Filth-inhabiting Flies of Guam

By GEORGE E. BOHART and J. LINSLEY GRESSITT

INTRODUCTION

Guam is an oceanic island nearly 30 miles long and 4 to 8 miles wide. It lies between 144° 37′ and 144° 57′ east longitude and 13° 15′ to 13° 40′ north latitude and is about 1,200 miles from Luzon, the nearest continental island. Apparently it has been isolated for a long period, as it has a limited and specialized fauna. The total number of insect species on the island is probably about 2,000, or very little over that figure. Because of its relatively recent volcanic origin, it has an even poorer native fauna than have oceanic islands of greater antiquity, such as Hawaii and Samoa. Another clue to the relatively recent origin of the island and its fauna is the low proportion of endemic families or genera, and the similarity of the species to those of the nearer continental islands.

Possibly as many as one-fourth of all the species of insects on Guam were introduced by man, either accidentally or purposely. Of the insects of agricultural and medical significance, it is probable that the majority belong in this category.

Fresh-water insects are poorly represented on Guam, and the two orders Ephemeroptera and Plecoptera are absent, as are many aquatic families. In the Diptera, the large families Culicidae (mosquitoes) and Chironomidae are represented by only nine species each.

Few of the insects of primary medical significance are peculiar to Guam. Some of the Heleidae (biting midges) and Psychodidae, which includes the true sand flies, are endemic; but, with the possible exception of one midge, none of them feed on human blood. Many of the muscoids and other higher flies are widely distributed species, though a number of important widely distributed species have not yet reached Guam. Among the latter are the lesser house fly (*Fannia canicularis*), the common house fly of temperate regions (*Musca domestica*), blow flies of the genera *Calliphora, Phormia, Pollenia,* and many *Lucilia* and bot flies (*Gasterophilidae*). Other less easily transported medical flies absent from Guam are the true sand flies (*Phlebotomus*), black flies (Simuliidae), horse flies (Tabanidae), and eye flies (*Hippelates*).

GEOGRAPHICAL ZONES IN RELATION TO FLY POPULATIONS

Geologically and biologically, Guam is separated into a northern and a southern half. The northern half of the island is an elevated limestone plateau of coral reef origin, which is about 300 feet high, with a few regions as high as 600 feet. At the margin are precipitous, jagged cliffs 200 to 300 feet above sea level. Along the shoreline there are a few forested coves surrounded by cliffs and sea. The plateau is largely covered with dense, scrubby jungle not extensively cleared or inhabited until the advent of American troops. The southern half is composed of low but rather steep and mostly barren hills with coves and stream valleys which are usually cultivated and inhabited. This section was little touched by battles or the establishment of military camps. The middle zone is composed of rolling hills and a broad valley to the west containing the principal town of Agana. This is the most heavily populated part of the island and was the most disturbed by battles and military camps. (See map, fig. 1.)

In the north, fly problems are mostly centered around a few large airfields and some isolated ranch houses and tiny villages. Jungle-inhabiting species of flies, such as *Sarcophaga stricklandi* and *Dichaetomya saperoi,* were more common here than elsewhere. However, most of the species dealt with in this paper occur in the north and could become locally abundant under certain conditions.

In the south, the numerous villages and native farms present, with their livestock, a greater problem. It is also the area which produces the most copra, and the resulting piles of waste coconuts probably breed various species of flies in the proper seasons. In this region *Musca sorbens* is dominant, probably because of the large number of pig pens, the indiscriminate dropping of human feces, and, perhaps, the handling of cattle manure. In the villages, *Chrysomya megacephala* is nearly as common as *Musca sorbens* and breeds primarily in poorly constructed and untreated privies.

In the central part of the island, a variety of conditions has resulted in a rather high population of most kinds of flies, except in certain well-sanitated camps. The numerous unauthorized garbage dumps near military camps during the war, the piling of manure at the Island Farm, and the scattered ranches with their pigs and water buffalo are contributing factors to the densities of *Musca vicina* and *M. sorbens, Chrysomya megacephala,* and several species of *Sarcophaga.* The offal washed in from ships in Apra Harbor and standing off the central coast furnishes ideal breeding grounds for many flies. Also, in this area, the several native towns built by naval construction battalions had privies which were neither kept closed nor treated and seemed to be ideal for the breeding of *Chrysomya megacephala* and *Hermetia illucens.* The dangerous conditions in this area from a disease dissemination standpoint

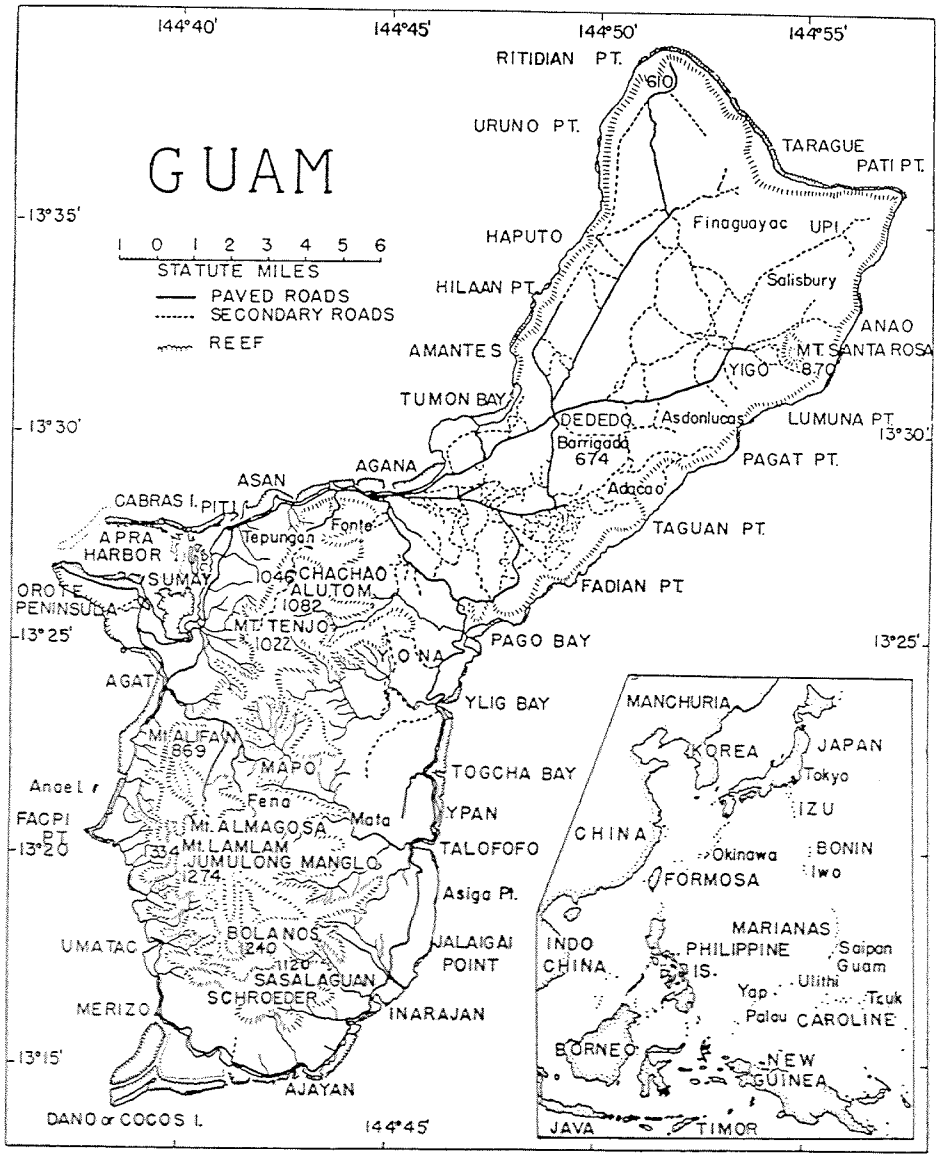


FIGURE 1.—Map of Guam.

were clearly shown by Harris and Down (33)[1] who studied the intestinal fauna, through examination of the feces, of *Chrysomya* taken from traps near the privies, many of which were located only a few hundred feet from military camps. Another circumstance in this area which maintains blow-fly and flesh-fly populations and would make control work difficult is the large number of toads lying dead along the roads. The flies on these toads attract more toads which are in turn run over and breed more flies. It is hard to say what the result of such a condition is on the ultimate population of flies and toads.

