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Bureau of Entomology and Plant Quarantine
Division of Fruit Insect Investigations

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INVESTIGATIONS OF FRUIT FLIES IN HAWAII
(Formerly Oriental Fruit Fly Investigations.)

QUARTERLY REPORT

July 1 - September 30, 1952.

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WORK PROJECT I-c-3 - Chemical Control - Loren F. Steiner, Project Leader

SUMMARY

Line Project I-c-3-1. Geigy 22870 in screening tests was more effective than G-22008 as a residual toxicant against the oriental fruit fly. Neither material was as effective against capitata as dorsalis.

Among residues on field-sprayed guava foliage, DDT was more toxic to dorsalis than to cucurbitae with capitata in an intermediate position. Dorsalis and capitata were equally susceptible to methoxychlor residues. As with DDT, cucurbitae was least affected.

Fungicides, such as wettable sulfur, ferric dimethyl dithiocarbamate or Tribasic copper sulfate, when combined with parathion or DDT wettable powders at rates commonly used on the mainland and applied to guava trees had no adverse effect on residual effectiveness. Bordeaux mixture, when combined with DDT had no adverse effect for 6 days but thereafter greatly reduced the effectiveness.

Under laboratory conditions in closed glass cages, aldrin proved much more toxic to adult dorsalis as a fumigant than dieldrin, with parathion least effective of the three. Parathion effected a total knockdown in 1 hour followed by a substantial recovery. Under field conditions parathion is most effective and there is no recovery. Aldrin caused no knockdown in 3 hours' exposure but 100 per cent mortality resulted in 24 without further exposure.

Line Project I-c-3-2. Within two 30-fruit samples of rose apple averaging about 20 grams each, the infestation ranged from 1 to 31 larvae per fruit and averaged 10. Samples of more than 40 fruits would be required to obtain a standard error as low as 10 per cent of the mean at the infestation level of about 230 per pound.

In tests replicated 4 times with a Tifa fog machine in which flies were caged in the bottom and on the rim of a gulch at distances ~~from 200 ft.~~ to 850 ft. from the point of discharge, G-22008 at 20 gms. per acre effected a mean 94 per cent mortality on the rim and 75 per cent in the bottom of the gulch of dorsalis, compared to 99 and 96 per cent, respectively, of cucurbitae in the same cages. G-23611 was substantially less effective, while DDT at 3 times the G-22008 application rate was less than half as effective. The G-22008 in one test gave 100 per cent kills 1/4 mile downwind. Cucurbitae which is more resistant than dorsalis to spray residues was the most susceptible to aerosols regardless of toxicant. At none of the 40 exposure points did DDT cause 100 per cent mortality. G-22008 produced 100 per cent mortalities of dorsalis at 15 of the 24 points 200 to 500 ft. from the point of discharge.

In field tests where parathion 25 WP was applied at 20 lbs. per acre to trees or ground and compared with Systox at 10 pts. per acre on small replicated guava plots, the former effected 65 and 63 per cent reductions of dorsalis infestation in picked fruit from a pre-spray mean of 104 per pound. Systox effected 59 and 12 per cent reductions where applied to foliage or ground, respectively.

In incompleted field tests on 2-tree papaya plots replicated 5 times, where only the fruit is sprayed, information is being developed on the comparative speed of action of various materials in the face of heavy attacks of both dorsalis and cucurbitae. Dieldrin, parathion, and CS-708 are most promising.

Field tests involving 45 acres of replicated mango plots on Maui and nearly 30 acres of non-replicated plots on Molokai were completed. Of this, 36 acres on Maui and 14 on Molokai were sprayed with 3 bait-spray formulas (parathion, sugar, and protein) and 3 residual treatments (DDT-EPN, Dilan-malathon, and parathion alone). On Maui, a bait spray of 1 lb. protein hydrolysate, 5 lbs. raw sugar, and 4 lbs. of parathion 25 WP effected a 97 per cent reduction from the pre-spray level of 4.4 larvae per pound during the 2-week intervals after each of 3 sprays. Parathion alone at 10 lbs. per acre gave a 95 per cent reduction, the Dilan-malathon combination 93, and the DDT-EPN 92. The sprays greatly reduced fly activity in the replicated unsprayed plots rendering them useless as controls. The costs of the bait-spray treatment approximated $30.00 per acre for the season for a crop that sold for $750 per acre. Costs of the other treatments were slightly higher. The bait-spray had no depressive effect on parasitization. Parathion alone left the plots with the least mite infestation and mite damage. DDT-EPN was damaged by mites somewhat more than the unsprayed.

On Molokai the parathion in the Maui bait-spray formula was reduced to 1/2 lb. toxicant per acre for 1 plot and increased to 2 lb. for the other. Sprays were applied 3 times at 2-week intervals. Per-acre costs for materials were $3.68 and $7.52 per application. The weaker formula effected mean reductions on 3 varieties of 88 to 98 per cent 7 and 14 days after each spray from the pre-spray levels of 5.2, 5.4, and 16.5 larvae per pound. The stronger formula, tested on 2 varieties, gave reductions of 96 to 99 per cent. The bait sprays on Molokai were applied with a boom attachment at the rate of 16 gal. per minute and 6 1/2 minutes per acre.

