Fruit Fly Infestation and Parasitization in Fiji

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INTRODUCTION

In order to measure the infestation of fruits, and the parasitization of fruit flies in Fiji, collections and rearings were made during 1961, 1962, and 1963. Most of the samples were taken during the summer months of January through April, the period of greatest fruit abundance. A few collections were made on the islands of Vanua Levu and Taveuni but the majority were gathered in south-eastern Viti Levu.[2]

Table 1. Host Plants of Trypetid Fruit Flies* in Fiji

	Infested by *D. passiflorae*	Infested by *D. xanthodes*
Ananas comosus (L.) Merrill, pineapple		×
Artocarpus altilis (Park.) Fosberg, breadfruit	×	×
Artocarpus integra (Thunb.) Merrill, jak fruit	×	×
Barringtonia edulis Seem., vutu	×	×
Calophyllum inophyllum L., dilo	×	
Capsicum frutescens L., pepper	×	
Carica papaya L., papaya	×	×
Chrysophyllum cainito L., star apple	×	
Citrus spp., oranges, lemons, limes, grapefruit	×	×
Coffea spp., coffee	×	
Inocarpus fagiferus (Park.) Fosberg, ivi	×	×
Lycopersicum esculentum Mill., tomato		×
Mangifera indica L., mango	×	
Passiflora quadrangularis L., granadilla	×	×
Persea americana Mill., avocado	×	
Pometia pinnata J.R. & G. Forster, dawa	×	
Psidium guajava L., guava	×	
Psidium littorale Raddi, cherry guava	×	
Syzygium malaccense (L.) Merrill and Perry, kavika	×	
Terminalia sp., tavola	×	
Theobroma cacao L., cocoa	×	

* Hosts of *D. distinctus* Malloch are as yet unknown.

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Host fruits of the trypetids, *Dacus passiflorae* Froggatt and *D. xanthodes* (Broun), are listed in Table 1. These records are taken from a file maintained by the Department of Agriculture in Fiji.

Indigenous and introduced enemies of fruit flies have been discussed by Silvestri (1914), Simmonds (1936), Lever (1938 a,b,c), and O'Connor (1960). Parasites known to attack trypetids in Fiji are listed in Table 2. Fruit fly enemies introduced but apparently not established include the larval parasites *O. humilis* Silvestri (see Simmonds, 1936), *O. incisi* Silvestri, *O. vandenboschi* Fullaway (O'Connor, 1960), and a chalcidid pupal parasite, *Dirhinus giffardii* Silvestri (Simmonds, 1937).

Table 2. Parasites of Trypetid Fruit Flies in Fiji

	Stage Attacked	Origin	Reference
Braconids			
Opius oophilus Fullaway	Egg-larval	Introduced	O'Connor (1960)
O. longicaudatus Ashmead	Larva	Introduced	O'Connor (1960)
O. hageni Fullaway	Larva	Indigenous	
O. fijiensis Fullaway	Larva	Indigenous	
Eulophids			
Melittobia indicum Silvestri	Mature larva	Introduced	Lever (1938b)
Tetrastichus giffardianus Silvestri	Mature larva	Introduced	Simmonds (1936)
Pteromalids			
Pachycrepoideus vindemniae Rondani	Pupa	?Indigenous	
Spalangia ? cameroni Perkins	Pupa	?Introduced	Simmonds (1929)

Apparently both *D. passiflorae* and *D. xanthodes* are susceptible to parasitization by the four species of *Opius* listed in Table 2 as well as by the two pteromalid pupal parasites. *Melittobia* has also been reared from both hosts and, although *Tetrastichus* has been recorded only from *D. passiflorae,* it readily attacked mature larvae of *D. xanthodes* under laboratory conditions (Simmonds, 1936). Eggs of *D. passiflorae* are sometimes eaten by the lygaeid bug, *Germalus pacificus* Kirkaldy, and ants may destroy maggots in certain environments (Simmonds, 1936).

REARINGS FROM FRUIT COLLECTIONS

Host fruits were collected during the fruiting seasons of 1961, 1962, and 1963. Ripe native fruits (ivi, vutu, and dawa) were picked up from the ground at various points in southeastern Viti Levu. The cherry guava was collected at two points on Viti Levu, near Deuba and near Sawani, but the common guava was sampled at numerous locations on Viti Levu and Vanua Levu. Some half-ripe guavas of both species were picked from the trees but most of the fruits taken were fully ripe on the tree or on the ground. Ripe citrus fruits were obtained from several sources on Viti Levu, Vanua Levu, and Tavenui.

