	1.1
Syzygium jambos (L.) Alston (pommeroos)	Indo-Malaysian region	12	57	852	46	0	43	0	5.40	16.7	0.0
Syzygium malaccensis (L.) Merr. & Perry (malay apple)	Malaysia	161	1276	69,873	565	169	203	42	0.81	10.0	7.4
Syzygium samarangense (Blume) Merr. & Perry (curacao apple)	Malaysia	1,457	22,045	496,807	13,108	3,674	5,532	535	2.64	20.5	4.1
Oxalidaceae											
Averrhoa carambola L (carambola)	Indonesia	4,639	35,670	2,301,135	76,575	1,242	57,200	133	3.33	32.1	0.2
Palmae											
Bactris gasipaes H.B.K. (paripoe)	S. America	9	622	8,272	62	0	0	0	0.75	0.0	0.0
(Palmfruit)	S. America	4	43	1,347	1	1	0	0	0.07	0.0	0.0
Papilionaceae											
Swartzia amshoffiana Cowan	S. America	2	40	68	3	0	0	0	4.41	0.0	0.0
Rhamnaceae											
Zizyphus jujuba Mill. (olijf, jujube)	China	136	2510	27,546	220	7	123	0	0.80	11.0	0.0
Rutaceae											
Citrus grandis (L.) Osbeck (pummelo)	Malaysia	8	10	5,508	8	0	0	0	0.15	0.0	0.0
Citrus paradisi (grapefruit)	West-Indies	37	122.50	43,998	48	6	4	0	0.11	8.1	0.0
Citrus reticulata Blanco (mandarin)	China	35	140	12,267	21	1	15	0	0.17	8.6	0.0
Citrus sinensis (L.) Osbeck (sweet orange)	S. China	134	640	87,906	45	3	8	0	0.05	0.8	0.0
Sapindaceae											
Blighia sapida Koenig (akee)	W. Africa	4	29	2,129	1	0	0	0	0.05	0.0	0.0
Sapotaceae											
Chrysophyllum cainito L. (star apple)	Central America	156	524.5	69,357	3,755	2,695	40	12	5.41	3.2	0.3
Lucuma nervosa A. DC. (eggfruit)	S. America	9	31	2,771	21	15	0	0	0.76	0.0	0.0
Manilkara achras (Mill.) Fosberg (sapodilla)	Central America	140	591.5	42,948	1,618	1,151	74	7	3.77	6.4	0.4
Pouteria macrophylla	S. America	6	150	3,744	7	4	0	0	0.19	0.0	0.0
Total		9,966	110,918	4,273,268	118,207	19,867	65,277	1,917			

Table 2. Plant species from which no fruit flies were reared.

