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Host Fruit of Mango Fly (*Bactrocera frauenfeldi* (Schiner)) (Diptera: Tephritidae) in the Federated States of Micronesia.

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Abstract—Host records of mango fly (*Bactrocera frauenfeldi* (Schiner)) in the Federated States of Micronesia are reported. During two years of surveying (1994-1996), 1123 samples of commercial or edible fruit and wild fruit, covering 127 species in 95 plant genera in 52 families, were collected and incubated for the emergence of fruit flies (family Tephritidae) in a fruit-holding laboratory in Pohnpei. Twenty-six species of commercial/edible fruits and 9 species of wild fruit, belonging to 24 genera in 15 families, were noted as hosts of mango fly. The importance of each host is discussed with regards to infestation levels, expressed as percentage of infested fruit. Also reported are the mean and maximum number of fruit fly puparia recovered from individual fruit and the number of puparia recovered per kilogram of ripe fruit.

Introduction

Mango fly (*Bactrocera frauenfeldi* (Schiner)) (Diptera: Tephritidae) is a major pest of fruit in the Independent State of Papua New Guinea (PNG), the Solomon Islands, the Republic of Palau, the Federated States of Micronesia (FSM), the Republic of the Marshall Islands, the Republic of Nauru, the Gilbert Islands in the Republic of Kiribati, and in parts of north Queensland in Australia. It is very common throughout the island countries where it occurs. It is present even on remote atolls in Micronesia, including Nukuoro and Kapingamarangi (Leblanc 1996).

It was accidentally introduced into the northernmost area of Queensland in 1974 (Drew 1976), but did not reach the Cairns area until 1994 (Prof. R.A.I. Drew, Griffith University, Brisbane, pers. comm.). Early records suggested that it is present in the Commonwealth of the Northern Mariana Islands (Hardy and Adachi, 1956), but has never been collected during intensive trapping with cue-lure carried out since the 1950s (Aubrey Moore, Community College of Northern Mariana Islands, pers. comm.). Its record in Malaysia (Tan et al., 1982) was based on a misidentification of *Bactrocera albistrigata* (de Meijere) (R.A.I. Drew, Griffith University, Brisbane, pers. comm.).

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Surveys of hosts of mango fly have been limited until recently. Hardy & Adachi (1956) listed guava, mango, breadfruit, and *Syzygium* apples. Host lists were reviewed by Drew (1989) and White & Elson-Harris (1992) and included breadfruit, guava, mango, mountain apples *(Syzygium malaccense)*, sauh *(Manilkara kauki)*, tropical almonds *(Terminalia catappa)* and *Syzygium branderhostii.* Additional host records from surveys in Papua New Guinea were published by Dori et al. (1993) and Tenakanai (1997). Intensive and systematic host surveying was initiated in 1994 in Federated States of Micronesia (FSM) and Solomon Islands and in 1998 in Nauru, under the auspices of the FAO/AusAID/UNDP/SPC Regional Fruit Fly Project in the Pacific, the Project on Regional Management of Fruit Flies in the Pacific, the ACIAR Project No.9403 on Identification and control of pest fruit flies in Vanuatu, Solomon Islands and Federated States of Micronesia, and under the North Australian Quarantine Strategy in the Torres Strait Islands and northern Queensland. Results from the FSM have already been partly published (Leblanc & Allwood 1997).

This paper provides complete host records of mango fly from two years of surveying in FSM and discusses the importance of major host species.

Methods

Samples of commercial/edible and wild fruit were collected in the four FSM States of Chuuk, Kosrae, Pohnpei and Yap from December 1994 to December 1996. Fruit sampling methods employed were described by Leblanc et al. (2001). One method involved extensive surveys where large numbers of fruit were collected and placed on sieved, sterilized sawdust in plastic containers with a vented lid covered by a fine mesh cloth. This sampling method provides information on host range and indicates the relative importance of each species through a comparison of the number of larvae or puparia obtained per kilogram of fruit. A second method involved carrying out damage assessments where 10-25 fruits were collected with each fruit separately incubated in individual containers. This method provides data on the percent infested fruit and the mean density of fruit fly larvae per individual fruit.

