# A Survey of Fly Occurrence and Breeding in Leeward Kohala, Hawaii

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**Abstract.** A survey of fly occurrence and incidence of fly breeding in leeward Kohala, Hawaii, was conducted between August and November, 2007. The survey areas included four state parks and 13 ranches near the coastline. This study found that the occurrence of two major species of flies, *Tricharaea occidua* (a flesh fly) and *Musca sorbens* (dog dung fly) within the complaint areas corresponded with the breeding of flies at the ranches nearby; and *T. occidua* was the principal inhabitant in cattle, horse, and mule dung at the ranches.

**Key words:** *Tricharaea occidua*, *Musca sorbens,* Hawaii

## Introduction

Fly problems were common in Hawaii in the 1970s and 1980s, and the dog dung fly, *Musca sorbens* Wiedemann, was the subject of most fly complaints owing to its persistent habit of landing on people and animals (Wilton 1963, Ikeda 1974, Toyama and Ikeda 1976, Lee and Toyama 1989). In leeward Kohala (island of Hawaii), dog dung fly outbreaks occurred in the 1980s and studies were conducted to address the problem (Lee and Toyama 1990, 1991). From mid-August through December, 2007, more than a decade after the initial outbreaks, a fly infestation occurred again in this area and resulted in an increase of complaints to the Hawaii State Department of Health Vector Control Branch from tourists and residents. Visitors to the parks complained that the flies not only swarmed all over them and their picnics but also bit people. From these complaints, it was evident that there were more than one fly species involved in the infestation.

The objective of this study was to obtain basic information including (1) adult fly species in the complaint areas and nearby ranches, (2) fly species breeding in the animal feces at the ranches, and (3) most importantly, which species among these flies were most prevalent and causing the complaints.

## Materials and Methods

The survey was conducted in the northern leeward portion of the Kohala district (Mahukona Beach Park and northwards to just south of Hawi), on the island of Hawaii. Within the area, there are four state parks and 13 ranches with 3,381 animals during the survey period (3353 cows and cattle, 27 horses, and 1 mule). Animals at 12 ranches were fed only pasture grass, and the cows of a dairy were fed an enriched grain supplement.

**Adult fly survey.** From August to November, 2007, 68 field collections within the survey areas, about five times for each ranch or park, were made by three Vector Control Branch personnel. Flies were caught using insect-collecting nets, put into bottles, and stored in a freezer for later identification and quantification. The flies were identified using the keys provided by Pratt et al. (1975) and Department of Health, Vector Control Branch (unpub-

lished). Voucher specimens were deposited in the State of Hawaii Department of Health, Vector Control Branch collection facility, located in Halawa Valley, Oahu, Hawaii. The positive collection rate of each fly species, which also indicated the abundance of a species, was calculated by dividing the number of the positive field collection times during which a particular species was caught by the total number of field collection times.

**Fly breeding survey.** A total of 27 samples from individual fresh dung pats were collected from 13 ranches on October 11, and October 12, 2007. At the dairy, in addition to samples of fresh dung pats, two samples were collected from older consolidated and piled cow dung. For each sample about 630 $cm^3$ of dung was held in the lower part of mosquito breeders (10 cm high, 11 cm in diameter) (BioQuip Products Co., Gardena, CA). The samples were held at the facility of the Vector Control Branch in Honokaa. At the facility, the dung was covered with dry vermiculite in each breeder for mature larva pupation. The samples were held at ambient temperature and received both artificial and natural light. Upon emergence, adult flies were attracted to the top part of the breeder. After these flies died, they were collected, identified, and counted as previously described. A sample infestation rate for species was obtained from the number of infested samples divided by the total number of samples.

**Data analysis.** Comparisons of mean values among the three abundant species of adult flies in survey areas were examined using one-way ANOVA (Analytical Software. 1996). Effects found to be significant were examined further using Tukey HSD test. The data were transformed by the square-root method before analysis. Comparisons of mean values in *Tricharaea occidua* and *Musca sorbens* breeding in cattle's dung were made using Student's *t*-tests (Analytical Software 1996).