Plant family, scientific name and common name	Origin	Number of		Sample weight (g)
		samples	fruits	
Anacardiaceae				
Pistachia vera L. (pistache)	W. Asia	1	12	92
Tapirira guianensis Aubl. (tapiriri)	S. America	1	250	59
Tapiriri sp.	S. America	2	1300	1,072
Annonaceae				
Anaxagorea dolichocarpa Sprague et Sandw. (boesi-soensaka)	S. America	1	21	32
Annona montana L. (mountain soursop)	C. America	19	35	23,717
Annona muricata L. (soursop)	West-Indies	41	57	28,724
Annona reticulata L. (Bullock's heart, kasjoema)	West-Indies	5	16	1,329
Annona sericea Dun (boesi-soensaka)	S. America	5	28	449
Annona spp.	S. America	6	33	1,091
Annona squamosa L. (sugar apple, kaneelappell)	West-Indies	10	33	4,439
Duguetia calycina R. Ben. (boesi-soensaka)	S. America	1	13	178
Fusaea longifolia (Aubl.) Saff. (panta)	S. America	2	2	802
Guatteria scandens Ducke (kofibali)	S. America	1	125	88
*Rollinia exsucca (*Dun) A. DC. (boesi-soensaka)	S. America	1	8	22
Apocynaceae				
Stemmadenia grandiflora (*Tabernaemontana grandiflora* Jacq.)	S. America	1	5	65
Tabernaemontana heterophylla Vahl (merki-tite)	S. America	1	2	8
Tabernaemontana sp.	S. America	2	10	112
Thevetia peruviana (Pers.) K. Schum. (lucky nut, yellow oleander)	S. America	6	22	390
Araceae				
Montrichardia arborescens (L.) Schott (moko-moko)	S. America	6	8	2,475
Unknown		4	81	84
Bignoniaceae				
Pachyptera alliacea (Lam.) A. Gentry (knoflook liaan)	S. America	2	10	626
Pithecoctenium crucigerum (L.) A. Gentry (keskeskankan)	S. America	1	6	550
Bixaceae				
Bixa orellana L. (koesoewe)	S. America	1	8	78
Bombacaceae				
Bombax flaviflorum Pulle (sabana katoen)	S. America	1	40	2,320
Bombax globosum Aubl. (boesikatoen)	S. America	1	10	135
Bombax surinamense Uitt. (kapok)	S. America	2	12	700
Cordia sericicalyx A. DC. (tafrabong)	S. America	4	157	463
Cordia tetrandra Aubl. (tafrabong)	S. America	1	56	46
Bromeliaceae				
Bromelia		1	70	41
Burseraceae				
Canarium commune L. (java almond, canari nut)	Malaysia	1	69	959
Protium heptaphyllum (Aubl.) March. (sabana-tingimoni)	S. America	2	184	76
Tetragastis sp.	S. America	2	375	420

Cont.

Table 2. Continuation

Plant family, scientific name and common name	Origin	Number of		Sample weight (g)
		samples	fruits	
Cactaceae				
Opuntia sp.		4	92	2,846
Caesalpiniaceae				
Bauhinia sp.	Tropics	1	3	7
Caesalpinia bonduc (L.) Roxb. (wacht-een-beetje)	S. America	1	22	230
Cassia latifolia G.F.W. Mey (legwana tite)	S. America	2	80	1,170
Cassia quinquangulata L.C. Rich. (jorka pesi)	S. America	2	32	433
Cassia spp.	S. America	4	83	431
Inocarpus edulis Forst. (gajam)	Polynesia	5	28	2,078
Macrolobium angustifolium (Benth.) Cowan (watra-biri-oedoe)	S. America	1	7	126
Tamarindus indica L. (tamarind)	T. Africa	3	25	402
Campanulaceae				
Centropogon cornutus (L.) Druce (dia klaroen)	S. America	1	12	7
Capparaceae				
Crateva tapia L.	S. America	1	68	1,560
Caryocaraceae				
Caryocar nuciferum L. (ingi noto)	S. America	1	1	634
Chrysobalanaceae				
Chrysobalanus icaco L. (plum)	S. America	13	154	707
Couepia cognata (Steud.) Fritsch (hardbast sabana kwepie)	S. America	2	45	761
Parinari sp. (foengoe)	S. America	2	23	136
Convolvulaceae				
Ipomoea sp. (patatate)		2	40	100
Cucurbitaceae				
Cucumis anguria L. (West-Indian gherkin, angrokie)	Trop. America	1	1	25
Melothria fluminensis Gardn. (snekikomkomro)	S. America	1	18	12
Momordica charantia L. (bittergourd)	Asia-Africa	5	212	765
Dilleniaceae				
Davilla kunthii St. Hil (*D. aspera*) (liana)	S. America	1	500	12
Davilla sp. (liana)	S. America	1	180	9
Dillenia indica L. (olifantsappel)	India	4	33	13,620
Doliocarpus dentatus (Aubl.) Standl. (diatite)	S. America	1	200	36
Ebenaceae				
Diospyros discolor Willd. (fluweelapple)	Philipines	2	2	56
Euphorbiaceae				
Aleurites moluccana Willd. (candle nut, kemiri)	Malaysia			
Jatropha	Tropics	1	15	237
Margaritaria nobilis (L.f.) Muell.Arg.	S. America	2	85	46
Phyllanthus acidus (L.) Skeels (gooseberry)	India, Madagascar	8	347	594
Ricinus communis L. (castor)	Africa	5	580	3,007

Cont.