Oviposition punctures in some of the half-ripe common guavas and cherry guavas were examined. All eggs or chorions of hatched eggs were removed, mounted in lactophenol, heated, and examined under a microscope. Of 512 eggs, 465 had hatched and 47 (9 percent) had been infected by fungi or other microorganisms. Of the 47 dead eggs, at least 17 (36 percent) contained visible mouthhooks of *O. oophilus* larvae. Altogether 142 cherry guavas and 75 common guavas were examined. The average number of hatched eggs per fruit was 0.6 for the cherry guavas and 5.0 for the much larger common guavas; however, infestation as measured by the number of flies (and parasites) reared per fruit was lower, 0.5 for the cherry guavas and 4.2 for the common guavas (cf. Bess et al, 1963). Rearings per fruit were 20.9 for ivi and 12.8 for vutu. Very few flies were reared from the citrus and the infestation density was less than 0.1 per fruit. The density of infestation was not calculated for dawa fruits but it was probably higher than common guava and lower than vutu. The rearings on which these measurements of infestation are based were obtained by keeping representative samples of fruits over moist sand, then sifting out the puparia and holding them for emergence in cotton-stoppered glass tubes.

In addition to the infestation indices, the rearings provided data on the host preferences of *D. passiflorae* and *D. xanthodes,* and on the levels of parasitization in different host fruits. These results are summarized in Table 3. For the eulophid parasites, the number of host individuals parasitized are given since at least five wasps emerged from each puparium. A few *D. passiflorae* and no parasites were reared from Viti Levu grapefruit. Sweet oranges on Taveuni, sour oranges on Viti Levu, and mandarins on Vanua Levu and Viti Levu were apparently free from infestation. However, O'Connor (1960) reported rearings from oranges and grapefruits discarded at the Suva market because of their infestation: 1,503 *D. passiflorae,* 411 *O. oophilus,* and 6 *O. longicaudatus,* a total of 1,920 and a parasitization rate of 21.7 percent.

During March 1963, *O. oophilus* was observed on guava fruits in a grove near Labasa, Vanua Levu. Since no release of *O. oophilus* had been made on Vanua Levu during the 1951 and 1954 introductions, it must have reached the island either by adult emigration across a 50-mile water gap or, more likely, by accidental transport within infested fruit. Parasitization, as determined by a small rearing, was about 33 percent.

DISCUSSION

Parasitization levels were lower in rearings from native fruits than in those from introduced fruits (Table 3). The averages ranged from 4.5 percent for dawa to 9.4 percent for ivi as compared with a range of 21.7 percent for citrus (O'Connor, 1960) and 24.2 percent for common guava to 61.3 percent for cherry guava. This difference in ranges is largely due to the more effective attacks of *O. oophilus* on eggs of *D. passiflorae* in guavas and citrus. *O. oophilus* parasitization averaged 21 percent in citrus, 22 percent in common guava, and 55 percent in cherry guava. O. *longicaudatus* was the predominant parasite in rearings from ivi and vutu but parasitized no more than 8 percent of the maggots

in any host. *O. hageni,* reared from ivi, was the only native parasite recovered. *O. fijiensis* appears to have been completely displaced in the areas studied. Since Simmonds (1936) reported combined parasitization by *O. fijiensis* and *O. hageni* of 5 percent in common guava and 14 percent in cherry guava, the introduced parasites can be considered about four times more effective, but it is not known if the indigenous parasites were displaced by the same mechanisms, such as physiological inhibition of egg development and combative interactions of larvae, observed in Hawaiian studies on *D. dorsalis* (van den Bosch and Haramoto, 1953). There is no evidence that the eulophids (or the pteromalids) were more effective prior to the introduction of *O. oophilus* and *O. longicaudatus.*

Table 3. Rearings of Fruit Flies and their Parasites

	HOST FRUITS				
	Ivi	*Vutu*	*Dawa*	*Common Guava*	*Cherry Guava*
Fruit Flies	2,519	1,911	105	360	65
D. passiflorae	95.2%	33.0%	100%	100%	100%
D. xanthodes	4.8%	67.0%	—	—	—
Parasites	262	131	5	115	103
O. hageni	12	—	—	—	—
O. longicaudatus	223	125	1	10	11
O. oophilus	13	6	—	105	92
Melittobia	14	—	2	—	—
Tetrastichus	—	—	2	—	—
Total Rearings	2,781	2,042	110	475	168
Total Fruits	133	160	(20)	113	336
Percent Parasitization	9.4%	6.4%	4.5%	24.2%	61.3%
Approximate fiducial limits at the 99% level	8–11%	5–8%	1–13%	20–29%	51–71%