The large-scale test of methyl eugenol-G22008 in which 180 feeding stations are distributed over a 6-square mile area of the Hamakua coast and retreated at monthly intervals began giving good control in the second (main) guava crop. Male dorsalis flies within the area were extremely scarce compared to outside. Fruit samples (50 guavas each) were collected 5 times from 2 locations at each of 5 elevations within and both North and South of the treated area between July 30 and September 16. The crop reached its peak abundance late in September. Mean control at 300' averaged only 31 per cent but it had improved from 0 in July to 78 per cent September 16. At 700' it averaged 96 per cent, at 1100' 61 per cent, at 1500' 99 per cent, and at 1900' there were no infestations in either treated or control areas. Since all O. oophilus were attributed to dorsalis and since parasitization in several instances was 100 per cent (only capitata and oophilus emerged) the estimated reductions are probably conservative particularly at 1100 ft.

The evidence indicates that reduced competition from dorsalis in the treated area permitted capitata to increase there above normal, that high parasitization of dorsalis there is a result of the reduced dorsalis population rather than the cause of it and that the methyl eugenol-poison stations are definitely effecting control, the cost of which could be held to 25 cents per acre per year if operated on a large-scale commercial basis.

Data obtained in the evaluation of these tests are proving that the frequently observed stratification of dorsalis and capitata at different levels on a steep gradient is not a result of differences in temperature.

In the smaller Kilauea experiment flies began moving in on the treated area in September as the crop there began to mature.

Line Project I-c-3-3. Parathion analyses on mangoes from the Maui experiments failed to indicate that any residues in excess of 2 ppm. were likely to be encountered 1 or more days after spraying from applications of parathion 25 WP at 10 lb. formulation per acre. The bait-spray formula in which 4 lbs. were used resulted in proportionately lower residues.

Line Project I-c-3-4. The residual toxicant tests of 6 insecticides initiated in March as summarized herein, show that DDT-75 WP at 0.5 lb. toxicant remained outstanding for 6 months. Its average effectiveness on each surface was 99 to 100 per cent. DDT emulsifiable was never completely effective but ranked second, with Dilan third, lindane fourth, chlordane fifth, and methoxychlor last. Lindane and chlordane were effective longest on the most absorbent surfaces. Lindane was superior to 6 times as much DDT emulsion on canec for 112 days. DDT emulsion was least effective on unpainted canec and most on aluminum and galvanized iron. Dilan emulsion was least effective on painted plywood but most effective on the unpainted. It was superior to DDT emulsion on plastic screening as well as unpainted canec and plywood surfaces.

Line Project I-c-3-6 and I-c-3-7. In field tests prefermentation of the soy meal lure with yeast without use of diastase before culturing with bacteria did not improve the lure. Soy flour was found to be no better than soy meal. It was found that the concentrated (10%) soy meal culture could be packed for shipping and held at room temperature for one week without affecting its performance indicating that this material may be shipped to the outer islands or to the mainland by air for testing there on other pests if desirable. Addition of castoreum to the standard lure and to the soy meal lure gave no gains in the field although castoreum improved the performance of the standard lure in olfactometer tests. A study of the effect of concentration on the soy meal showed a concentration of 1% to be superior to 2% or 4% over a two weeks' exposure period. We believe this result taken together with other studies of the soy meal lure indicates the presence of repellents as well as attractants in this lure.

Anthranilic acid and indole both failed to act as chemical percussors of the proteinaceous attractants. Combination of the soy meal lure with the standard fermenting lure resulted in reducing the attractiveness of the combined lure to that of the standard, indicating that the proteinaceous lure attractants are probably nitrogenous compounds.

The relative attractiveness of the proteinaceous and the fermenting lures were found to vary with time and with location. Analysis of the data from field experiments over a four months' period indicates that the proteinaceous lure is possibly a more reliable index of fly population than the fermenting lure.

A "spot" method of testing materials in the olfactometer has been developed and has proved to be a very rapid technique for screening attractants which requires extremely small quantities of materials. The method is not nearly as sensitive as the trap method and does not give information as to sex response with D. dorsalis, so can be regarded only as a preliminary method for weeding out non-attractive materials. A large number of aromatic compounds, essential oils, and coded "E" series compounds have been screened by this method. Of 320 compounds and essential oils screened, 32 were attractive to D. dorsalis and 12 to C. capitata, so the method serves to eliminate about 90% of the materials screened.

WORK PROJECT I-c-3. - Chemical Control - Loren F. Steiner, Project Leader

The resignation of Mr. Morishita to accept a position with the University of California late in August resulted in a real loss to the project. Mr. Kinoshita ably assisted in completion of the mango tests on Maui and Mr. Holloway in the guava and papaya field tests conducted on Oahu.

Line Project I-c-3-1. Preliminary Laboratory Testing of Insecticides. (Keiser Fujimoto, Steiner)

Testing of New Compounds (by Keiser)

Geigy compound 22870 was tested residually against adult D. dorsalis and the results are shown in table 1. G-22008 was included in the experiment for comparative purposes.

Table 1.—Comparative effectiveness of two Geigy compounds against adult D. dorsalis when exposed to laboratory residual deposits.