Table 2. Continuation

Plant family, scientific name and common name	Origin	Number of samples	Number of fruits	Sample weight (g)
Gnetaceae				
Gnetum nodiflorum Brongn. (liana)	S. America	1	16	87
Guttiferae				
Clusia grandiflora Splitg. (abrasa)	S. America	4	16	4,046
Clusia minor L.	S. America	1	?	56
Clusia nemorosa G.F.W.May (sabana-mangro)	S. America	4	93	850
Clusia spp.	S. America	7	87	2,456
Garcinia mangostana L. (mangistan, mangosteen)	Malaysia	4	27	1,532
Mammea americana L. (mamey)	Greater Antilles	8	23	2,988
Rheedia sp. (pakoeli)	S. America	6	32	3,899
Vismia cayennensis (Jacq.) Pers. (oema pinja)	S. America	4	290	252
Vismia japurensis Reichardt (pinja)	S. America	1		185
Vismia macrophylla H.B.K. (pinja)	S. America	3	221	394
Vismia sp.	S. America	7	868	1,081
Humeriaceae				
*Humiria balsamifera (*Aubl.) St. Hil. (meri)	S. America	3	664	353
Humiria sp. (meri)	S. America	3	536	271
Sacoglottis cydonioides Cuatr. (witbast-boefroe oedoe)	S. America	1	39	?
Lauraceae				
Persea americana Mill. (avocado)	Mexico	16	32	8,047
Lecythidaceae				
Gustavia augusta L. (tapoeripa)	S. America	1	3	50
Lecythis davisii Sandw. (kwatapatoe)	S. America	4	24	704
Leguminosae				
Psophocarpus tetragonolobus (L.) DC. (ketjipir, winged bean)	Asia	1	3	20
Loranthaceae				
Phthirusa squamulosa Eichl.		1	75	14
Malpighiaceae				
Byrsonima coriacea (Sw.) Kunth (lontoekasi)	S. America	1	170	58
Byrsonima crassifolia (L.) H.B.K. (sabana-kwari)	S. America	1	91	8
Byrsonima spp. (lontoekasi)	S. America	4	876	525
Malvaceae				
Hibiscus tiliaceus L. (maho)	Tropics	3	48	662
Melastomataceae				
Henrietta succosa (Aubl.) DC. (mispel)	S. America	1	150	100
Miconia ciliata (L.C. Rich.) Urb.	S. America	2	320	17
Miconia spp.	S. America	10	2571	523
Meliaceae				
Carapa procera DC (krapa)	S. America	2	2	875
Guarea guidonia (L.) Sleumer (roodbast doifi siri)	S. America	5	425	781

Cont.