In the course of our general collecting on Guam, about 1,000 species of insects were obtained. These collections, including immature stages and adults, are now largely deposited in the United States National Museum. About 230 of them were flies, of which 99 are discussed in this paper. Of the approximately 100 species obtained, we reared 55 from eggs and larvae.

Keys and drawings are included for the separation of species in all stages. The biology and possible medical significance of the various species, as they were found on Guam, are discussed and suggestions for specific control measures are given. The habitats of flies and the materials in which they breed are discussed in regard to their place in the general scheme of fly breeding and disease dissemination on the island. Also included, as a basis for understanding the problems involved, are brief discussions of the morphology and biology of the Diptera and a summary of their role in the spreading of diseases.

SCOPE OF PAPER

Because we feel that any species of fly commonly associated with filth has the potentiality for mechanical transmission of disease, we have decided to include all flies with such habits. The habitats considered under the term "filthy" include all forms of excrement; decaying flesh; and certain decaying plant materials, such as garbage, large masses of rotting vegetation, and fermenting fruits. For genera most species of which were found to be filth-inhabiting, we also include species of unknown habits in the key to adults. Borderline situations, such as decaying vegetation, are included because many of the insects which breed in them also breed in excrement or carrion. An example of this is the stable fly (*Stomoxys*), which we found breeding equally well in piles of decaying vegetation and in cow manure. *Ophyra chalcogaster* and *Chrysomyza aenea* are examples of species which breed in all three media: excrement, carrion, and rotting vegetation. Fermenting fruits are also significant, because the flies which breed in them are commonly found around garbage and are attracted to food in kitchens. Thus, the flies could carry pathogens from garbage to food intended for human consumption or could cause either accidental or false intestinal myiasis by ovipositing in food;

[1] Numbers in parentheses refer to the Bibliography, page 141.

and some groups, such as *Drosophila*, which normally breed in fruit, occasionally visit and breed in human excrement.

Table 1 shows the number of families, genera, and species of flies on Guam presumed to be filth-inhabiting, listed according to their major taxonomic categories. Probably several of these were only accidentally associated with filthy environments at the time of their capture. The table includes only flies collected or reared from filth during the field work on Guam.

TABLE 1

	FAMILIES		GENERA		SPECIES	
Taxonomic Category	Total collected on filth	Definitely associated with filth	Total collected on filth	Definitely associated with filth	Total collected on filth	Definitely associated with filth
Nematocera	6	3	6	3	10	5
Brachycera	2	1	3	2	4	2
Aschiza	2	2	6	6	9	9
Cyclorrhapha Acalypterata	12	9	34	25	46	31
Cyclorrhapha Calypterata (Muscoidea)	4	4	15	14	25	24
Total	26	19	64	50	94	71

METHODS OF STUDY

POPULATION AND HABITAT STUDIES

Bait trapping was the basic method for determining abundance and food preference of flies. The traps were semi-cylindrical in shape and 18 inches long by 10 inches wide by 7 inches high, fitted inside with a roof-shaped piece of screen with an entrance slot along the ridge of the "roof." The trap was supported on short wire legs, which were placed in cups of oil to exclude ants. A pan of bait was set on the ground under the trap. Where dogs were abundant, it was necessary to fasten the trap to the ground with wire and stakes and to suspend or stake down the bait. Unfortunately, such traps limited accurate analyses. Very small flies, such as phorids and drosophilids, had no difficulty in getting out through the screen; and no practical method was found to prevent toads from taking a percentage of the flies before they entered. Furthermore, some substances, such as breadfruit, although highly

attractive in the open to many muscoid flies, were not effective as baits when placed under traps.

For studies on the food and habitat preferences of the flies, each trap was baited with a different substance and set as nearly as possible in the same environment as the others, but at least 150 feet distant. These trap lines were maintained for several days in order to determine the periods of maximum attractiveness during the aging of the baits.

For comparison of habitats, each of a series of traps was set with the same bait, a mixture of several substances, and placed in environments such as jungles, beaches, native villages, farms, and camp kitchens.

By combining data obtained by all the trapping methods, information was procured on the total relative abundance of the species and on the ratio of the sexes coming to baits.

Field Observations and Collecting

Trapping was supplemented with field observation and collecting; and an attempt was made to observe the adult flies found in the immediate neighborhood of the various types of filthy environments and in buildings, particularly kitchens and mess halls. For identification purposes, we collected as many specimens of adults as possible and compiled lists of those frequenting representative filthy environments. We also collected larvae, or maggots, of the various fly species in all types of situations for rearing in the laboratory. In addition, the jungles were searched for flies which did not readily enter village or camp areas.

On the beach at the north end of the island, a human corpse four days old was put under weekly observation for a month, in order to study the succession of fly species attracted to and breeding in it during the process of decomposition.

To determine accurately the various types of media on which the different flies would feed or oviposit, various materials were exposed in bait cans at different localities. These materials included dead mammals, birds, amphibians, fish, crustacea, and echinoderms, excrement from various animals, cooked vegetables, wild fruits, and rotten coconuts. Some of the experiments were to determine what species of flies would be attracted to the various baits, others to capture for laboratory use adult female flies or mating pairs for oviposition. In other experiments, baits were exposed for several hours in open cans with dampened dirt in the bottoms then tightly covered with cloth for three or four weeks. The cans were then opened and the contents examined for puparia and for adult flies which had developed from eggs laid when the baits were exposed.

Rearing

Rearing was undertaken for three major purposes: (1) to determine life cycles and larval habits, (2) to compare various materials as larval foods, and (3) to obtain correlated specimens of the developmental stages of each species.

For most of the controlled laboratory rearing, eggs or young larvae were isolated as to species in small, wide-mouthed jars. They were placed on several thicknesses of paper toweling cut enough larger than the diameter of the jar to form a concave nest. The atmosphere in most of the jars remained moist and the larvae could choose the degree of dampness necessary for pupation by migrating between the layers of paper at various levels. Food was provided in small quantities, moistened frequently, and replenished as needed. The jars were covered with tightly woven cloth held firmly in place by rubber bands.

At various stages of a rearing, specimens were placed in a rubber-stoppered procaine tube containing alcohol. When the rearing was completed, the tube contained eggs, larvae, puparia, and adults.

Shortly before we left Guam, we started a comparison of media as food sources for maggots. Eggs of the more important species of flies were placed on the following series of seven standardized media representing the principal breeding materials available on the island: meat (liver); C-ration stew; human, pig, and cattle excrement; rotting coconut; and decaying breadfruit. Rates of development and survival were measured for the flies on each material. Although the laboratory experiments were not completed, interesting preliminary results were obtained.