Micrograms insecticide per square centimeter of glass surface	Per cent mortality 1/			
	24 hours		48 hours	
	G-22870	G-22008	G-22870	G-22008
0.18	97	55	99	70
.25	97	67	98	79
.38	98	74	100	84
.50	97	89	99	94
1.00	100	97	99	100

1/ Average of 3 replicated cages. Fifty flies per cage, or 150 flies for each insecticide at each dosage level. Insecticides dissolved in xylene. Two milliliters solution pipetted into each Petri dish and allowed to dry for 18 hours before flies introduced.

G-22870 proved to be more effective than G-22008 against D. dorsalis as a residual toxicant. However, neither compound was as effective against C. capitata as against dorsalis. After 48 hours' exposure, the average oriental fruit fly mortality for G-22870 for the 5 concentrations tested was 99.0 per cent, and for G-22008, 85.4 per cent. Against C. capitata, the average mortalities were 58.2 for G-22870 and 58.3 for G-22008 in comparable tests.

Comparative Effectiveness of Field Deposits on Guava Against 3 Species of Fruit Flies (Keiser & Prange) by Keiser

In the course of the tests with field-sprayed guava foliage reported last quarter (page 114) all 3 species of flies were combined, when available, in the tests with DDT and methoxychlor. The results, summarized in table 2, indicate that cucurbitae was most tolerant of DDT WP-50 deposits and dorsalis least, with capitata intermediate. Cucurbitae was also most tolerant of methoxychlor 25 WP while capitata and dorsalis were equally affected.

Table 2.--Comparative mortalities of fruit flies exposed to guava foliage with DDT and methoxychlor insecticidal residues. Brodie Gulch, 1952.

Number of days after third treatment	Per cent mortality after 24 hours[1/]					
	DDT[2/]			Methoxychlor[3/]		
	D. dorsalis	*D. cucurbitae*	*C. capitata*	*D. dorsalis*	*D. cucurbitae*	*C. capitata*
19	79	18	37	76	36	80
25	25	9	5	8	3	15
39	44	5	16	58	20	45
Mean	49	11	19	47	20	47

1/ Average of four replicated treatments. Four terminal twigs of guava foliage from each replicate. Fifty *D. dorsalis*, 30 *D. cucurbitae*, and 15 *C. capitata* per replicate.
2/ At the rate of 10 lbs. toxicant per acre in 200 gals. water.
3/ At the rate of 20 lbs. toxicant per acre in 200 gals. water.

These tests emphasize the need for further comparisons which must await the availability of adequate fly stocks.

Effect of Certain Fungicides on Residual Toxicity
(Keiser and Prango)

A special test was initiated on August 12 at the Tripler guava plots to determine the effect of different fungicidal additives to DDT and parathion suspension sprays against adult *D. dorsalis* and against other fruit fly species when available. Table 3 presents the mortalities associated with each treatment and indicates that none of the fungicides tested (with the possible exception of Bordeaux) affected the DDT or parathion during the period when effective residues were ordinarily present (as noted by the mortalities of these poisons without fungicides). Bordeaux appeared to affect DDT residues 9 days after treatment. However, the remaining DDT formulations showed mortalities of 50 to 73 per cent.

Fifteen *capitata* adults were included in each cage with the oriental fruit flies. The numbers were not sufficient to show any significant adverse effects of the fungicides if present. However, collectively the mean mortalities for the various formulas showed a greater tolerance of *capitata* for the two insecticides than *dorsalis*. This is indicated below:

Days after treatment	Mean mortality - per cent			
	DDT formulas		Parathion formulas	
	dorsalis	*capitata*	*dorsalis*	*capitata*
1	98	48	99	84
3	95	65	82	73
6	79	22	54	20
9	60	41	7	10
13	25	12	3	5

Table 3.--Comparative effectiveness against adult D. dorsalis of DDT and parathion suspension sprays prepared with different fungicides, when applied to guava foliage in the field. August 12-25, 1952.

Treatment				Per cent mortality after 24 hrs. from collections made after different numbers of days weathering[1/].				
Insecticide		Fungicide						
Name	Pounds toxicant per 100 gallons	Name	Pounds toxicant per 100 gallons	1	3	6	9	13
Parathion 25 per cent WP	1	---	0	97	59	41	3	0
"	1	Wettable sulphur	5	100	92	73	15	3
"	1	Fermate	1.5	100	79	37	2	2
"	1	Tribasic copper sulphate	3	100	96	66	9	5
DDT 50 per cent WP	2	---	0	95	92	87	73	15
"	2	Wettable sulphur	5	99	99	79	50	16
"	2	Fermate	1.5	99	96	71	63	29
"	2	Tribasic copper sulphate	3	97	93	80	53	39
"	2	Bordeaux mixture	2	94	83	75	16	7

1/ Mortalities are average of 4 replicated cages. Thirty adult D. dorsalis per cage. 0.02 inch rain between 3 and 6 days; 0.05 between 6 and 9; and 0.42 between 9 and 13 days.

Fumigant Qualities of Insecticides
(Keiser and Prange) by Keiser

In the course of screening insecticides against the oriental and other fruit flies, it would be desirable to know how mortality is effected--contact, stomach poison, fumigant, or combination of those modes of action. The two techniques employed at the present time, namely topical and residual, have been very satisfactory to date for determining the contact insecticidal values of different chemicals. However, as reported in the last quarter, these procedures may not give a true picture of stomach poison properties, if present without or with little contact value. Accordingly, the insecticide was incorporated with sweetened water, placed on a cotton plug and exposed to caged flies. Mortalities achieved in this manner over and above those noted by the topical or residual procedures could be validly ascribed to stomach poison action.