Fruit at different stages of maturity (green, mature green, ripe, fallen) were collected into paper bags, and returned to the laboratory, where fruit from each sample were weighed, counted and incubated in containers. Small fruits not likely to release excess juice were placed on petri dishes over a layer of finely sieved sawdust (kept for two hours in an oven at 120ºC or frozen overnight to kill mites) in a plastic container covered with fine gauze fabric for ventilation. Larger fruit, likely to release excess juice while decomposing, were placed on fine gauze fabric on chicken wire mesh over a plastic container to catch the juice. The container was placed inside a large plastic or cardboard box with the bottom covered with sieved sawdust. The samples were checked after 10 days of incubation by dissecting fruits to ensure larvae had exited the fruits and pupated in the sawdust. Fruit fly puparia were extracted from the sawdust with a sieve.

Table 1: Published host record of mango fly (*Bactrocera frauenfeldi* (Schiner)) in northeastern Australia, Papua New Guinea (PNG), Solomon Islands and Federated States of Micronesia (FSM).

Host species	Host family	Common name	Australia	FSM	PNG	Solomon Isl
Aleurites moluccana (L.) Willd.	EUPHORBIACEAE	Candlenut	X			
Anacardium occidentale L.	ANACARDIACEAE	Cashew	X		X	
Annona glabra L.	ANNONACEAE	Pond apple	X	X		
Annona muricata L.	ANNONACEAE	Soursop		X	X	X
Annona reticulata L.	ANNONACEAE	Bullock's heart			X	
Annona squamosa L.	ANNONACEAE	Sweetsop		X		
Areca catechu L.	ARECACEAE	Betel nut (ripe)			X	
Artocarpus altilis (Parkins.) Fosb.	MORACEAE	Breadfruit		X	X	X
Artocarpus heterophyllus Lam.	MORACEAE	Jackfruit				X
Artocarpus mariannensis Trecul.	MORACEAE	Marianas breadfruit		X		
Averrhoa carambola L.	OXALIDACEAE	Carambola	X	X	X	X
Baccaurea papuana F.M.Bailey	EUPHORBIACEAE				X	
Barringtonia careya F. Muell.	LECYTHIDIACEAE		X			
Barringtonia edulis Seem.	LECYTHIDIACEAE				X	X
Barringtonia racemosa (L.) K. Spreng.	LECYTHIDIACEAE		X			
Broussonetia papyrifera (L.) Venten.	MORACEAE	Paper mulberry				X
Burckella obovata (Forst.) Pierre	SAPOTACEAE				X	
Calophyllum inophyllum L.	CLUSIACEAE	Indian laurel	X	X		X
Calophyllum kajewskii A.C.Sm.	CLUSIACEAE					X
Cananga odorata (Lam.) Hook. f.&t. Thoms.	ANNONACEAE	Ylang Ylang		X		
Carica papaya L.	CARICACEAE	Papaya	X	X	X	X
Casimiroa edulis Llave	RUTACEAE	White sapote	X			
Cerbera manghas L.	APOCYNACEAE			X		X
Chrysophyllum cainito L.	SAPOTACEAE	Star apple	X	X	X	
Citrofortunella x mitis (Blanco) J. Ingram & H.E. Moore	RUTACEAE	Calamansi		X		
Citrus aurantium L.	RUTACEAE	Sour orange		X		X
Citrus limetta Risso	RUTACEAE	Sweet lemon	X			
Citrus limon (L.) Burm.f.	RUTACEAE	Lemon	X			
Citrus maxima (Burm.) Merill	RUTACEAE	Pomelo			X	X
Citrus reticulata Blanco.	RUTACEAE	Tangerine/mandarin	X	X	X	