Taxonomic Study

Preliminary identifications of adults were made in the field, and representative specimens were sent to the United States National Museum for further identification. When we returned to Washington with the complete collection, groups of flies were distributed among and studied by various specialists as follows: Nemocera, Alan Stone; Aschiza (except Phoridae), C. T. Greene; Phoridae, G. E. Bohart; Cypselidae, O. W. Richards; Drosophilidae, A. H. Sturtevant; Ephydridae, E. T. Cresson, Jr.; Chloropidae, C. W. Sabrosky; other acalypterates, George Steyskal; Sarcophagidae, D. G. Hall, G. E. Bohart; and other muscoids, J. L. Gressitt and G. E. Bohart.

CLASSIFICATION OF DIPTERA

The scheme of Diptera classification followed for the most part in this paper is that used by Comstock in "An introduction to entomology" (11). The major categories containing filth-inhabiting flies on Guam are as follows:

canal occurred after a heavy storm, when materials such as seaweed, sea animals, carcasses, and garbage and other wreckage from ships were washed up on the beaches and assumed importance as breeding sources for many species of flies.

COMMON SUBSTANCES WHICH BREED AND ATTRACT GUAM FLIES

Human Excrement

The most dangerous material exposed to filth-visiting flies is human excrement. It not only attracts adults of most species, but is one of the most potent sources of breeding. It is the natural place for flies to contaminate themselves externally and internally with fecal-borne pathogens. Isolated deposits of excrement in the shade or partially concealed under leaves or stones are ideal for visitations and ovipositions by flies. Feces in the direct sun often dessicate too rapidly for protracted attractiveness to flies or for survival of maggots. This applies particularly to periods of hot, dry weather. Feces in large masses in deep pits do not seem to attract oviposition by many species of flies. The darkness of the pit probably discourages light-loving forms, and the type of decomposition may be unfavorable to the development of many larvae. According to Herms (36), areas of excrement in privy pits which receive light often receive oviposition by house flies, whereas areas in the dark do not.

Table 3*

Species	Abundance	Notes
Lycoria sp.	once	very old excrement
Hermetia illucens	common	in privy pits
Megaselia scalaris	common	in buildings
Tubifera arvora	once	in septic tank
Drosophila ananassae	once	isolated stools
Chrysomyza aenea	once	in laboratory
Atherigona orientalis	once	in a tent
Ophyra chalcogaster	twice	isolated stools
Musca sorbens	several times	isolated stools
Chrysomya megacephala	common	in privy pits
Sarcophaga ruficornis	common	isolated stools
Sarcophaga gressitti	common	stools on beach
Sarcophaga knabi	common	isolated stools
Sarcophaga dux	occasional	stools in jungle

* Buxton (8) also reared *Synthesiomyia nudiseta* from human excrement in Samoa.

In our studies on Guam, *Chrysomya megacephala* was found to be the principal breeder in human excrement, in or out of privy pits. Another fly commonly breeding in the pits was *Hermetia illucens*. In the open, several species of *Sarcophaga* bred as freely as *Chrysomya megacephala* did in feces, but were usually crowded out when in competition with the latter. Apparently

maggots of *Musca domestica* commonly infest privy pits and other accumulations of feces in temperate climates, but we did not observe its close relative, *M. vicina,* breeding in any form of human excrement. *M. sorbens,* which is supposed to be a common breeder in human excrement in the tropics, was found only occasionally in isolated deposits and never in pits. However, as our survey of fecal material from privies or isolated deposits in the open was not extensive, it is probable that more thorough investigation would considerably alter these remarks.

Table 4

Species	Abundance	Notes
Psychoda sp. a	several times	on lab. table
Diploneura cornuta	once	on lab. table
Leptocera spp.	common	marshy places
Actocetor solitarius	common	in privies
Chlorichaeta tuberculosa	once	septic tank
Octhera canescens	once	near road puddle
Sobarocephala sp.	several times	in jungle
Drosophila spp.	several times	in lab. and jungle
Rhodesiella boharti	twice	traps
Cadrema bilineata	common	traps
Lasiopleura virilis	several times	traps
Desmometopa tarsalis	common	near manure, marshes
Lonchaea filifera	unusual	observation
Lonchaea sp.	fairly common	traps and observation
Mimegralla galbula	very common	in jungle
Acrosticta apicalis	unusual	traps
Notogramma stigma	unusual	traps
Scholastes aitapensis	fairly common	jungle, coconut groves
Scholastes hirtiventris	common	jungle, coconut groves
Pogonortalis fulvofemoralis	fairly common	restricted jungle sites
Pseudeuxesta prima	uncommon	traps
Neoeuxesta sp.	occasional	restricted jungle sites
Dichaetomyia saperoi	occasional	jungle
Dichaetomyia nigroscuta	twice	jungle
Fannia pusio	common	traps
Pygophora lobata	once	observation
Atherigona longipalpus	uncommon	traps
Limnophora plumiseta	once	traps
Musca vicina	common	traps, observation
Lucilia cuprina	common	traps, observation
Chrysomya rufifacies	uncommon	traps
Sarcophaga "peregrina"	common	traps
Sarcophaga stricklandi	fairly common	in jungle

Howard, in his extensive treatise on the insect fauna of human excrement (41), gives a good discussion of the problem in the area around Washington, D. C.

Table 3 lists the species of flies which were bred on Guam from natural ovipositions on human excrement; table 4, those which were merely attracted to it. Further study should considerably increase the number found breeding.

Liquid Sewage and Other Liquid Wastes

Careful investigations of liquid environments were not conducted on Guam, partly because stagnant bodies of water are not common in the porous soil of Guam, though some search was made of slowly moving ditch water in Agana wherein the rat-tailed maggots of *Tubifera arvora* were seen, as were moth-fly larvae (probably *Psychoda alternata*). However, in the Solomons, a stagnant ditch containing waste washing water was covered with a thick scum in which wriggled huge numbers of rat-tailed maggots and the leathery larvae of *Hermetia illucens*. Larvae of the house mosquito, *Culex quinquefasciatus,* teemed around the edges of the scum. It is, of course, well known that *C. quinquefasciatus* has a liking for polluted water. On Okinawa, rat-tailed maggots and larvae of soldier flies (mostly of the genus *Ptecticus*) and *Culex quinquefasciatus* are the most conspicuous inhabitants of village ditches, but various species of moth-fly larvae are even more abundant.

Herms (36) has shown that drying sludge from sewage is a good medium for the development of house flies and stable flies.

Pig Excrement and Pens

As might be expected from the omnivorous feeding habits of pigs, the fly fauna in their excrement is similar to that in the excrement of man. However, it is usually somewhat more limited because pig manure dries out more quickly and the pigs themselves feed on larvae and puparia of flies. From our observations, it appears that the largest share of the *Musca sorbens* population on Guam is bred from the excrement in pig pens. Especially is this true in muddy pens where the feces fall into deep hoof tracks, where they remain moist and where the pigs cannot get at them. This is also true in dry weather, when the deep tracks are "frozen" in the hard mud. The most common flesh fly on the island, *Sarcophaga knabi,* is apparently supported largely by pig feces, although it breeds in human and horse excrement. *Chrysomya megacephala* rarely breeds in pig feces, and apparently *Musca vicina* never does. Adjacent to the government pig pen was a field with heaps of cow manure which bred countless *M. vicina,* but none of these laid eggs in the pen so far as could be observed.

The use of garbage for pig feed is another factor which makes pig pens good places for maggots of many species of flies to develop, especially when the garbage is allowed to accumulate out of reach of the pigs.

On Okinawa, where pigs were fed in concrete tanks which received human feces through a slit between slabs of concrete in the roof, as well as straw and other materials, the pigs ate royally on maggots and puparia but could not keep up with the oviposition rate of the adult flies which continually

swarmed about. The resulting combination of human feces, pig feces, straw and other pig feed, and maggots were used to fertilize the rice fields.