It was also desirable to ascertain the fumigant qualities of insecticides independent of their contact or stomach poison qualities. An apparatus was prepared (figure 1) for exposing adult flies to fumes only, and then removing these from the source and observing subsequent results. Some fumes may remain in the jar with flies for a short period of time after removal from insecticide vapors. However, with this technique, it is possible to remove the flies from any continued exposure without disturbing them from their original container.

In the first series of tests (table 4), an arbitrary dosage of one pound toxicant per 1000 cubic feet was used.

Table 4.--Comparative effectiveness of insecticidal fumes against adult D. dorsalis when exposed for 3 hours under laboratory conditions.

Insecticide 1/	Deposit	Per cent mortality after 18 hours 2/
Aldrin	emulsion	100
	suspension	97
Parathion	emulsion	7
	suspension	57
Dieldrin	emulsion	91
	suspension	59
Check (xylene)	---	0

1/ Active ingredients at rate of one pound per 1000 cubic feet. Emulsions and suspensions at rate of one pound active ingredient in 22.2 gallons total spray.

2/ Treatment duplicated. Fifty flies per cage, or 100 flies per treatment. Fed sugar water on cotton after separated from fume chamber. Mortalities listed average of 2 cages.

Figure 1.—Convenient apparatus for preliminary screening of materials for fumigant action. Sprayed foliage, or the insecticide alone, may be introduced in the large jar. Flies in the small jar are held therein with a cap constructed of 2 rings soldered together. A loose disk of hardware cloth is held between jar and ring. The small jar is coupled upside down to the large jar for the required exposure period and then removed and held as is for the required observation period. Food and water may be furnished the flies after exposure.

In practice, 2 grams of a 25 per cent material (for example) were placed in a 100 ml. volumetric flask, filled with water to proper mark, and 10 ml. removed after adequate agitation and placed in bottom of the 2-quart jar. This was allowed to dry for 24 hours. Flies were gassed with CO_2, placed in the quart holding jars, allowed to revive, and then connected to the 2-quart fumigant bottle by means of the double screw cap. By visual observation, it was noted that the flies in the parathion fumes were "down" after one hour, and in the xylene emulsion (check) after 3 hours. All exposures were ended at that time, and the jars with flies removed from their respective 2-quart fuming jars. As noted in table 4, all flies "down" in the xylene emulsion recovered, as observed 18 hours later, as did most of those in the parathion emulsion. It is of interest to note that while none of the flies in the aldrin tests appeared affected for the 3-hour exposure period, there was 100 per cent mortality after 18 hours, in both replicates of the emulsions, and one of the two replicates of the suspensions. The reasons for the recovery of the parathion-exposed flies have not been determined.

In the previous experiment, the suspensions and emulsions were allowed to dry and there was the possibility (extremely slight) that insecticidal particles from the lower 2-quart jar reached the one containing the flies, and contact action may have affected mortalities. A second test was run in which identical quantities of emulsions and suspensions were used, but the jar with flies were connected immediately after the bottoms of the 2-quart jars were wet with the formulations.

Table 5 lists the mortalities 21 hours after exposure was terminated. One hour after exposure, it was again noted by visual observation that the flies exposed to the xylene emulsion (check) and parathion emulsion were all "down". The jars with flies were separated from their respective 2-quart containers in all instances after only 1 instead of 3 hours' exposure as in the first experiment.

Table 5.--Comparative effectiveness of insecticidal fumes against adult <u>D. dorsalis</u> when exposed for one hour under laboratory conditions.

Insecticide 1/	Deposit	Per cent mortality after 21 hours
Aldrin	emulsion	100
	suspension	100
Parathion	emulsion	3
	suspension	1
Dieldrin	emulsion	12
	suspension	30
Check (xylene)	---	2

1/ Active ingredients at rate of one pound per 1000 cubic feet. Emulsions and suspensions at rate of one pound active ingredient in 22.2 gallons total spray.

2/ Treatment duplicated. Fifty flies per cage, or 100 flies per treatment. Mortalities listed average of 2 cages. Fed sugar water on cotton after separated from fume chamber.

As noted in table 5, aldrin again showed 100 per cent mortalities, even though there was no knock-down after the 1-hour exposure period. The parathion formulations and check (xylene emulsion) showed almost complete recoveries. Flies exposed apart from foliage in field plots in 1950-51 indicated that parathion and dieldrin residues were considerably more effective than aldrin in killing flies by apparent fumigant action.

Miscellaneous (by Keiser)

Approximately 130 automatic waterers were made for the fly-rearing section. A simple wick waterer was devised which supplies adequate water for at least 15 days. Several were given to the rearing personnel for trial. They found the device satisfactory and 130 were subsequently made for all their cages. Flies are not disturbed daily by inserting the watering syringe. The rearing section claims it saves 2 man hours a day labor. Also, fly mortality was less since they not disturbed so often.

Considerable time was spent in working up reports of tests with coded compounds.