Host species	Host family	Common name	Australia	FSM	PNG	Solomon Isl
Citrus sinensis (L.) Osbeck.	RUTACEAE	Orange	X	X		X
Citrus x paradisi Macfady.	RUTACEAE	Grapefruit	X			X
Clymenia polyandra (Tanaka) Swingle	RUTACEAE				X	
Diospyros blancoi A. DC	EBENACEAE	Mabolo	X			
Diospyros digyna Jacq.	EBENACEAE	Black sapote			X	X
Diospyros hebecarpa A.Cunn.	EBENACEAE					X
Diospyros kaki L.f.	EBENACEAE	Persimmon	X			
Eugenia reinwardtiana (Bl.) DC.	MYRTACEAE	Beach cherry	X			
Eugenia uniflora L.	MYRTACEAE	Surinam cherry		X		
Fagraea cambagei Domin	LONGANIACEAE	Porcelain fruit	X			
Ficus carica L.	MORACEAE	Edible fig	X			
Ficus leptoclada Benth.	MORACEAE	Atherton fig	X			
Ficus sp.	MORACEAE					X
Fortunella japonica (Thunb.) Swingle	RUTACEAE	Kumquat	X			X
Garcinia mangostana L.	CLUSIACEAE	Mangosteen			X	
Garcinia xanthochymus Hook. f. ex T. And.	CLUSIACEAE	Yellow mangosteen		X	X	
Guettarda speciosa L.	RUBIACEAE		X	X		X
Inocarpus fagifer (Park.) Fosb.	CAESALPINACEAE	Tahiti chestnut		X	X	X
Malpighia glabra L.	MALPIGHIACEAE	Acerola	X	X		
Mammea odorata (Raf.) Kosterm.	GUTTIFERAE			X		
Mangifera indica L.	ANACARDIACEAE	Mango	X	X	X	X
Mangifera minor Bl.	ANACARDIACEAE	Wild mango				X
Manilkara kauki (L.) Dubard	SAPOTACEAE	Sauh	X			
Manilkara zapota (L.) Van Royen.	SAPOTACEAE	Sapodilla	X	X	X	X
Melastoma malabathricum var. Mariannum (Naudin) Fosb. & Sachet	MELASTOMACEAE			X		
Musa x paradisiaca L.	MUSACEAE	Banana (ripe)	X		X	
Nauclea orientalis (L.) L.	NAUCLEACEAE	Leichhardt tree	X			
Neonauclea forsteri Seem. Ex Harv.) Merr.	NAUCLEACEAE					X
Niemeyera prunifera F. Muell.	SAPOTACEAE	Plum boxwood	X			
Ochrosia oppositifolia (Lam.) K. Schum.	APOCYNACEAE			X		

Host species	Host family	Common name	Australia	FSM	PNG	Solomon Isl
Passiflora edulis Sims.	PASSIFLORACEAE	Passionfruit	X		X	
Persea americana Miller.	LAURACEAE	Avocado		X	X	X
Pometia pinnata J.R. & G Forster	SAPINDACEAE	Pacific lychee			X	
Pouteria cainito (Ruiz & Pav.) Radlk	SAPOTACEAE	Abiu	X		X	
Pouteria campechiana (HBK) Baehni	SAPOTACEAE	Canistel			X	
Pouteria sapota (Jacq.) H.E. Moore & Stearn	SAPOTACEAE	Mammey sapote	X			
Psidium guajava L.	MYRTACEAE	Guava	X	X	X	X
Psidium littorale Raddi.	MYRTACEAE	Strawberry guava	X		X	
Sandoricum koetjape (Burm. f.) Nakai	MELIACEAE	santol	X		X	
Scaevola taccada (Gaertn.) Roxb.	GOODENIACEAE					X
Spondias cytherea Sonn.	ANACARDIACEAE	Golden apple		X		X
Syzygium aqueum (Burm. f.) Alston.	MYRTACEAE	Water apple	X	X	X	
Syzygium branderhorstii Lauterb.	MYRTACEAE		X			
Syzygium forte var. *forte* (F.Muell.) B. Hyland	MYRTACEAE		X			
Syzygium jambos (L.) Alston.	MYRTACEAE	Rose-apple	X	X		
Syzygium malaccense (L.) Merr. & Perry	MYRTACEAE	Mountain apple		X	X	X
Syzygium samarengense (Blume) Merrill & L.M. Perry	MYRTACEAE	Java apple	X	X		
Syzygium suborbiculare (Benth.) T.G. Hartley & L.M. Perry	MYRTACEAE		X			
Syzygium tierneyanum (F. Muell.) T.G. Hartley & L.M. Perry	MYRTACEAE		X			
Terminalia arenicola Byrnes	COMBRETACEAE		X			
Terminalia carolinensis Kaneh	COMBRETACEAE			X		
Terminalia catappa L.	COMBRETACEAE	Tropical almond	X	X	X	X
Terminalia kaernbachii Warb.	COMBRETACEAE	Okari nut			X	
Terminalia muelleri Benth.	COMBRETACEAE		X			
Terminalia samoensis Rech.	COMBRETACEAE			X		
Terminalia sericocarpa F. Muell.	COMBRETACEAE		X			
Terminalia whitmorei Coode	COMBRETACEAE					X
Trichosanthes cucumerina L.	CUCURBITACEAE	Snake gourd				X
Ximenia americana L.	OLACACEAE	Putit	X			

Puparia from each sample were counted and kept in moist sawdust in a petri dish. The petri dish was placed on a moist paper tissue inside a small plastic container with the top covered with fine gauze fabric. Emerging flies were fed for five days with sugar and water so that colours and markings fully developed. Adult flies were killed by freezing for about 20-30 minutes. Freezing ensured that flies retained their colours long enough for identification.

