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## Refuse Containers as a Source of Flies in Honolulu and Nearby Communities

DONALD P. WILTON  
DIVISION OF SANITATION  
HAWAII STATE DEPARTMENT OF HEALTH  
HONOLULU, HAWAII

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The garbage can has long been recognized as an important site of domestic fly production. Quarterman et al. (1949) found garbage cans second only to the city dump as a source of flies in Savannah, Georgia. They reported fly breeding in or under 60 per cent of the containers examined. Fifty per cent of the infested media detected by Schoof et al. (1954) in fly breeding surveys conducted in Charleston, West Virginia were garbage. A similar situation was found by Siverly and Schoof (1955) in Phoenix, Arizona. Kilpatrick and Bogue (1956) demonstrated fly emergence from ground surfaces under and near garbage cans at Mission and Pharr, Texas. As an illustration of the significance of garbage as a breeding medium for domestic flies, it was stated by Siverly and Schoof (1955) that as many as 70,000 flies have been produced by one cubic foot of this material.

Campbell and Black (1960) reporting on an investigation of prepupal migration of fly larvae from refuse containers in Concord, California recommended twice-a-week refuse collection during hot weather. They suggested that this would remove refuse before any significant migration (and hence, any significant fly production) could occur. Often, however, routine refuse collection fails to remove all the material in the can. As pointed out by Quarterman et al. (1949), a sludge-like deposit which is not dislodged when the container is upended frequently builds up in the bottoms of neglected cans. Preliminary observations in Honolulu showed that more often than not, this "garbage sludge" was infested with fly larvae.

The need for an evaluation of garbage cans as a source of domestic flies in Honolulu has been recognized by the State Health Department for some time. According to U.S. census figures, in 1950 the city of Honolulu contained 59,594 housing units. In 1960 the Hawaii State Planning Office reported that the number had increased to 80,326; a gain of 20,732 units. Much of this expansion has taken place at the expense of farming operations. Housing developments have taken over land, some of it within the city proper, which formerly was occupied by dairies, hog farms and poultry ranches. As a consequence, these farms have been forced to relocate in places remote from the city. Thus a substantial increase in the number of garbage cans has been accompanied by a

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TABLE I. Number of addresses where pre-adult flies were found in one or more refuse containers. Inspections made between September 1958 and October 1960.

District	No. of Addresses	No. Positive	Per Cent Positive
Aliamanu/Foster Village.....	153	15	9.8
Kalihi.....	451	9	2.0
Makiki.....	174	30	17.2
Manoa.....	38	5	13.2
Waikiki.....	214	58	27.1
Diamond Head.....	58	8	13.8
Kahala.....	153	20	13.1
Waialae-Kahala.....	148	4	2.7
Aina Haina.....	150	36	24.0
Kuliouou/Portlock Road.....	117	14	12.0
Kailua.....	307	50	16.3
Lanikai.....	83	16	19.3
TOTALS.....	2,046	265	13.0

constant decrease in the number of major fly sources located within or close to residential areas.

A survey was begun in the summer of 1958 to determine whether domestic garbage cans remain an important source of flies in areas which receive twice-a-week refuse collection service. Although fly production reaches a peak in Hawaii during September and October, fly breeding occurs throughout the year, enabling the survey to be continued intermittently through the summer of 1960.

#### SURVEY PROCEDURE

In residential parts of Honolulu and other communities on the island of Oahu mixed refuse is collected twice each week by personnel of the City and County of Honolulu. Residents place refuse containers at or near the curb for collection. During the survey reported here the refuse cans at 2,046 addresses in Honolulu and the suburban communities of Kailua and Lanikai were closely inspected shortly following regular refuse collection while the containers were still at the curb. The presence of any pre-adult stage in these "empty" cans was taken as clear evidence of active fly production. No address was counted as positive unless at least one pre-adult stage was actually demonstrated, regardless of how insanitary the refuse cans were.

#### SURVEY RESULTS

As shown in Table I, fly production, as defined above, was demonstrated in one or more garbage cans at 265 or 13 per cent of the 2,046 addresses visited.

When the data of Table I are re-arranged according to the kind of dwelling units represented they take on considerably added significance. Table II shows the extent of garbage can fly breeding indicated by the survey at single-family

dwellings as compared with apartments. For present purposes an apartment house is defined as "any house, building or portion thereof containing two or more dwelling units."<sup>1</sup> While only 10 per cent of the single-family dwellings were found positive for garbage can fly breeding nearly 38 per cent of the apartment buildings were positive.

#### SPECIES OF FLIES BREEDING IN GARBAGE CANS

Samples of fly larvae or of infested residue material were taken from 68 emptied cans between September, 1959 and August, 1960. The samples were collected in one pint disposable containers to which plastic emergence cages were attached (Wilton, 1960). Larvae frequently were collected from relatively clean cans containing little residual material. In such cases canned dog food was placed in the rearing container to provide sufficient food for development. All samples were held for one month. Twenty-three species of flies representing 12 families were reared out. They are listed below in the order of decreasing frequency of occurrence.

#### DISCUSSION AND CONCLUSIONS

The incidence of garbage can fly breeding encountered varied from 2 per cent of the addresses checked in Kalihi to 27 per cent in Waikiki. There was no indication that the socio-economic level of a neighborhood related directly to the significance of its refuse containers as a fly source. Early in the survey it became apparent, however, that there was considerably more garbage can fly

<sup>1</sup> Chapter 2, Article II, PUBLIC HEALTH REGULATIONS, STATE OF HAWAII.