The flies which we found attracted to and breeding in pig feces on Guam are listed in table 5, and their relative abundance is indicated.

Table 5

Bred from feces		Merely attracted to feces	
Species	Abundance	Species	Abundance
Psychoda sp. a	very common	Lycoria sp.	unusual
Megaselia suis	moderately common	Chonocephalus hirsutus	unusual
Leptocera femorina	moderately common	Drapetis sp.	unusual
Allotrichoma sp.	very common	Tubifera arvora	unusual
Paralimna aequalis	very common	Desmometopa sp.	common
Lonchaea filifera	moderately common	Atherigona orientalis	very common
Ophyra chalcogaster	common	Lucilia cuprina	common
Stomoxys calcitrans	unusual	Musca vicina	unusual
Musca sorbens	very common		
Chrysomya megacephala	once		
Sarcophaga knabi	very common		

Cattle Droppings and Manure Heaps

Experience on Guam showed that cattle droppings and manure heaps must be studied separately. Manure heaps, usually mixed with hay and well-aerated in feeding or milking barns, have a fauna closely resembling that of vegetable compost or other accumulations of decaying vegetation. They remain moist for a considerable period and support several generations of flies. Isolated droppings in the field breed cattle flies of two species, *Haematobia exigua* and *Siphona carabao,* and the stable fly, *Stomoxys calcitrans,* which also breeds in manure heaps. On the other hand, *Musca vicina,* which breeds well in manure heaps, was not found in cattle droppings. *M. sorbens* was found once in cattle droppings and once in a pile of manure, but neither seems to be its normal breeding medium. *Hermetia illucens,* which requires a long time for development, breeds in manure heaps but not in isolated droppings. This parallels its breeding in latrines and not in isolated deposits of human feces. *Ophyra chalcogaster,* one of the most common inhabitants of cattle droppings, is rare in manure heaps, whereas the reverse is true of *Chrysomyza aenea.* Neither seems to support blow flies or flesh flies on Guam, although adults of these flies are somewhat attracted to fresh droppings.

From the standpoint of breeding flies which are active in the dissemination of human diseases, manure heaps are the more suitable since they breed house flies. Cattle droppings are much more suitable for the breeding of cattle pests.

Hammer, in his "Biological and ecological investigations of flies associated with pasturing cattle and their excrement" (31), gives a detailed and excellent account of the ecology of cattle droppings in Denmark.

Table 6 lists the flies bred from cattle droppings and from heaps of cow manure, with the relative abundance of each species.

TABLE 6*

From cattle droppings		From heaps of cow manure	
Species	Abundance	Species	Abundance
Lycoria sp.	unusual	Lycoria sp.	fairly common
Leptocera spp.	very common	Hermetia illucens	fairly common
Desmometopa tarsalis	common	Microchrysa flaviventris	common
Milichiella lacteipennis	common	Tubifera arvora	unusual
Chrysomyza aenea	fairly common	Leptocera spp.	very common
Ophyra chalcogaster	very common	Desmometopa tarsalis	very common
Stomoxys calcitrans	very common	Milichiella lacteipennis	very common
Siphona carabao	very common	Chrysomyza aenea	very common
Haematobia exigua	very common	Ophyra chalcogaster	unusual
Musca sorbens	once	Stomoxys calcitrans	very common
		Musca sorbens	unusual
		Musca vicina	very common

* In addition to the species listed in this table, flies found commonly around dairy barns were *Lonchaea* sp., *Cadrema bilineata*, *Atherigona orientalis*, *Sarcophaga knabi* and *ruficornis*, *Chrysomya megacephala*.

Horse Droppings

Large accumulations of horse manure were not available for study, but isolated groups of droppings in a fairly moist environment were found to have a richer fauna of potential disease spreaders than has cow manure. Flesh-fly larvae of two species, *Sarcophaga knabi* and *S. ruficornis*, were quite common, as were larvae of *Musca sorbens*. Larvae of *M. vicina* were not seen, although they probably do breed in such material since horse excrement is known to be the favorite breeding medium for *M. domestica* (Hewitt, 37). Larvae of *Chrysomyza aenea* were also abundant in the horse droppings on Guam.

Decaying Vegetation

A large and constantly accumulating pile of aquatic vegetation which had been dragged from the Agana Spring reservoir was excellent for the study of fly breeding in such material. It remained very moist, in places having almost a fecal odor. The accumulated heat of decomposition was too great for fly breeding in some parts of it, but generally it was an excellent medium. Its fauna closely resembled that of cattle manure heaps, except that *Musca vicina* larvae were not found. Both species of *Musca* were abundant visitors to the pile, but they apparently did not oviposit. *Chrysomyza aenea* was the most prolific breeder in the drier material, but in the very moist, slimy portion, *Stomoxys calcitrans* was dominant. Of the two soldier flies, *Microchrysa flaviventris* was much more abundant than *Hermetia illucens*. The same relationship for all four of the above species was present in the manure heaps. Similarity between decaying vegetation and heaps of manure was also demonstrated by small acalypterate flies such as *Leptocera*, *Milichiella*, and *Desmometopa*, all of which bred in exceeding abundance in both materials.

Decaying Fruit

It is difficult to conceive of the amount of mashed and fermenting breadfruit on the ground in the neighborhood of native villages during certain seasons. At such times swarms of flies are attracted and cover all exuding portions of the fruit.

Although not usually considered a filthy substance, decaying fruit on Guam has several important connections with filth-inhabiting flies. In the first place some types, such as breadfruit and species of *Anona*, are powerful attrahents for such flies as *Chrysomya megacephala*, both species of *Musca*, and *Atherigona orientalis*. Some of this fruit is eaten raw from the ground by the natives, and the flies which come to feed on it also visit human feces and table food.

Flies such as *Atherigona orientalis* and several species of *Drosophila*, which probably breed chiefly in fruit, also breed in human excrement on occasion.

Table 7 lists the species of flies bred from decaying breadfruit and the flies attracted to but not found breeding in it. The relative abundance of each species is indicated.

TABLE 7

Breeding		Attracted but not breeding	
Species	Abundance	Species	Abundance
Psychoda sp. a	very common	Diploneura cornuta	unusual
Psychoda alternata	unusual	Megaselia scalaris	unusual
Cecidomyidae gen. sp.	common	Drapetis spp.	fairly common
Megaselia sp.	unusual	Actocetor solitarius	common
Chonocephalus subglaber	very common	Chrysomyza aenea	common
Chaetodrosophilella quadrilineata	very common	Scholastes aitapensis	rather common
Drosophila ananassae	very common	Acrosticta apicalis	unusual
Drosophila melanogaster	common	Cadrema bilineata	rather common
Drosophila, 2 spp. undetermined	both common	Lasiopleura virilis	unusual
Notogramma stigma	unusual	Atherigona longipalpus	unusual
Atherigona orientalis	very common	Fannia pusio	common
Limnophora plumiseta	common	Musca sorbens	very common
		Musca vicina	common
		Chrysomya megacephala	very common
		Sarcophaga ruficornis	fairly common

Decaying Coconuts

It is unfortunate that the possibilities of decaying coconuts for fly breeding on Guam were not more thoroughly investigated. Most decaying nuts seemed to harbor only larvae of *Scholastes* and *Atherigona orientalis* and to have an

odor rather like that of cheese, which it probably is in a sense. However, some coconuts rotted in a different manner and developed an odor like that of diarrhetic stools. These seemed to support a rich fauna. From the two such nuts investigated, *Sarcophaga "peregrina," Chrysomya megacephala, Cadrema bilineata,* and *Megaselia scalaris* were reared, in addition to the usual *Scholastes* and *Atherigona*. We suspected on several occasions that *Musca sorbens* might breed in the coconuts under certain conditions, though we found none of their larvae. However, D. G. Hall informs us that while on an island in the Marshalls, he reared *M. sorbens* from some rotten coconuts he had picked up in the field and placed in tightly covered cans.