Table 2. Continuation

Plant family, scientific name and common name	Origin	Number of		Sample weight (g)
		samples	fruits	
Mimosaceae				
Inga edulis Mart. (swit bonki)	Trop. America	1	3	50
Inga ingoides (LCRich) Willd. (swit bonki)	S. America	1	26	225
Leuceana leucocephala/glauca (shade tree, lamtoro)	Indonesia	2	251	690
Monimiaceae				
Mollinedia sp.	S. America	1	26	38
Siparuna guianensis Aubl. (oema-jarakopi)	S. America	1	110	87
Siparuna sp.	S. America	1	30	52
Moraceae				
Artocarpus communis Forst. (*A. altilis* (Park) Fosberg) (breadfruit)	Polynesia	6	7	5,800
Artocarpus heterophyllus Lam. (katehar, jackfruit, nangka)	India	10	11	36,066
Cecropia sciadophylla Mart. (boesipapaya)	S. America	2	56	295
Ficus maroniensis R. Ben.	S. America	1	?	28
Ficus maxima Mill. (merki-oedoe)	S. America	3	237	2,276
Ficus sp.	S. America	1	36	28
Helicostylis tomentosa (Poepp. et. Endl.) Rusby (umpatapu)	S. America	1	?	425
Musaceae				
Musa sapientum L. (bacove)	Asia	23	356	49,777
Phenakospermum guianense Miq. (giant paloeloe)	S. America	4	17	4,164
Sugar banana	Asia	1	1	45
Apple banana	Asia	1	22	1,060
Myristicaceae				
Myristica fragrans Houtt. (nutmeg)	Moluccas	1	1	35
Virola sebifera Aubl. (egron baboen)	S. America	1	40	75
Myrtaceae				
Eucalyptus sp.	Australia	2	318	119
Eugenia cf *florida* DC (forest cherry)	S. America	1	44	24
Psidium littorale Raddi (strawberry guava)	Brazil			
Syzygium cumini (L.) Skeels (jambolan, djamoen)	Brazil	23	669	3,184
Oxalidaceae				
Averrhoa bilimbi (bilimbi) L.	Malaysia	18	135.5	848
Palmae				
Astrocaryum paramaca Mart. (paramaka)	S. America	1	?	883
Astrocaryum sciophilum Pulle	S. America	1	?	575
Astrocaryum vulgare Mart. (*A. segregatum*) (awarra)	S. America	10	94	2,197
Attalea maripa (Corr. Serr.) Mart. (maripa)	S. America	11	258	6,991
Bactris sp.	S. America	2	110	60
Euterpe oleracea Martius (pinapalm)	S. America	1	2	3
Guilielma gasipaes Bailey (amana)	S. America			
Mauritia flexuosa L. f. (Mauriti palm)	S. America	2	9	526
Oenocarpus bacaba Mart. (koemboe)	S. America			

Cont.

Table 2. Continuation

Plant family, scientific name and common name	Origin	Number of		Sample weight (g)
		samples	fruits	
Oenocarpus oligocarpa (Griseb.) W. Boer.	S. America	1	71	950
Chinese awarra		1	18	395
Bactris sp. (keskesmaka)	S. America	3	1117	1,544
Ornamental palm		1	16	352
Papilionaceae				
Andira inermis (Wright) H.B.K. (drasbos rode kabbes)	S. America	5	79	2,666
Bocoa prouacensis Aubl. (ijzerhart)	S. America	1	25	37
Crotalaria anagyroides H.B.K. (green manure)	Trop. America	1	57	56
Dalbergia glauca (Desv.) Amsh.	S. America	1	400	292
Dalbergia monetaria L.f.	S. America	1	100	201
Dioclea macrocarpa Hub. (liana)	S. America	2	8	2,180
Dipterex sp. (tonka)	S. America	4	59	1,049
Machaerium lunatum (L.f.) Ducke (brantimaka)	S. America	1	45	229
Mucuna sloanei Fawcett &Rendle (kawai)	S. America	2	40	1,370
Myroxylon balsamum (L.) Harms (perubalsemboom)	S. America	1	83	281
Sesbana sp.		1	10	53
Swartzia sp.	S. America	3	173	22
Passifloraceae				
Passiflora edulis Sims (passion fruit, markoesa))	Brazil	4	21	1,643
Passiflora foetida L. (sneki-markoesa)	S. America	17	634	949
Passiflora laurifolia L. (water lemon, para markoesa)	S. America	1	33	427
Passiflora prob. *grandulosa* Cav.	S. America	1	1	23
Passiflora quadrangularis L. (giant granadilla, bigi markoesa)	S. America	2	7	1,464
Passiflora sp.	S. America	1	10	97
Passiflora vespertillo L.	S. America	1	6	61
Polygonaceae				
Coccoloba uvifera (L.) Jacq. (sea grape)	Trinidad	20	450	2,132
Proteaceae				
Panopsis sessilifolia (L.C. Rich.) Sandw. (manari-oedoe)	S. America	1	10	670
Punicaceae				
Punica granatum L. (pome granate)	Iran	10	17	1,525
Rubiaceae				
Coccocypselum guianense (Aubl.) K. Schum.	S. America	2	89	11
Coffea liberica Bull ex Hiern (coffee)	Ethiopia	5	212	765
Faramea occidentalis (L.) A. Rich. (penpen)	S. America	1	75	24
Genipa americana L. (tapoeripa)	S. America	5	37	1,616
Geophila herbacea	S. America	1	108	16
Morinda citrifolia L. (didibri-apra)	S.E. Asia	7	20	2,530
Psychotria sp.	S. America	2	580	181
Randia formosa (Jacq.) K. Schum. *(Rosenbergiodendron formosum)*	S. America	5	161	324
Sabicea glabrescens Benth.	S. America	1	27	6