<u>Line Project I-o-3-2. Field Testing of Insecticides.</u> (Steiner, Morishita, Holloway, Lee, and Kinoshita)

<u>Fruit Sampling Studies</u> (Steiner)

Samples of 30 picked and 30 fallen rose apples from a tree in Honolulu were held individually as a part of our studies of fruit infestation variability. The fallen fruit represented drops on the ground less than 4 hours. The results are tabulated below:

	Picks	Drops
Mean weight per fruit	17.7 gms.	22.3 gms.
Mean larvae per fruit	9.7	10.9
Range in larvae per fruit	1-31	1-29
Mean larvae per pound	246	222
Per cent fruit infested	100	100
Per cent larvae parasitized	81.5	77.1
Per cent *C. capitata*	0.4	0.3
Per cent of parasites--*oophilus*	65.9	71.6
longicaudatus	30.8	25.8
vandenboschi	3.3	2.5
Sample size required to reduce SE to 10% of Mean =	44 fruits	42 fruits

Unlike guavas, the drops yielded as many larvae as did ripe picks. This fruit is lighter in weight than guava and contains much less moisture, hence the injurious effect of concussion on eggs, young larvae, and the fruit itself may be of much less consequence.

<u>Tifa Fog Tests</u>. (Morishita, Holloway, Steiner)

Because of the poor performance of fog sprays containing aldrin or DDT when applied to areas subject to reinfestation by immigrating flies, and possible hazards involved in experiments with highly effective fogs of parathion and C-22008, our rented equipment was returned to the mainland. However, before this was done one final test was urgently needed to explore further the possibilities of controlling flies in non-inhabited areas (including gulches) with fogs that would reach out farther than DDT and that could be applied with ground-operated equipment.

Flies were caged along the far rim and in the bottom of a gulch ranging from 25 ft. to 100 ft. deep. (See figure 2.) The gulch was surrounded by pineapple and the direction of travel was therefore restricted. The fog machine was driven along a 500 ft. front at right angles to the prevailing trade winds. The flies were caged at distances of 200, 450, 500, 700, and 850 ft. downwind from the route of travel in 14-mesh monel metal screen cylinders. Those on the rim were well-exposed while those in the bottom of the gulch were hung in dense guava stands. From 45 to 50 flies of mixed sexes and in a ratio of 3 or 4 <u>dorsalis</u> to 1 melon fly were placed in each cage. The flies were collected at random from the large olfactometer cage where they had been well fed with a protein-fortified diet.

Figure 2.--Approximate cage locations in fogging experiment with G-22008 and G-23611. Lateral of Helemano Gulch.