## Results

Table 1 summarizes the total number and positive field collection rate of each fly species collected. A total of 18 species of flies were caught from the survey area. Of these, 6 species were small flies, including *Sepsis* sp. (Sepsidae) and *Drosophila* sp. (Drosophilidae) (Table 1). Because these small flies generally were not pestiferous (Toyama and Ikeda 1976), only the larger Diptera with a potential to become nuisances as described in the complaints are discussed here. Overall, *Tricharaea occidua* (Fab.), with 2,685 adults captured, was most abundant, followed by house fly, *Musca domestica* L. (494), and dog dung fly, *M. sorbens* (461) (Table 1). Also, *T. occidua* had the highest positive field collection rate, with 85.3%, followed by *M. sorbens* with 53.7% and *M. domestica* with16.4%. Significant differences were found among these three averages ($F_{2,195} = 21.01$; $p < 0.001$) (ANOVA) (Table 1). Of the less abundant species, 28 horn flies, *Haematobia irritans* L., were collected at a positive field collection rate of 15%.

Table 1 also shows that the number of *M. domestica* caught at the parks, the major complaint centers, was very low (23) compared to *M. sorbens* (347) and *T. occidua* (2,340).

Table 2 summarizes the species of flies recovered from animal dung, average number per sample (±SE), and infestation rate for each fly species. Of 10 species of flies recovered from 29 samples, *T. occidua* was the principal inhabitant of the dung of cattle, horses, and mules. The average of *T. occidua* adults recovered from the cattle dung samples was 28.4 (±8.7) and the sample infestation rate was 73%. Second in abundance was *M. sorbens* with an average of 26.7 (±24.9). However, the sample infestation rate was very low; the flies were only recovered from three samples. Also, no *M. sorbens* was recovered from the horse and mule dung samples. A significant difference was found between these two averages (*t*-test; $p < 0.05$) (Table 2). *Musca domestica* was recovered only from the samples collected from pile cow dung at the dairy, where heavy breeding of this species was observed. The horn fly, *H. irritans*, had an infestation rate of 36% but was found in low average number 4 (±2.1).

**Table 1. Fly species collected at ranches and parks by insect collecting nets in north leeward Kohala, Hawaii.***

| Species | Total | Mean (±SE)** | At ranches | At parks | Positive field collection rate (%) |
|---|---|---|---|---|---|
| ***Tricharaea occidua* (Fab.)** | **2685** | **39.5 (10.5) a** | **345** | **2340** | **85.1** |
| *Sepsis* sp. | 636 | | 227 | 409 | 43.3 |
| ***Musca domestica* L.** | **494** | **7.3 (4.9) b** | **471** | **23** | **16.4** |
| ***Musca sorbens* Wiedemann** | **461** | **6.8 (1.5) b** | **114** | **347** | **53.7** |
| *Drosophila* sp. | 252 | | 0 | 252 | 13.4 |
| ***Anthomyia bisetosa* Thomson** | **80** | **1.2 (1.0)** | **70** | **10** | **3.0** |
| ***Chrysomya rufifacies* (Macquart)** | **56** | **0.8 (0.5)** | **2** | **54** | **16.2** |
| *Piophila* sp. | 50 | | 50 | 0 | 1.5 |
| Sphaeroceridae | 39 | | 39 | 0 | 1.5 |
| ***Chrysomya megacephala* (Fab.)** | **36** | **0.5 (0.3)** | **0** | **36** | **12.0** |
| ***Haematobia irritans* L.** | **28** | **0.4 (0.1)** | **12** | **16** | **15.0** |
| *Milichiella lacteipennis* | 26 | | 0 | 26 | 3.0 |
| ***Orthellia caesarion* (Meigen)** | **18** | **0.3 (0.3)** | **18** | **0** | **1.5** |
| ***Ravinia iherminieri* (Robineau-Desvoidy)** | **11** | **0.2 (0.1)** | **4** | **7** | **8.9** |
| ***Brontaea quadristigma* Thomson** | **11** | **0.2 (0.1)** | **9** | **2** | **8.9** |
| ***Liosarcophaga dux* Thomson** | **6** | **0.1 (0.1)** | **0** | **6** | **1.5** |
| Phoridae | 2 | | 0 | 2 | 1.5 |
| ***Calliphora vomitoria* L.** | **1** | **0.01 (0.01)** | **0** | **1** | **1.5** |

* Larger species are in bold font.