Carrion

Carrion of all sorts is the principal adult and larval food for most of the species of filth-inhabiting flies on Guam. Nearly all of the human excrement-inhabiting species can breed in carrion and many species are apparently entirely carnivorous. All, except possibly two, of the flesh flies and blow flies breed well in carrion, and all but two of the anthomyids whose habits were studied also breed in it commonly. The same can be said for the tiny phorid flies. Even *Stomoxys calcitrans* breeds in it occasionally, according to the literature (Seguy, 114). The principal flies which were not found in carrion in the larval stage are cattle flies (which are confined to cattle droppings), both species of *Musca,* and some of the otitids. However, all of these, except the cattle flies, are attracted to carrion as adults.

For the most part, samples of carrion from different sorts of animals were about equally attractive to flies for feeding and oviposition. In the Solomons it had been found that crushed crabs were particularly attractive, but these were not available in sufficient numbers for tests on Guam. Animals with fur were oviposited on more readily than bare pieces of meat but showed no special feeding attraction to adults. Echinoderms were slow to rot, but when semi-liquefied, furnished excellent bait. Dead sea snails were very attractive, especially to phorids and several acalypterates, for visitations and oviposition. Most flies oviposited in dead snails without showing a preference for early or late stages of decay. *Parafannia* and *Puliciphora,* however, showed a distinct preference for old material.

Under normal conditions, there is a distinct succession of insect faunae breeding in a large piece of carrion and a less distinct one in the adult insects visiting it for food. Fuller, in "The insect inhabitants of carrion" (26) describes in detail the succession in animal carcasses of temperate Australia. Mégnin (79) gives an exhaustive account of the fauna of human corpses in France. Studying buried corpses in a cool climate, he was able to determine their ages quite accurately from a study of the insect inhabitants. This sort

of knowledge has been used to some extent in medico-legal work and criminal detection.

Our best opportunity to study the succession of insects in carrion was the aforementioned human corpse on a remote beach at the north end of Guam. At the time of our first visit, when the corpse was four days old, great numbers of mature *Chrysomya megacephala* larvae were already migrating from the abdomen of the corpse to pupate in the sand. At this time, *C. rufifacies* were the most abundant adult flies, and they deposited several egg masses while we watched. A small proportion of mature *C. rufifacies* larvae was also present. A week later the corpse had lost its bloated appearance and the flesh was easily pulled from the bones. About 15 feet from the body, several flowering trees of the genus *Tournefortia* were swarming with adults of all three species of *Chrysomya* and smaller numbers of *Sarcophaga dux* and *Musca sorbens*. Many of the striking "hairy maggots" of *C. rufifacies* were seen leaving the carcass in company with some maggots of *C. megacephala* and *C. "nigripes."* Examination of the abdominal cavity of the corpse revealed many full-grown maggots of *C. rufifacies* and even greater numbers of *C. "nigripes"* in various stages of development. A species of *Sarcophaga* larva, probably *dux,* was also present in small numbers. Two weeks later, when the corpse was about a month old, it was considerably dessicated and had the musty smell of old carrion, although the deeper muscle tissues were still moist and highly putrid. Probably the extended preservation of some of the tissues was due to a high tide that had washed over the body and left a deposit of salt and to the fact that it had been sprayed with oil, presumably by a sanitation detail. The most abundant inhabitants in the corpse and in the sand about it were now adults and larvae of larder beetles (Dermestidae, *Dermestes*), ham beetles (Corynetidae, *Necrobia*), and steel beetles (Histeridae, *Saprinus*). Adults of the muscoids *Atherigona orientalis, Ophyra chalcogaster, Musca sorbens,* and *Rhinia testacea* were rather common on the corpse, as were the acalypterates *Pseudeuxesta prima, Scholastes hirtiventris,* and *Hecamede persimilis*. Numerous larvae of the *Pseudeuxesta* were found in the muscle tissue close to the bones. Directly under the body in the moist sand we found many larvae of the little gray beach ephydrid, *Hecamede persimilis*. Still viable puparia of *Chrysomya "nigripes"* were in the same situation. Pieces of old tissue which were brought back to the laboratory for rearing of the *Pseudeuxesta* became infested with *Fannia pusio* and *Ophyra chalcogaster* larvae.

Table 8 presents a list of the more important species which were found breeding in carrion on Guam. The asterisks indicate the frequency and degree of infestation in carrion from scarce (*) to very abundant (****). The parenthetical remarks refer to the stage which they usually occupy in the succession of faunae. Preference for mollusks, if present, is indicated.

TABLE 8

SPECIES	ABUNDANCE	TIME OF INVASION	MEAT PREFERENCE, IF ANY
Hermetia illucens	*	tertiary	
Megaselia scalaris	***	primary to tertiary	
Megaselia stuntzi	*	secondary	on mollusks
Parafannia molluscovora	**	secondary to tertiary	on mollusks
Puliciphora wymani	**	secondary	mollusks and fish
Puliciphora nigrosterna	*	secondary	on mollusks
Diploneura cornuta	**	secondary	especially mollusks
Discomyza maculipennis	**	tertiary	especially mollusks
Hecamede persimilis	*	tertiary	
Chrysomyza aenea	*	secondary	
Pseudeuxesta prima	*	tertiary	
Atherigona orientalis	**	secondary and tertiary	
Fannia pusio	***	tertiary	
Ophyra chalcogaster	***	tertiary	
Rhinia testacea	*	late secondary	
Lucilia cuprina	**	primary	
Chrysomya megacephala	****	primary to secondary	
Chrysomya rufifacies	****	early secondary	
Chrysomya "nigripes"	***	secondary to tertiary	
Sarcophaga ruficornis	***	primary to secondary	
Sarcophaga gressitti	***	secondary	
Sarcophaga knabi	**	secondary	
Sarcophaga "peregrina"	***	primary to secondary	
Sarcophaga dux	****	primary to secondary	

Table 9 lists the flies which showed a distinct attraction to carrion but were not found breeding in it. Abundance, as indicated with asterisks, is based on total counts in our traps.

TABLE 9

SPECIES	ABUNDANCE	SPECIES	ABUNDANCE
Drapetis spp.	*	Scholastes hirtiventris	*
Chlorichaeta tuberculosa	*	Notogramma stigma	**
Actocetor solitarius	*	Dichaetomyia saperoi	*
Sobarocephala sp.	*	Dichaetomyia nigroscuta	*
Rhodesiella boharti	*	Atherigona longipalpus	**
Cadrema bilineata	****	Limnophora plumiseta	**
Lasiopleura virilis	*	Musca sorbens	****
Lonchaea filifera	*	Musca vicina	**
Lonchaea sp.	***	Synthesiomyia nudiseta	*
Acrosticta apicalis	*	Stomorhina quadrinotata	*
Neoeuxesta sp.	*	Sarcophaga stricklandi	*

GARBAGE DUMPS

The contrast between controlled and uncontrolled dumping of garbage in relation to fly breeding was clearly brought out by a study of the flies at two

Guam dumps which we visited frequently. The one near the Government Farm serviced kitchens for at least 50,000 persons and covered several acres. At the start, garbage was buried under only a few inches of soil but was piled as pure garbage to such a depth that the heat of decomposition prevented fly breeding, except where small amounts were mixed with soil or had slopped over the edges of the burial trenches. The odors attracted vast numbers of flies which were mostly *Chrysomya megacephala* and *Musca vicina*. Most of them must have come from considerable distances. Other species seen in numbers were: *Lucilia cuprina, Atherigona orientalis, Musca sorbens,* and *Chrysomyza aenea*. After a few weeks, the burial trenches were made deeper and the garbage was covered daily with several feet of soil, greatly reducing the odor and, consequently, the adult flies in the area.