Results

Between 28 December, 1994 and 31 December, 1996, 1123 samples were collected, totalling more than 47909 fruit (2051 Kg), on Pohnpei (861 samples), Kosrae (108 samples), Chuuk Lagoon Islands (35 samples), Yap (92 samples), Mwoakilloa atoll (20 samples) and Pakin atoll (7 samples). In total, fruit from 127 plant species, in 95 genera and 52 families, were sampled. Of these, 35 species belonging to 24 genera in 15 families were identified as fruit fly hosts. Of the 35 host species, 26 may be considered commercial or edible fruit and 9 were wild or forest fruit. A total of 119226 fruit fly puparia were obtained from 42.7% of the samples. Mango fly was the only fruit fly species to emerge. No hymenopteran parasitoids were recovered. Table 1 contains host records from the FSM, plus all other published host records from northern Australia (Hancock et al. 2000), Papua New Guinea (Dori et al. 1993; Tenakanai 1997; Leblanc et al. 2001) and Solomon Islands (Vagalo et al. 1997; Leblanc 2000). In these countries and in the FSM, mango fly has been bred from 98 host species, in 56 plant genera across 34 families. One of these host species is a yet unpublished record from Nauru.

For damage assessments, 7632 fruit from 25 host species were incubated separately in individual containers. Infestation levels for each host are presented in Table 2. The total number of fruit collected and their stage of maturity are indicated. Data are based on ripe fruit, unless otherwise indicated. The percentage of infested fruit and the mean and maximum number of puparia per infested fruit are based on individually incubated ripe fruit, while the larval load, or number of puparia per kilogram of ripe fruit, is based on all of the ripe fruits incubated individually and in bulk.

The most heavily infested hosts, that are also very common and widespread in FSM, belong to the families Myrtaceae, Moraceae, Combretaceae and Caesalpiniaceae. Guava is by far one of the most preferred hosts, and bears large number of larvae. *Syzygium* apples and Surinam cherry *(Eugenia uniflora)* are important mango fly hosts, although individual fruit are infested by only a few larvae. However, large numbers of fruit are produced on each tree, so the high numbers of puparia per kg fruit and the large number of fruit carried by the tree may impact significantly on the overall mango fly population. Species of *Terminalia* are very important hosts for mango fly. Larvae consume only the outer soft layer of the fruit. *T. samoensis* is an important host on atolls. One highly infested sample from Pakin Atoll had 88.2% of the fruit infested and produced 296.4 puparia per kg of fruit. Polynesian chestnut *(Inocarpus fagifer)* is a major host for mango

Table 2: Levels of infestation on host plants of *Bactrocera frauenfeldi* in Federated States of Micronesia. N.D.= Damage assessments not attempted on individual fruits. (1) = Mature and ripe fruits mixed in samples. (2) = Damage assessment on *T. samoensis* and *G. speciosa* each based on one heavily infested sample. (3) = Damage assessments based on very few fruits.