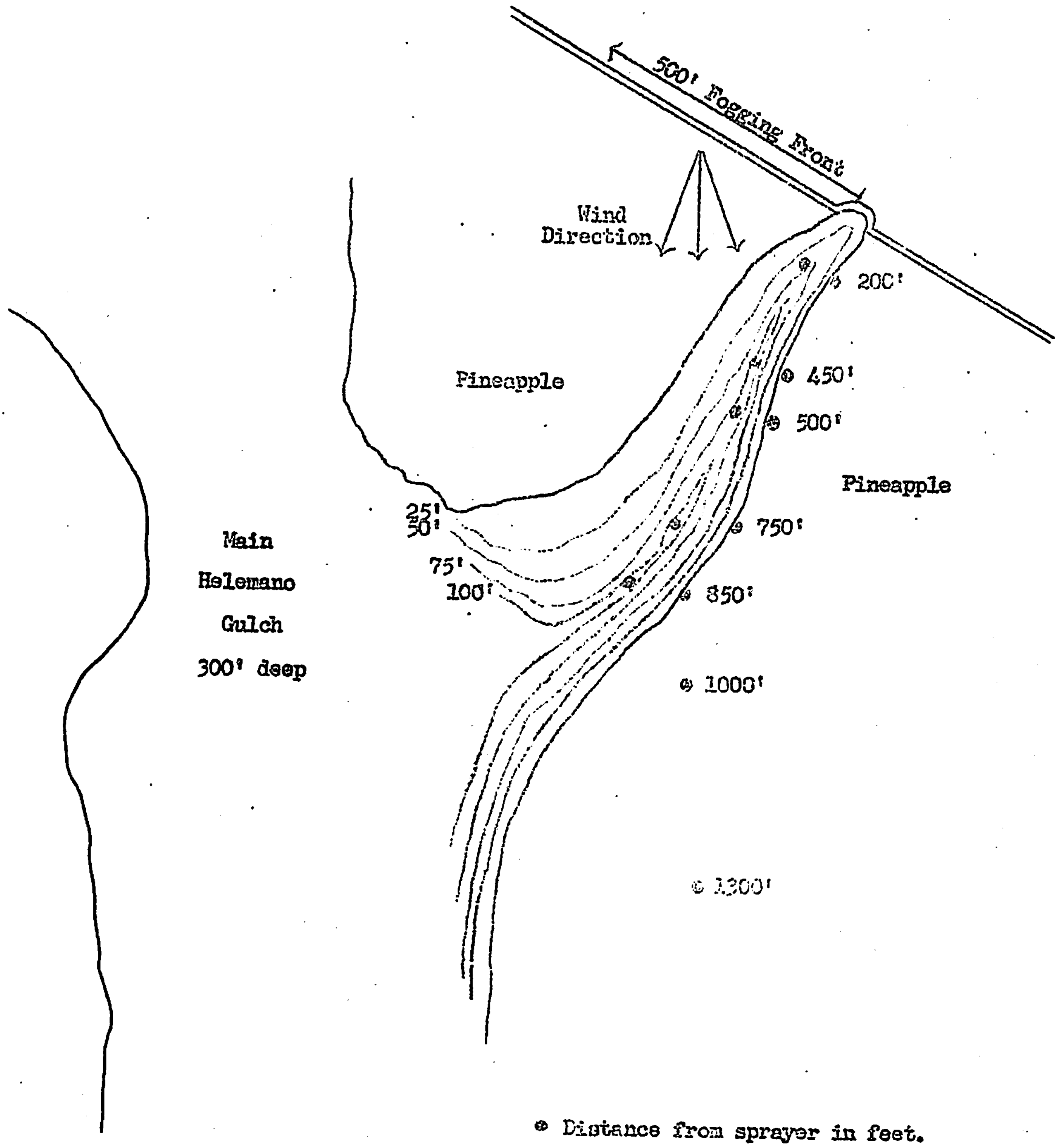


Table 6.—Results of Tifa fog sprays against caged flies.

R=Rim G=In Gulch	July 28				July 30				Mean	
	Replication									
	A		B		C		D			
Location	Dor.	Cuc.	Dor.	Cuc.	Dor.	Cuc.	Dor.	Cuc.	Dor.	Cuc.
	DDT—2 ozs. per 100 ft.				DDT—6.7 ozs. per 100 ft. travel (1 lb. per gal.)					
200-R	55	40	44	38	85	67	97	78	70	56
G	51	11	60	67	36	73	15	70	30	55
450-R	28	64	74	25	60	65	46	84	52	60
G	60	83	68	80	8	67	12	67	37	74
500-R	45	14	39	9	39	75	13	80	34	44
G	38	86	53	0	16	67	8	44	29	49
700-R	36	33	73	56	71	92	30	50	52	58
G	63	25	37	33	21	88	9	36	32	46
850-R	27	24	59	67	65	89	23	69	44	62
G	36	43	26	16	30	57	20	0	28	29
Mean R	38	35	58	39	64	77	42	72	50	56
Mean G	50	50	49	39	22	70	13	43	31	51
	G22008—0.3 lb. per gal.				2 ozs. toxicant per 100 ft. travel					
200-R	100	100	100	100	100	100	100	100	100	100
G	98	100	100	100	100	100	100	–	99	100
450-R	100	100	100	100	100	100	100	100	100	100
G	80	100	100	100	57	100	96	100	83	100
500-R	52	–	100	100	97	100	100	100	87	100
G	72	100	100	100	81	–	60	100	78	100
700-R	98	93	100	100	96	–	100	–	98	99
G	14	63	94	100	44	100	86	100	60	91
850-R	65	89	89	100	94	–	83	–	83	94
G	33	54	100	100	60	100	19	100	53	89
Mean R	83	97	98	100	97	100	97	100	94	99
Mean G	59	83	99	100	68	100	72	100	75	96
1000' R	–	–	–	–	73	100	100	100		
1300' R	–	–	–	–	61	85	100	100		

Table 6 (cont'd)

R=Rim G=In Gulch	July 28				July 30					
	Replication									
	A		B		C		D		Mean	
Location	Dor.	Cuc.	Dor.	Cuc.	Dor.	Cuc.	Dor.	Cuc.	Dor.	Cuc.
G-23611--0.3 lb. per gal. 2 ozs. toxicant per 100 ft. travel										
200-R	100	100	100	100	100	100	100	100	100	100
G	97	100	88	94	91	88	19	98	74	95
450-R	100	100	70	77	100	97	75	70	86	86
G	92	100	49	91	90	50	45	88	69	82
500-R	95	100	59	62	87	69	20	64	65	79
G	100	100	42	59	94	86	33	67	67	78
700-R	98	93	55	75	52	100	33	67	60	84
G	93	80	45	80	45	84	0	0	46	61
850-R	89	90	15	57	62	60	22	64	47	68
G	96	80	95	25	52	58	31	71	68	58
Mean R	96	97	60	74	80	89	50	73	72	83
G	94	92	64	70	74	73	26	65	65	75
Mean no. flies per test	34	11	37	11	40	10	39	10		

Toxicants were dissolved in xylene to make 3 pts. plus 5 pts. Shell Helix agricultural spray oil per gallon of solution and applied at the rate of 1/2 gal. solution per minute. The tests were run in sequence in the same location and repeated 4 times, 2 each on July 28 and 30.

The wind was variable as usual, both as to direction and velocity but generally remained in the ENE and at a velocity of 6 to 8 mph. The fogs were rarely visible beyond 700 ft.

DDT as the standard treatment was tested at only 0.3 lb. per gal. through an error on July 28. It was increased to 1 lb. per gal. for the subsequent tests. Geigy compounds 22008 and 23611 were tested throughout at 0.3 lb. per gal. or 2 ozs. per 100 ft. of travel.