** Per collecting trip; mean numbers captured of three fly species were analyzed (ANOVA); means within same columns not followed by the same letter are significantly different (Tukey HSD test; $P < 0.01$)

**Table 2. Flies reared from individual animal dung pats (cattle, horse, and mule) and cow dung piles sampled at ranches in north leeward Kohala, Hawaii.***

| Species | Cattle (22)** | | Horse (4) | | Mule (1) | Cow dung piles (2) |
|---|---|---|---|---|---|---|
| | Infestation rate (%) | Average ± SE | Infestation rate (%) | Average ± SE | | Average |
| **Muscidae** | | | | | | |
| *Musca domestica* | | | | | | 20 |
| *Musca sorbens* | 14 | 26.7 ± 24.9[a] | | | | |
| *Haematobia irritans* | 36 | 4.0 ± 2.1 | | | | |
| *Orthellia caesarion* | 9 | 2.8 ± 0.5 | | | | |
| **Sarcophagidae** | | | | | | |
| *Tricharaea occidua* | 73 | 28.4 ± 8.7[b] | 100 | 102 ± 63.7 | 95 | |
| *Ravinia iherminieri* | 5 | 0.1 ± 0.1 | | | | |
| **Other** | | | | | | |
| *Sphaeroceridae* | 5 | 0.3 ± 0.3 | | | | |
| *Sepsis sp.* | 73 | 50.1 ± 17.9 | 25 | | 1 | |
| Sciaridae | 5 | 0.7 ± 0.7 | | | | |

* Means within columns not followed by the same letter are statistically different at $P \leq 0.05$ (T test; df = 21; P = 0.03).
** Number of samples.

## Discussion

*Tricharaea occidua* had been reared from a variety of breeding media including carrion, animal excrements, and fruit and vegetable wastes in the mainland USA (Haines 1953, 1955). This species was first reported from Hawaii in 1962 (Joyce and Wilton 1962). Toyama and Ikeda (1976) reported that *T. occidua* was found only at dairy farms in individual dung pats, and no samples were ever recovered from accumulated manure in their survey at animal farms in leeward and central Oahu. Our results showed that *T. occidua* was only recovered from individual dung pats on a dairy farm and cattle ranges, where animals were either fed an enriched grain supplement or pasture grass. *Tricharaea occidua* was not considered to be a major nuisance fly by Toyama and Ikeda (1976). But, we believe that with a large number of flies present, it caused annoyance to the complainants. Vector Control Branch personnel have experienced this fly swarming over them while they collected samples.

*Musca sorbens* breeds in a variety of animal dungs (Lee and Toyama 1990), but at the dairy farms it bred only in individual dung pats (Toyama and Ikeda 1976). In addition, this fly rarely breeds in the dung of range cattle or milk cows fed only grass (Toyama unpublished). This study provides further evidence for this observation.

*Musca domestica* breeds in large cow dung piles and usually does not breed in individual cow dung pats on ranches (Toyama and Ikeda 1976). Among the 13 ranches, piled cow dung was only found at the dairy farm. This study indicated that the house fly was not important in the complaint areas because 95% were caught at the dairy farm where they bred, 3% from the Old Coast Guard Station, which is near the dairy farm, and 2% from the rest areas including parks and another ranch (Table 1).

Moon (2002) reported that horn flies occurred in far greater numbers on grazing cattle than on animals confined in drylots or indoors; also, for unknown reasons, dung from horses, sheep, and other mammals was unsuitable. Our data support this conclusion (Table 2). Despite low numbers in survey areas, horn flies could be considered an important species because of their biting behavior and the complaints by park users of being bitten.

Our study revealed that the two major species of flies, *T. occidua* and *M. sorbens*, in the complaint areas in the north leeward Kohala area matched the breeding of flies at the ranches, and *T. occidua* was the principal inhabitant in the cattle, horse, and mule dung at the ranches. Obviously, the animal feces at these ranches are the breeding sources of flies. According to Gary Toyama (unpublished) flies from the ranches were believed to be windblown by almost constant trade winds prevailing in the area from ranch areas to parks farther down the coast.

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