Cont.

Table 2. Continuation

Plant family, scientific name and common name	Origin	Number of		Sample weight (g)
		samples	fruits	
Rutaceae				
Citrus aurantifolia Sw. (lime)	East Indies	2	75	3,053
Citrus aurantium L. (sour orange)	S.E. Asia	1	5	1,045
Citrus medica L. (citron)	S.W. Asia	14	61	33,756
Citrus paradisi X *reticulata* (tangelo)	hybrid	8	13	3,417
Citrus reticulata Blanco (mandarin, variety gele king)	China, India	3	8	1,544
Citrus reticulata X *sinensis* (tangor, variety rode king)	China, India	2	7	1,529
Citrus spp.	Ásia	4	13	5,063
Triphasia trifolia (Burm.f.) P. Wilson (lime berry)	Asia	5	333	370
Sapindaceae				
Cupania scrobiculata L.C. Rich.	S. America	1	?	177
Melicocca bijuga L. (knippa)	S. America	2	16	118
Nephelium lappaceum L. (rambutan)	S.E. Asia	1	5	84
Paullinia pinnata L. (fefifinga)	S. America	6	184	184
Talisia micrantha Radlk. (boesiknepa)	S. America	1	5	14
Simaroubaceae				
Quassia amara L. (kwasibita)	S. America	3	126	44
Solanaceae				
Cestrum latifolium Lam.	S. America	1	270	56
Lycopersicon esculentum Mill. (tomato)	Trop. America	1	7	347
Several species		7	156	384
Solanum asperum L.C. Rich.	S. America	1	35	50
Solanum stramonifolium Jacq.? (bolomaka)	S. America	1	7	11
Solanum surinamense Steud. (parabita)	S. America	1	48	220
Theaceae				
Ternstroemia punctata (Aubl.) Sw.	S. America	4	234	352
Tiliaceae				
Apeiba echinata Gaertn.	S. America	1	9	135
Verbenaceae				
Citharexylum sp.	S. America	2	356	270
Vochysiaceae				
Vochysia tomentosa (G.F.W. Mey.) DC. (wanakwari)	S. America	1	27	159
Zingiberaceae				
Renealmia exaltata Linn. fil. (masoesa)	S. America	1	6	34
Unknown family				
Unknown species		5	51	768
Funastrum clausum		1	3	28
Ptychosperma macarthurii H. Wendl		1	62	72
Total		654	23477.5	328,844

dominated.