The data as summarized in table 6 indicate that compound 22008 was substantially more effective than 23611 at the application rate used, which was less than 20 gms. per acre as calculated on the 1300 ft. coverage evident from results in replicates C and D. It was highly effective up to at least 1/4 mile from the point of discharge.

DDT, as in previous tests, gave unsatisfactory results even at the 200 ft. distance. The D replication of the DDT treatment was thought to have gone on under ideal fogging conditions. Wind velocity was low and steady. Apparently, however, a good breeze is necessary to carry effective sized particles more than 200 ft. and particularly down into the dense guava.

Results were better on the rim than in the gulch regardless of toxicant. D. <u>cucurbitae</u> proved more susceptible to the aerosol fogs than D. <u>dorsalis</u>. This greater susceptibility to aerosol applications was noted first in early tests with the G-651 DDT formula (see page 165 of the Sept.-Dec., 1949 Quarterly report).

The results strongly indicate, as did earlier cage tests over pineapple with both parathion and G-22008 (page 635, April-June, 1951, Quarterly Report), that fog sprays utilizing G-22008 (or parathion) might be very useful in quickly ridding uninhabited areas of adult fruit flies, providing the areas to be treated can be approached to within 1/4 mile on the upwind side.

That compound 22008 in the xylene-oil solution is extremely dangerous was indicated when one of the spraymen splashed oil used to rinse out the Tifa on the right side of his face and clothing. Within 15 minutes the pupil of the right eye was rapidly contracting and he became quite nauseated and weak. A few hours after hospitalization and a single intravenous dose of atropine sulfate, he began recovering and felt normal the following day. This accident occurred several hours after completion of the field spray.

<u>Comparison of Parathion and Systox on Guava</u>
(Holloway and Steiner)

Field tests conducted on the last guava crop in the Tripler Hospital plots (Quarterly Report for October-December, 1951, pages 133-148) resulted in superior control with Systox at 2 lbs. toxicant per acre or 2 pts. formulation per 100 gals. applied only to scattered guava. The 97 per cent control obtained may be compared with 81 per cent in similar plots sprayed with half as much parathion (in a bait spray) and to 98 per cent where the parathion was used at 2 lbs. but applied to whole plots instead of only scattered trees. The Systox which has much less residual action against adult flies than parathion either acted as a strong repellent or was highly effective as a systemic.

To investigate this further, the two materials were applied to small guavas, 3 to 5 ft. tall and bearing their first guava crop. Only 1 application could be made because of the short producing period. The guavas were part of the H.A.E.S. planting set out partly for our use at the Waimanalo farm.

Treatments were arranged in a restricted randomisation and replicated 4 times on different terrace levels with 5 plants per replicate. Application rates were comparable to 20 lbs. parathion 25 WP per acre or 10 pts. Systox. On a per 100 gal. basis the dilutions were 1 lb. and 0.5 pt., respectively. Two plots were thoroughly sprayed with a 7 g.p.m. Bean conventional-type sprayer at 400 lbs. p.s.i. Equal quantities of the spray mixtures were withdrawn and applied with sprinkling cans to the soil only, of two other plots. Ripe guavas were removed at intervals from the trees and ground underneath and samples held for emergence in the usual manner.

One sample of drops and one of picks were collected August 11, 6 days after the plots had been cleared of all mature fruit. The average infestation was 93.8 larvae per pound. Emergence from 32 samples was 2.8 per cent _O. oophilus_, 0.1 per cent _C. capitata_, and 97.1 per cent _dorsalis_. Despite a heavy _D. cucurbitae_ population in the plots this species was not reared from any of the guavas either before or after the sprays. Neither _oophilus_ nor _capitata_ increased in proportion to _dorsalis_ in subsequent samples.

Because of the rapid decline in production, samples were not always available in some plots. The available data, however, are summarized in table 7.

Table 7.--Infestation indices in guava plots treated August 11 with parathion or Systox.

Date	Plot and Larvae per pound guava (data are means of 4 replicates)									
	1 Control		2 Para. Spray		3 Para. Ground		4 Systox-Spray		5 Systox-Ground	
	P.	D.	P.	D.	P.	D.	P.	D.	P.	D.
Pre-spray Aug. 11	130.5	98.9	91.3	69.9	86.7	86.3	109.2	98.2	104.2	63.0
Means	Picks = 104.4				Drops = 83.3			Both = 93.8		
Post-spray 4 days	148.4	150.8	50.4	69.6	102.8	110.5	53.6	68.2	167.2	116.9
9 days	41.7	130.0	-	48.0	12.8	76.9	27.2	45.0	56.3	43.8
14 days	106.8	56.3	21.8	35.0	0	47.5	48.6	68.4	52.6	60.6
Post-spray means	98.9	112.2	36.1	50.8	38.5	78.2	43.1	60.5	92.0	73.8
Per cent change from mean pre-spray level	-5	+35	-65	-39	-63	-6	-59	-27	-12	-11

A series of 7 picked samples taken August 5 had averaged 64.3 larvae per pound. Since the infestation was on the increase, estimates of the effect of the spray based on the mean pre-spray level (Aug. 11) should be conservative.

Much of the spray applied to the foliage, dripped to the ground. At the concentrations used parathion gave better results than Systox but neither performed as well as in the Tripler tests and neither gave control that could be considered at all satisfactory. An effective systemic poison would be useful in controlling fruit flies on some of the non-edible hosts and further tests will be conducted.