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TABLE II. Incidence of garbage can fly breeding by type of dwelling.

District	Single Units			Apartment Buildings		
	No. of Addresses	Positive		No. of Addresses	Positive	
		No.	%		No.	%
Aliamanu/Foster Village.....	153	15	9.8	...	...	...
Kalihi.....	451	9	2.0	...	...	...
Makiki.....	121	10	8.3	53	20	37.7
Manoa.....	38	5	13.2	...	...	...
Waikiki.....	84	10	11.9	130	48	36.9
Diamond Head.....	58	8	13.8	...	...	...
Kahala.....	153	20	13.1	...	...	...
Waialae-Kahala.....	148	4	2.7	...	...	...
Aina Haina.....	150	36	24.0	...	...	...
Kuliouou/Portlock Road.....	117	14	12.0	...	...	...
Kailua.....	271	35	12.9	36	15	41.7
Lanikai.....	83	16	19.3	...	...	...
TOTALS.....	1,827	182	10.0	219	83	37.9

TABLE III. Flies reared from sixty-eight garbage can samples collected in Honolulu, Kailua and Lanikai, Hawaii.

Species	Family	Frequency (Cans)
<i>Phaenicia cuprina</i> (Wiedemann)	Calliphoridae	60
<i>Puliciphora wymani</i> G. Bohart	Phoridae	34
<i>Megaselia scalaris</i> Loew	Phoridae	33
<i>Musca domestica</i> Linnaeus	Muscidae	24
<i>Desmometopa</i> sp.	Milichiidae	16
<i>Drosophila</i> spp.	Drosophilidae	14
<i>Chrysomya megacephala</i> (Fabricius)	Calliphoridae	14
<i>Atherigona orientalis</i> (Schiner)	Muscidae	13
<i>Diploneura cornuta</i> Bigot	Phoridae	12
<i>Fannia pusio</i> Wied.	Muscidae	9
<i>Hermetia illucens</i> (Linn.)	Stratiomyidae	5
<i>Boettcheria peregrina</i> (Robineau-Desvoidy)	Sarcophagidae	5
<i>Parasarcophaga misera</i> (Walker)	Sarcophagidae	4
<i>Drosophila melanogaster</i> Meigen	Drosophilidae	3
<i>Scatopse fuscipes</i> Meig.	Scatopsidae	2
<i>Milichia orientalis</i> Malloch	Milichiidae	2
<i>Milichiella lacteipennis</i> Loew	Milichiidae	2
<i>Chrysomya rufifacies</i> Macquart	Calliphoridae	2
<i>Psychoda alternata</i> Say	Psychodidae	1
Unidentified	Itonididae	1
<i>Limosina</i> sp.	Sphaeroceridae	1
<i>Caldrema pallida</i> (Loew)	Chloropidae	1
<i>Opheya</i> sp.	Muscidae	1

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production in areas containing apartment houses (Makiki, Waikiki, Kailua) than in districts made up entirely of one-family dwelling units.

When the data pertaining to the two types of dwellings are considered separately it becomes apparent that apartment houses have considerable importance as sites of fly production. The incidence of garbage can fly breeding at apartment houses was found to be almost four times that recorded for one-family units. The significance of apartment houses is enhanced by the fact that large buildings may have ten or more refuse cans. The presence of fly larvae in more than one can at these places was not unusual. Such multiple infestations at single-family dwellings were encountered, but with far less frequency.

*Phaenicia cuprina* (Wiedemann) was the fly most frequently seen in and around garbage cans and was reared from 60 of the 68 samples collected. It is one of the commonest flies in residential areas in Hawaii and is strongly attracted by both fermenting or sour-smelling substances and food odors. The attraction of cooking odors for this species accounts for its frequent and annoying presence in kitchens and dining rooms. Garbage appears to be its primary breeding medium.

The house fly, *Musca domestica* Linn., was less conspicuous than *P. cuprina* around garbage cans and refuse storage areas and was reared from only 24 of the samples. Moreover, it was reared in much smaller numbers. A total of 4,454 *P. cuprina* adults were obtained as compared with 426 house flies.

The phorid flies, *Puliciphora wymani* G. Bohart and *Megaselia scalaris* Loew, were obtained abundantly from garbage can material. In total numbers reared the phorids probably exceeded all the other species combined. Because of their small size and restricted range, however, they rarely become troublesome and are seldom even noticed.

Since fly production in refuse containers was demonstrated at only 13 per cent of the dwellings surveyed, there can be little doubt that twice-a-week refuse collection is effective in restricting fly production from this source. Room for improvement remains, however. Particularly is this true in areas zoned for apartment houses where fly production at rates up to 42 per cent of the buildings inspected was recorded. The reasons for a markedly higher incidence of fly breeding at apartment houses are not completely known. It is highly probable, however, that the explanation will involve the question of individual responsibility. The occupants of a single-family dwelling are more likely to be conscientious in the matter of refuse disposal since the responsibility for a dirty, foul-smelling, fly-producing garbage can is clear-cut. In apartment houses, on the other hand, many people frequently use refuse containers in common and there may be little regard for the sanitation of those containers. Too frequently apartment house managers or owners fail to provide enough refuse cans and are negligent about keeping them clean.

The survey has indicated an opportunity for further reduction of residential area fly populations through greater emphasis on the need for clean properly maintained garbage cans especially in apartment house zones.

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