Three samples of hog plum (*Spondias mombin* L.) were found infested with CFF, in one case combined with *Anastrepha*, being two samples from Apura (Sipaliwini),

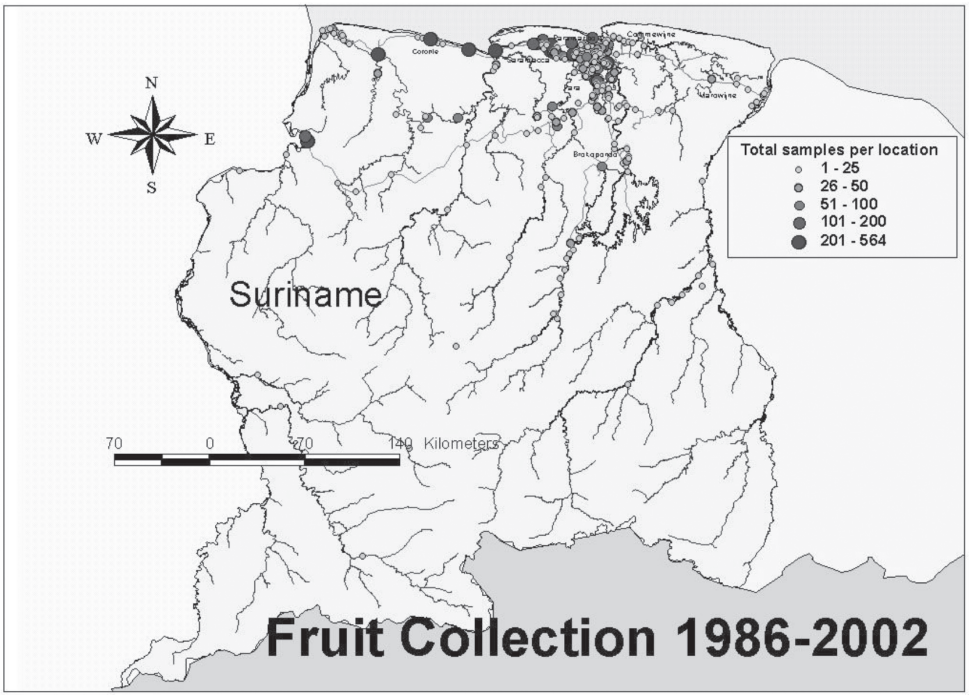

Figure 1. Distribution and importance of collection sites.

in 1995. At that time, the CFF population in the village was high. The third sample was collected in 1997 in Commewijne, also in an area with a high CFF population. The total number of CFF from these three samples was 10. Due to the fact that hog plum is a common, widespread tree in Suriname, adaptation of CFF to this native host could have implications on the progress of the eradication project. Therefore more emphasis was placed on sampling hog plum fruits, as potential occasional native host for CFF.

Citrus species were not observed as an important host. The collections made for grapefruit (*Citrus paradisi* Macf., which were infested with CFF and *Anastrepha*, all came from a single tree.

Hosts found in SE Asia, but not in Suriname are: *Annona montana* Macf. (2) and *A. muricata* L.; *Thevetia peruviana* (Pers.) K. Schum (1), *Persea americana* Mill. (2), *Artocarpus altilis* (*communis*) (Park.) Fosberg (1) and *A. heterophyllus* Lam. (6), *Averrhoa bilimbi* L. (5), *Punica granatum* L. (1), *Capsicum annuum* L. (1) and *Lycopersicon esculentum* Mill. (1). It must be noted that the number of infested samples (in brackets) of these fruit species is low in most cases, and the number of samples collected in Suriname of these species is low. The following hosts were found only in Suriname and not in South East Asia: *Anacardium occidentale* L., *Spondias cytherea* Sonn., *Spondias mombin* L., *Garcinia dulcis* (Roxb.) Kurz, *Malpighia punicifolia* L., *Eugenia* cf. *patrisii* Vahl and *Citrus sinensis* (L.) Osbeck. Of these hosts, only the West Indian cherry is of importance as host, the other fruits were only found occasionally infested. Parasitoids were found in larvae reared from several fruit species (Table 1). The highest percentages of parasitism were observed in smaller sized fruits, most of these only infested with *Anastrepha*. There is no indication that parasites specifically attack CFF.

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