HOST PLANT SPECIES	No fruits sampled	% fruits infested	Max No puparia/ fruit	Mean No puparia per infested fruit	Mean No puparia per kg ripe fruits
Annona glabra	167	26.0	79	12.8	12.3
Annona muricata	34	28.1	17	4.9	1.2
Annona squamosa	18	N.D.	N.D.	N.D.	1.2
Artocarpus altilis	350	37.3	266	28.1	8.2
Artocarpus mariannensis	20	N.D. (3)	240	156.0	57.9
Averrhoa carambola	489	17.8	12	3.1	4.8
Cananga odorata	923	N.D.	N.D.	N.D.	N.D. (1)
Calophyllum inophyllum	1347	22.8	78	17.9	115.4
Carica papaya	27	N.D.	N.D.	N.D.	8.1
Cerbera manghas	36	N.D.	N.D.	N.D.	0.7
Chrysophyllum cainito	137	N.D.	N.D.	N.D.	0.2
x *Citrofortunella mitis*	759	N.D.	N.D.	N.D.	3.5
Citrus aurantium	450	N.D.	N.D.	N.D.	0.7
Citrus reticulata (Satsuma)	639	20.3	31	4.3	8.5
Citrus sinensis (Valencia)	410	4.0	30	5.0	0.7
Eugenia uniflora	1596	60.7	7	1.6	160.0
Garcinia xanthochymus	136	N.D.	N.D.	N.D.	4.5
Guettarda speciosa	326	41.7 (2)	12 (2)	4.2 (2)	31.4
Inocarpus fagifer	2610	56.0	291	49.3	200.6
Malpighia glabra	1236	3.7	2	1.0	19.0
Mammea odorata	51	N.D. (3)	173	56.0	346.4
Mangifera indica	456	8.1	18	8.1	2.9
Manilkara zapota	27	N.D.	N.D.	N.D.	52.6
Melastoma malabathricum var. *mariannum*	Not counted	N.D.	N.D.	N.D.	N.D. (1)
Ochrosia oppositifolia	147	49.1	68	14.5	113.1
Persea americana	25	N.D. (3)	50	32.5	20.6
Psidium guajava (large, pink)	1301	91.2	179	31.7	254.5
Psidium guajava (large, white)	732	85.7	69	25.1	276.1
Psidium guajava (small, pink)	664	31.1	9	5.2	32.0
Psidium guajava (small, white)	29	37.9	24	7.7	66.7
Spondias cytherea	104	1.0	1	1.0	0.1
Syzygium aqueum	3140	51.4	7	2.5	80.2
Syzygium jambos	34	57.9	4	3.4	27.5
Syzygium malaccense	302	43.8	15	4.8	78.9
Syzygium samarangense	672	38.2	14	2.6	52.8
Terminalia carolinensis	211	45.1	33	7.1	114.1
Terminalia catappa	5173	68.7	66	15.5	200.5
Terminalia samoensis	756	88.2 (2)	6 (2)	2.35 (2)	296.4

fly in FSM. The larval load is very high as indicated by the number of puparia produced, taking into account that only the pericarp is consumed by the larvae. Seedless breadfruit, of which there are over one hundred variety names on Pohnpei Island, has been well sampled. The percentage of infested fruits is identical for both rough and smooth skinned varieties (37.3%). Marianas breadfruit *(Artocarpus mariannensis)*, a species with fruit with seeds and very common on atolls, was heavily infested. Four fruit sampled on Mwoakilloa atoll were all infested, with a mean of 156 puparia per fruit and one fruit with 240 puparia.

In spite of the common name of *B. frauenfeldi*, mango is not a major host to mango fly in FSM. All of the varieties sampled were small and very fibrous. Introduced commercial varieties are likely to be much more susceptible, based on observations in Papua New Guinea and elsewhere in the Pacific, but were not available during the sampling period.

Many citrus fruit are hosts to mango fly, but Kosrean limes *(C. aurantifolia)* and Yapese lemons *(C. hystrix)* are not attacked. This was further confirmed by carrying out non-host status testing, in which ripe fruits were exposed to gravid female mango flies bred in laboratory colonies (Heimoana et al. 1997). Satsuma tangerine *(C. reticulata)*, very common on Kosrae, is the most seriously attacked citrus species. Though 20.3% of the ripe fruit are infested, only 2.8% of the mature green fruit, before colour-break, are infested. Valencia oranges *(C. sinensis)*, also commonly grown in plantations on Kosrae, are not a preferred host to mango fly. 4.0% of ripe fruit are infested and rarely more than two larvae occur per infested fruit. Several citrus species with sour fruits are not frequently attacked. These include calamondin or Panama orange (x *Citrofortunella* x *mitis*), sour orange *(Citrus aurantium)*, and sour mandarin *(C. reticulata)*.

Less abundant yet heavily infested commercial/edible host species include pond apple *(Annona glabra)*, sapodilla *(Manilkara zapota)* and avocado *(Persea americana)*. Other commercial/edible fruits that are less preferred hosts include soursop *(Annona muricata)*, sweetsop *(A. squamosa)*, golden apple *(Spondias cytherea)*, Barbados cherry or acerola *(Malpighia glabra)*, carambola or starfruit *(Averrhoa carambola)*, egg tree *(Garcinia xanthochymus)*, and star apple *(Chrysophyllum cainito)*. Papaya is a host when ripe, though it was not intensively sampled at stages of maturity past colour-break.