The other dump, in the Pago River Canyon, was probably supplied by only one small camp, since the material, although piled above ground, never totaled more than about 20 tons. As cans, packing boxes, jungle slashings, and waste paper, and other refuse were piled with the garbage, the mass was well-ventilated and not too warm for maggots. Hence this dump was breeding immense numbers of flies of several species and attracting many others. The following species were abundant:

Musca vicina: breeding in ears of corn and a meat-soaked rag.
Musca sorbens: not found breeding.
Fannia pusio: larvae on bones of old turkey carcasses.
Limnophora plumiseta: eggs in breadfruit squashed on road.
Atherigona orientalis: larvae common in corn and cans with adherent vegetables.
Ophyra chalcogaster: larvae in turkey carcass, meat-soaked rag, C-ration stew.
Stomoxys calcitrans: larvae in ears of corn, vegetation cuttings.
Sarcophaga gressitti: larvae not seen.
Lucilia cuprina: larvae in C-ration stew, green cowhide.
Chrysomya megacephala: larvae in turkey carcass, dead toads, green cowhide.
Chrysomya rufifacies: larvae in green cowhide.
Notogramma stigma: breeding not seen.
Chrysomyza aenea: larvae in ears of corn, rotting potatoes.
Mimegralla albimana galbula: probably not breeding in dump.
Lonchaea species: larvae not seen (perhaps stem borers).
Cadrema pallida bilineata: larvae not seen.
Desmometopa sp.: larvae in vegetation cuttings and corn ear sheaths.
Milichiella lacteipennis: larvae not seen.
Drosophila ananassae: eggs, larvae in breadfruit squashed on road.
Drosophila melanogaster: eggs, larvae in breadfruit squashed on road.
Chaetodrosophilella quadrilineata: eggs, larvae in breadfruit squashed on road.
Discomyza maculipennis: larvae in C-ration stew.
Leptocera (5 species): larvae not seen.
Megaselia scalaris: larvae in turkey carcass, C-ration stew.
Psychoda sp. a: larvae in rotting corn.
Lycoria (4 species): larvae in sheaths of corn ears.
Heleid: adults extremely common but larvae were overlooked.

TABLE 10.—FOOD HABITS OF LARVAE AND ADULTS OF COMMON FILTH-INHABITING FLIES*

† = Larvae ‡ = Adults

SPECIES	CLASSES OF FOOD													
			EXCREMENT						DECAYING VEG. MATERIAL					
	CARRION**	BODY SECRETIONS OR BLOOD	HUMAN	PIG	COW	HORSE	MANURE PILES	LIQUID SEWAGE	VEGETATION	FRUIT	STARCHY VEGETABLES	COCONUTS	SWEETS	FLOWERS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Psychoda sp. a	.....	.....	.....	†	.....	.....	.....	.....	.....	† ‡	.....	.....	‡	.....
Hermetia illucens	.....	.....	† ‡	.....	.....	.....	† ‡	† ‡	†	.....	†	.....	.....	‡
Microchrysa flaviventris	.....	.....	.....	.....	.....	.....	†	.....	†	.....	†	.....	.....	‡
Megaselia scalaris	† ‡	‡	† ‡	.....	.....	.....	.....	.....	.....	.....	†	† ‡	.....	.....
Megaselia suis	.....	.....	.....	† ‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Parafannia molluscovora	† ‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Puliciphora wymani	† ‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Chonocephalus subglaber	.....	.....	.....	.....	.....	.....	.....	.....	†	† ‡	.....	.....	.....	.....
Diploneura cornuta	† ‡	.....	† ‡	.....	.....	.....	.....	.....	.....	.....	†	.....	.....	.....
Tubifera arvora	.....	.....	‡	.....	‡	.....	† ‡	† ‡	.....	.....	.....	.....	.....	‡
Leptocera femorina	.....	.....	‡	‡	† ‡	† ‡	† ‡	.....	† ‡	.....	‡	.....	.....	.....
Discomyza maculipennis	† ‡	.....	‡	.....	.....	.....	.....	.....	.....	.....	.....	†	.....	.....
Hecamede persimilis	† ‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	‡
Paralimna aequalis	.....	.....	.....	† ‡	.....	.....	† ‡	‡	‡	.....	.....	.....	.....	.....
Allotrichoma species	.....	.....	.....	† ‡	.....	.....	‡	‡	‡	.....	.....	.....	.....	.....
Chlorichaeta tuberculosa	.....	‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Actocetor solitarius	‡	.....	‡	.....	.....	.....	.....	.....	.....	‡	.....	.....	‡	.....
Drosophilidae	.....	.....	† ‡	.....	.....	.....	.....	.....	.....	† ‡	† ‡	.....	.....	.....
Cadrema bilineata	‡	.....	‡	.....	.....	.....	.....	.....	.....	.....	†	† ‡	‡	.....
Milichiella lacteipennis	.....	.....	.....	.....	† ‡	† ‡	† ‡	.....	† ‡	.....	.....	.....	.....	.....
Desmometopa species	.....	.....	.....	.....	† ‡	† ‡	† ‡	.....	† ‡	.....	‡	.....	.....	.....
Lonchaea filifera	‡	.....	‡	† ‡	.....	.....	.....	.....	.....	‡	.....	.....	.....	.....
Lonchaea sp. (metallic)	‡	.....	‡	.....	.....	.....	.....	.....	.....	‡	‡	‡	.....	.....
Chrysomyza aenea	‡	.....	‡	.....	† ‡	† ‡	† ‡	.....	†	.....	† ‡	‡	.....	.....
Pseudeuxesta prima	† ‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Acrosticta apicalis	‡	.....	‡	.....	.....	.....	.....	.....	.....	‡	.....	.....	.....	.....
Scholastes aitapensis	.....	.....	‡	.....	.....	.....	.....	.....	.....	‡	‡	† ‡	.....	.....
Scholastes hirtiventris	.....	.....	‡	.....	.....	.....	.....	.....	.....	.....	.....	† ‡	.....	.....
Notogramma stigma	‡	.....	‡	.....	‡	.....	.....	.....	.....	† ‡	† ‡	‡	.....	‡
Dichaetomyia saperoi	‡	.....	‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Atherigona longipalpus	‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	‡	.....	.....	.....
Atherigona orientalis	† ‡	.....	† ‡	‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Limnophora plumiseta	‡	.....	‡	.....	.....	.....	.....	‡	.....	† ‡	.....	.....	‡	.....
Fannia pusio	† ‡	.....	‡	.....	.....	.....	.....	.....	.....	‡	.....	.....	.....	.....
Ophyra chalcogaster	† ‡	.....	† ‡	† ‡	† ‡	.....	†	.....	.....	.....	.....	† ‡	‡	.....
Stomoxys calcitrans	‡	‡	.....	†	†	†	†	.....	†	.....	.....	.....	.....	.....
Siphona carabao	.....	‡	.....	.....	†	.....	.....	.....	.....	.....	.....	.....	.....	.....
Haematobia exigua	.....	‡	.....	.....	†	.....	.....	.....	.....	.....	.....	.....	.....	.....
Musca sorbens	‡	‡	† ‡	† ‡	† ‡	† ‡	† ‡	‡	‡	‡	‡	‡	‡	‡
Musca vicina	‡	‡	‡	‡	‡	† ‡	† ‡	‡	‡	‡	† ‡	.....	‡	‡
Synthesiomyia nudiseta	‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Rhinia testacea	†(?)‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	‡
Lucilia cuprina	† ‡	.....	† ‡	‡	.....	.....	.....	‡	.....	‡	‡	.....	‡	‡
Chrysomya megacephala	† ‡	‡***	† ‡	‡	‡	.....	.....	.....	.....	‡	‡	† ‡	‡	‡
Chrysomya rufifacies	† ‡	.....	‡	.....	.....	.....	.....	.....	.....	‡	.....	.....	.....	‡
Chrysomya "nigripes"	† ‡	.....	‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	‡
Sarcophaga ruficornis	† ‡	.....	† ‡	.....	‡	† ‡	.....	.....	.....	‡	‡	.....	.....	‡
Sarcophaga gressitti	† ‡	‡***	† ‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	‡
Sarcophaga knabi	† ‡	.....	† ‡	† ‡	‡	†	.....	.....	.....	.....	‡	.....	.....	.....
Sarcophaga dux	† ‡	.....	† ‡	.....	.....	.....	.....	.....	.....	‡	‡	.....	‡	‡
Sarcophaga "peregrina"	† ‡	.....	‡	‡	.....	.....	.....	.....	.....	.....	.....	† ‡	.....	.....
Sarcophaga stricklandi	‡	.....	‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	‡