O. oophilus has not done as well in Fiji as it did in the Hawaiian Islands. In common guavas on Oahu, its parasitization of *D. dorsalis* averages about 76 percent (Haramoto, 1957). On Maui and Hawaii, the averages are lower, 61 percent and 44 percent respectively (Nakagawa *et al,* 1961) but not as low as the 22 percent observed on Viti Levu, Fiji. The egg mortality attributable to infections through oviposition punctures made by *O. oophilus* is also much higher in Hawaii than in Fiji. Newell and Rathburn (1951) estimated that on Oahu only 12 percent of *D. dorsalis* eggs hatched, but in Fiji, 91 percent of the *D. passiflorae* eggs had hatched. Even when parasitization was over 60 percent in one sample of cherry guavas, 81 percent had hatched. Although it seems improbable, the pathogens which enter eggs in Hawaii may be absent in Fiji. The reluctance of *O. oophilus* to search for eggs in fallen fruits (Haramoto, 1957), must reduce its efficacy since *D. passiflorae* oviposits in "ground fruits." Only on the cherry guava, the fruits of which remain on the tree long after ripening, do the oviposition habits of *D. passiflorae* and *O. oophilus* coincide.

The infestation levels of *D. xanthodes* in vutu and of *D. passiflorae* in guavas and various native fruits remain high enough to justify further efforts toward the biological control of fruit flies in Fiji. Such a project could not be supported by Fiji alone but would entail the co-operation of U.N., Commonwealth, or American agencies. Research on egg-larval parasites and their interactions with pathogens in Hawaii, Malaya, India and Africa might be productive. More studies on egg or larval predators in those areas could also be justified.

REFERENCES

BESS, H. A., F. H. HARAMOTO, and A. D. HINCKLEY. 1963. Population studies of the oriental fruit fly, Dacus dorsalis Hendel (Diptera: Tephritidae). ECOLOGY 44(1): 197–201.

HARAMOTO, F. H. 1957. Observations on the biology of Opius oophilus Fullaway (Braconidae-Hymenoptera). PROC. EIGHTH PACIFIC SCI. CONG. III(A): 1275–1289.

LEVER, R. J. A. W. 1938a. Fruit fly parasites: interim notes. AGRIC. JOUR., FIJI 9(2): 15.

———— 1938b. Fruit flies and their control: biological and chemical. AGRIC. JOUR., FIJI 9(3): 19–20.

———— 1938c. Local fruit-flies and their parasites. AGRIC. JOUR., FIJI 9(4): 14–15.

NAKAGAWA, S., T. YAMADA, L. MILLER and L. F. STEINER. 1961. Fruit fly infestations and percentage parasitization in 25 representative hosts on Hawaii and Maui before and after establishment of Opius oophilus. Unpub. mimeo. supplement, Fruit Fly Symposium, TENTH PACIFIC SCI. CONG., 5 pp.

NEWELL, I. M. and F. RATHBURN. 1951. Evaluation of effectiveness of natural enemies of fruit flies. UNIV. HAWAII AGRIC. EXPT. STA., ENT. DEPT., QUARTERLY REPT. April–June, 1951 (quoted in Haramoto, 1957).

O'CONNOR, B. A. 1960. A decade of biological control work in Fiji. AGRIC. JOUR., FIJI 30(2): 44–54.

SILVESTRI, F. 1914. Natural enemies of fruit flies. HAWAIIAN BD. AGRIC. AND FORESTRY, ENT. BULL. 3: 176 pp., 24 pls.

SIMMONDS, H. W. 1929. Introduction of Spalangia cameroni, parasite of the housefly, in Fiji. AGRIC. JOUR., FIJI 2(1): 35.

———— 1936. Fruit fly investigations, 1935. FIJI DEPT. AGRIC. BULL. 19: 18 pp.

———— 1937. Fruit Fly (parasites). AGRIC. JOUR., FIJI 8(3): 23.

VAN DEN BOSCH, R. and F. HARAMOTO. 1953. Competition among parasites of the Oriental Fruit Fly. PROC. HAWAIIAN ENT. SOC. 15(1): 201–206.