Other species of wild fruit are hosts to mango fly. *Ochrosia oppositifolia* is a highly preferred host for mango fly. Indian laurel *(Calophyllum inophyllum)* has a low percentage of infestation overall, but individual fruits are heavily infested, with a maximum of 78 recovered from one fruit. *Guettarda speciosa* is particularly common on atolls. Although the number of puparia per kg fruit is not particularly high, the plant produces large numbers of fruits and is common. Therefore, it may play an important role in generating large fruit fly numbers over a wide area and could be important if an eradication program had to be implemented against an exotic pest fruit fly species, as already experienced during the eradication program on Nauru. *Mammea odorata* is a heavily infested wild host when ripe. A few puparia were obtained from ylang ylang *(Cananga odorata)*,

Cerbera manghas, and *Melastoma malabathricum* var. *mariannum*. Fruit of the latter species are quickly consumed by birds as soon as they ripen, making it difficult for fruit fly larvae to complete their development.

Discussion

In north-eastern Australia, 62% of the fifty host fruit recorded for mango fly are regarded as commercial or edible fruit, as opposed to wild or forest fruit. This is similar to that in FSM, where 69% of host fruit species are classed as commercial or edible fruit and 31% as wild or forest fruit, whose flesh is generally not eaten by humans. This gives the impression that commercial or edible fruit play a greater role in maintaining mango fly populations than wild or forest fruit do. This is probably correct in urban and peri-urban or village areas where high concentrations of edible fruit trees are grown and fallen and over-ripe ripe fruit are rarely collected and destroyed. However, wild fruit, such as those of *Guettarda speciosa*, *Terminalia catappa, T. carolinensis, Ochrosia oppositifolia,* and *Calophyllum inophyllum,* occur in villages and in urban areas as well as in forest and disturbed areas and around the coastline. They contribute significantly to the overall population of mango fly in FSM.

Cataloging of the fruit fly fauna in countries or in different ecological zones within a country is not complete without information on their host records and the losses that are attributed to fruit flies. Knowing that 37.3 % of breadfruit are seriously damaged by mango flies or that between 31.1% and 91.2% of different varieties of guavas are destroyed by fruit flies gives adequate economic and social justification for undertaking fruit fly control programs to protect national food security. Similarly, for fruits that sustain very low levels of damage due to fruit flies, control programs may not be economically viable unless the product is to be exported, e.g., tangerine production in Kosrae.

Host surveying, as one method of quarantine surveillance for exotic fruit flies, is very important for those species that are not normally attracted to available synthetic male or female fruit fly lures. Fruit flies, such as the solanum fly *(B. latifrons* (Hendel)), cucumber fly *(B. cucumis* (French)), or Jarvis's fruit fly *(B. jarvisi* (Tryon)), all exotic to FSM, are not attracted to male lures. Species of fruit flies like these would be recorded, if they were inadvertently introduced into FSM, only by sampling fruit regularly or by using liquid protein or ammonia food baits. If an exotic fruit fly was recorded in FSM, then it would be possible to refer to the known host records in other areas of the fly's geographic distribution to obtain information on the fruit that would need to be surveyed or that would be infested.

The results of host surveys provide basic information on fruit flies, which is very useful in developing management or control programs for fruit flies. For example, knowing the commercial/edible and wild fruit that are major hosts for fruit flies might guide plant protection officers in targeting those fruits that need to be collected and destroyed, as part of cultural control of fruit flies. Embarking upon sound crop hygiene, including the destruction of unwanted, fallen, or dam-

aged fruits, removes a persistent source of egg-laying sites for fruit flies and a major component of the population of fruit flies in the egg and larval forms. If this is done on an area-wide basis on small islands, it is conceivable that such practices might reduce the overall population of fruit flies and play its part in an integrated pest management program for fruit flies.

Data on the hosts of fruit flies show very clearly those fruit for which quarantine treatments need to be developed, if the fruit are destined for export to overseas countries or between islands. Host surveys point to fruit or vegetables that are not infested by fruit flies or are tolerant to infestation at particular stages of maturity. In this case, fruit may be tested under laboratory conditions or in field cages to determine if flies will infest them under artificial conditions. If fruit are not infested under these stringent conditions, then importing countries may be prepared to consider the tolerance to attack by fruit flies as a quarantine treatment, such as green bananas, Kosrean limes and Yapese lemons.

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