* According to observations on Guam and based upon habits found in nature.
** Including fish and shellfish.
*** Seen on sores of natives.

Lonchaea (Carpolonchaea) filifera Bezzi (pls. 4, 11).

Adult: Body black; squamae white; wing yellowish; antenna with very long, bristly arista; length 3.4 mm; length of wing 3.3 mm. *Larva:* White, elongate, enlarged caudally as in *Stomoxys;* spiracles small, but prominent, subdorsal, each with a transparent thornlike process; length 7 mm. (pl. 4). *Puparium:* Short, rather broad, shining but with finely striated surface; posterior spiracles prominent, roughened, projecting dorsally; caudal end with strong transverse striae meeting at the impressed midline; length 3.2 mm. (pl. 11).

Distribution: Pacific islands and East Indies.

Adults, which are found around animal and human excrement, pig pens, and other filthy situations, were taken commonly in privies both in Guam and Saipan. In the Philippines, W. D. Pierce baited them with sugar and molasses. The larvae feed in pig manure. A number of maggots form a cell inside the manure, eating on the surface of the cell toward the outside. They are extremely active when disturbed and jump readily and repeatedly.

This species was moderately common on Guam, and frequently was caught in traps baited with carrion. Since it is attracted to feces, carrion, and sweets, it could easily carry pathogens from privies to food. However, as it is rather wary and does not readily enter houses, it must be considered of minor importance. As it probably breeds in a wide variety of substances, general sanitation and protection of food from flies are the only practical recommendations for its control.

Lonchaea species.

Adult: Dark metallic blue to blue-green with bronzy reflections; arista bare; ovipositor of female long; length, including ovipositor, 4 mm.

We collected adults regularly and sometimes abundantly from traps baited with either carrion or human feces. They were collected once in the field from a pile of garbage and several times from isolated deposits of human excrement.

This species is moderately abundant, especially around carrion; but its medical significance is probably slight, since it is not commonly seen around human habitations or on food. Nothing specific can be recommended as a control since the larval habits are unknown.

George Steyskal is planning to describe this species in a forthcoming paper covering several acalypterate families in the Pacific area.

Family Piophilidae, Cheese Flies

This is a small family, mostly inhabiting temperate to arctic regions, and apparently it is always a scavenger on proteinaccous substances such as meat, old hides, and cheese.

Genus **Piophila** Fallen

This genus, like the rest of the family, is largely of temperate or arctic distribution and develops on proteinaceous substances. *P. casei,* or the cheese skipper, which has a wide climatic range, is by far the most abundant and well-known species.

Piophila casei (Linnaeus).

Musca putris var. *casei* Linnaeus.
Musca atrata Fabricius.
Musca petasionis Du Four.

Adult: Medium-sized, shiny black, somewhat compressed dorsoventrally; face reddish with frons polished black; coxae and tarsi testaceous; length 4 mm.; wing length 4.5 mm. *Egg:* Ovate, reticulate, with a distinct nipple at anterior end but otherwise without grooves, ridges, or protuberances. *Larva:* Pale, tapering anteriorly, somewhat convex posteriorly; with two pairs of tubercles and a pair of slender processes on last segment. As the name indicates, the larva jumps. *Puparium:* Pale reddish brown, somewhat dorsoventrally compressed, flattened anteriorly; anterior spiracle with 11 or 12 lobes; posterior segment with a pair of fairly prominent upcurved hooklike processes and a pair of smaller tubercles above them; length 4.4 mm.

Distribution: Almost cosmopolitan.

Adults are found about decaying food of various sorts; and they are common in houses, abattoirs, and packing establishments. Each female is said to lay about 30 eggs. Larva breeds in cheese, fat of human corpses, ham and bacon, smoked meats, figs, putrid beef, and human feces. It is said that some types of cheese are not considered ripe in France until infested with "skippers."

This species is generally abundant in infested food storage areas, but is rarely observed in the wild. It was collected on Guam only as larvae, from stools of a soldier who had been serving in Okinawa. Because it commonly breeds in human food such as cheese and cold meats, it is a common cause of intestinal myiasis in human beings. The maggots may mature and pupate in the intestines. Control measures are the proper packing and care of cheeses and meats, the screening of houses and packing establishments, and the disposal of waste meat and dead bodies.

Information on this species was gathered mainly from the literature (see Alessandrini, 1) and from specimens in the United States National Museum collection.

Family Milichiidae (Phyllomyzidae), the Milichiids

Adult: Very small, black, with short, broad wings conspicuously broken in two places near the base of the costa; antennae short, nearly round; oral vibrissae present but weak. *Larva:* Very slender and active, with posterior spiracles prominent and directed outward. *Puparium:* Elongate and tapered toward both ends from the middle; anterior spiracles prominent, sometimes on short stalks; posterior end transversely carinate.

Adults of this family are fond of sunlit places on blades of grass, stones, fence posts, and the like. On Guam, they are abundant in such places as lawns, open fields, low beach vegetation, and open palm groves. They are not often seen on carrion, but some species visit human excrement. Larvae breed pri-

marily in decaying vegetation and excrement of herbivores, but a few species have been reared from human excrement (Howard, 41).

Genus **Milichia** Meigen

Species of this genus are sometimes taken as larvae in tubers, according to Malloch. The United States National Museum collection has several species taken on cattle dung in India.

Milichia orientalis Malloch.

Adult: Small, robust, uniformly dull silvery gray, with broad wings and a short, vertical face; arista bare; antenna orbicular; length 2.6 mm.

Distribution: Guam, Hawaii.

We collected adults several times in dark places, including a storage room for rodent food and caves containing nesting swiftlets. We also reared them from a collection of swiftlet guano which was composed almost entirely of dry insect fragments, and from a mixture of rodent food and rodent droppings. Unfortunately, we did not examine these materials for early stages.

This apparently common species of scavengers on dry waste accumulations probably has no medical significance, and control is unnecessary.

Genus **Milichiella** Giglio-Tos

Adults of this genus are commonly taken in pastures and in barns around manure and cattle feed.

Milichiella lacteipennis Loew (pl. 12).

Adult: Minute, shiny black in both sexes, with slightly milky wings and pale veins; halteres dark brown and tarsi reddish; head short, retreating below; length 2 mm. *Larva:* Elongate, active, with prominent divergent posterior spiracular knobs above the truncate caudal region; anterior spiracles with short, rounded processes; length 4 mm. *Puparium:* At least four times as long as broad, with posterior spiracles divided into three short fingerlike protuberances; length 3 mm. (pl. 12).

Distribution: Cosmopolitan.

Adults are found principally about decaying vegetation and sunlit spots in forested areas. They enter barns and dairies freely to oviposit on manure. We collected feeding adults several times from human excrement and piles of garbage. Larvae were bred on Guam from decaying aquatic vegetation and from cattle and horse manure. They were recorded by Illingworth (48) from hen manure and animal excrement in Hawaii, and by Malloch from guinea pig manure in Samoa. This species is very common in rank vegetation and manure.

Because of its abundance, its ready entry into buildings, and its scavenging habits it could contaminate milk in dairies and carry fecal pathogens to food. Proper disposal of animal manure might effect some reduction in the number of flies but would not affect natural breeding in decaying vegetation. Periodic

airplane spraying of DDT should be effective. Residual treatment of barns, dairies, screens, and the like with DDT should reduce their numbers in buildings.

Milichiella lacteiventris Malloch.

Adult: Similar in size and shape to *M. lacteipennis* but has pale halteres and squamae and black tarsi; abdomen of male silvery white; length 3 mm.

Most of our specimens were taken from light traps, where they were very abundant; but some were swept from rank vegetation growing in abandoned coconut groves.

Genus **Desmometopa** Loew

Habits of this genus are similar to those of *Milichiella,* but these flies are more often seen on human excrement. Evidently some species take rides on larger insects and feed from their prey (Knab, 59). Howard (41) reared *D. latipes* from various deposits of human excrement in Washington, D. C.

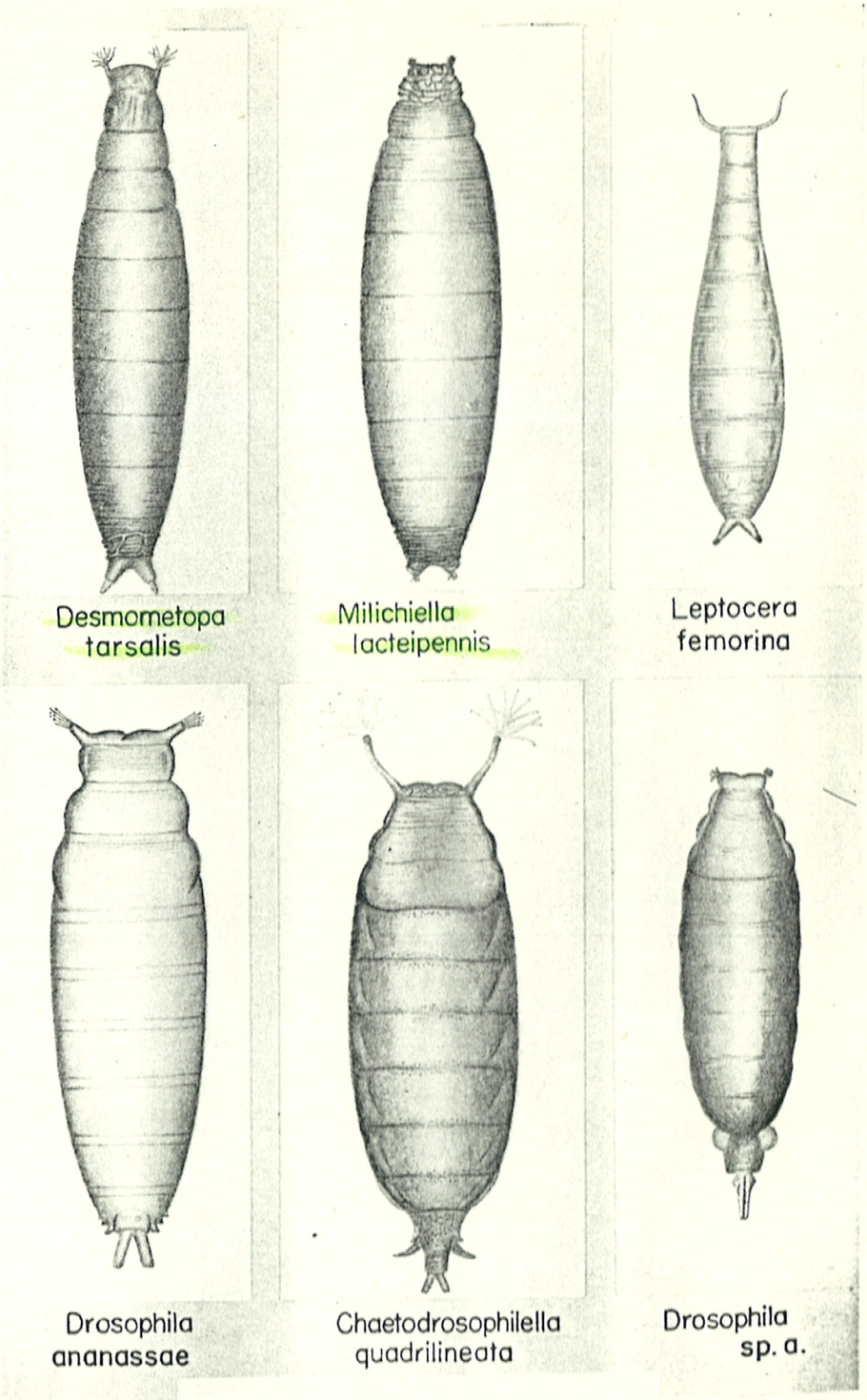
Desmometopa tarsalis Loew (pl. 12).

Adult: Minute, sooty black, with slightly depressed thorax and a somewhat horizontal frons which has a pair of silvery interfrontal stripes; palpi black, not especially large; length 2 mm. *Larva:* Elongate, very active, with posterior spiracles on rather long divergent stalks (fork-tailed); anterior spiracles with long, fingerlike processes; length 4 mm. *Puparium:* About four times as long as broad, with posterior spiracular stalks longer than broad and tipped with a slender pale portion; anterior spiracles not stalked but with distinct processes; length 3 mm. (pl. 12).

Distribution: Cosmopolitan.

The adult is usually seen in company with *Milichiella lacteipennis* around vegetation in the sun in such places as open marshes and manure sheds. It is extremely abundant in light traps and common around house lights. We collected feeding adults from human excrement several times. One was observed and collected while flying in short hops and holding in its legs a live weevil as large as itself. The larva is very common in decaying aquatic vegetation, and in moist cattle excrement, both fresh droppings and when piled as manure. A few maggots were also collected from the decaying stump of a papaya tree.

This is one of the commonest flies on Guam, but is easily overlooked because of its small size and drab appearance. Like *Milichiella lacteipennis* it is common in rank vegetation and manure; and because of its abundance, ready entry into buildings, and scavenging habits, could contaminate milk and carry fecal pathogens to food. Its stronger attraction to lights in dwellings might make it more dangerous than *M. lacteipennis.* Screens, of course, do not hinder its progress appreciably. Periodic spraying with DDT by airplane and residual treatment of barns, dairies, and screens with DDT are the best forms of control.


Desmometopa tarsalis
Milichiella lacteipennis
Leptocera femorina
Drosophila ananassae
Chaetodrosophilella quadrilineata
Drosophila sp. a.