<u>Field Tests on Papaya</u>. (Holloway & Steiner)

Small plot tests were started on papaya where only the fruit is being sprayed. The object was to evaluate different insecticides for speed of action in preventing oviposition by both <u>dorsalis</u> and <u>cucurbitae</u> females that in many instances contact the insecticide for the first time when they alight on the fruit.

Sprays were applied at 2-week intervals, with the first of three on Sept. 17. Eleven treatments were set up on 2-tree plots each replicated 5 times and distributed throughout a 2-acre field where rows vary from 8 to 25 ft. apart and trees 4 to 6 ft. apart in the rows with more than 500 trees per acre. The sampling procedure was to clean all sprayed trees of mature fruit at weekly intervals and to hold as many from each pair of trees as required to fill a holding box (4 to 9). Because of the abundance of <u>cucurbitae</u> among the fly population seen on ripe papayas it was hoped to obtain some information on the comparative performance of the better <u>dorsalis</u> insecticides against the melon fly.

Infestation indices (larvae per pound) for 10 small samples of about 3 lbs. each ranged from zero to 46.7 and averaged 15.5 on August 29. Samples taken Sept. 3 from all 55 replicates yielded from 0 to 25.4 larvae per pound and averaged 4.9 with a standard deviation of 7.1. Plot averages ranged from 0.8 to 8.2. Similar samples taken Sept. 10 yielded from 0 to 12.0 larvae per pound, averaged 2.3, and the plot means ranged from 0.3 to 4.8. On Sept. 16, before the first spray, the sample range was 0 to 19.7, the plot means from 0.02 to 4.2 and the general mean, 2.0. Variability was first thought due largely to varietal differences since the planting is one of mixed varieties, seedlings, and hybrids. However, the 3 complete series of pre-spray samples showed that there was no association of high or low infestations with certain plots. The infestation range among the 3 samples (0-25.4) within individual replicates was as great as that among the 55 samples taken on any one day. The only means of improving reliability in sampling papayas seems to be to restrict sampling to a narrow range in degree of maturity and to obtain large samples. At the 5 larvae per pound level the number of holding box samples required for a given degree of reliability would be twice as large for papaya as for guava. Emergence from all pre-spray samples averaged 20 per cent <u>cucurbitae</u> and 80 per cent <u>dorsalis</u> with less than 0.5 per cent parasitization. Reasons for the extremely low degree of parasitization in the Waimanalo area as indicated by both the guavas and papayas sampled prior to any use of insecticides are unknown.

The results from sprayed fruit are incomplete but present indications are that concentrations per 100 gals. such as DDT-75 WP 3 lbs., parathion 25 WP 2.5 lbs., dieldrin 25 WP, CS-708 25 WP, or heptachlor 25 WP at 4 lbs., or methoxychlor 50 WP at 8 lbs. though applied to the point of runoff will not give satisfactory control when flies have little opportunity to contact the deposits before they attempt oviposition. The present trends indicate that dieldrin, parathion, and CS-708 will be the 3 most effective treatments.

<u>Field Tests on Mangoes</u> (Steiner, Morishita, Kinoshita)

Through the cooperation of D. T. Fleming and Baldwin Packers, Ltd., of Lahaina, Maui, the two largest and most suitable blocks of mangoes in the Hawaiian Islands were made available to us for tests of promising insecticide control programs. Suitability here refers to crop prospects, variety, distribution, accessibility to spray equipment, availability of adequate water, uniformity of tree size and planting distance, etc. Another very satisfactory orchard was made available through the cooperation of the Hawaiian Sugar Planters' Association Experiment Station. This was located at their Mapalehu Quarantine Station on Molokai at sea level directly across the channel from the Maui set-up. The close planting distance and large trees in parts of this orchard, however, prevented use of some areas because of inaccessibility to spray equipment. On both islands fruit began ripening in June. Since a long harvest season was in prospect and since pre-spray infestation data were needed as a basis for evaluation of the control programs, the first sprays were not started until June 30.

Mr. Kinoshita, with a temporary local assistant was stationed on Maui and was responsible for the thrice weekly sampling of all plots, and the screening of holding-box samples. Sprays were applied by Steiner and Morishita. The Molokai sprays were applied by Steiner or Morishita on stopovers from Maui, and samples taken there once weekly were air-freighted to Honolulu for holding. The Molokai tests required that about 4 to 6 man-days per month be spent on that island.

<u>Methods and Results on Maui</u>:--The arrangement of plots was on a restricted randomisation basis in the 2 Maui orchards, which were located about 1 mile apart. (see fig. 3) (Although applications of parathion were made to the pineapple adjacent to the larger orchard in April and October and of DDT in May no insecticides were used during the mango season). The individual plot replicates averaged 3 acres each. Because of the terrain and direction of shallow irrigation ditches (feeding each tree) the A and B replicates were irregular in shape. Locations were assigned by random drawing but as a result unsprayed plots 1A and 1B each adjoined the two parathion plots, and 1C was downwind from one. Each of the replicated unsprayed plots therefore adjoined a spray plot highly attractive to flies and one or two having strong fumigating action.

Sprays were applied with the Lawrence Aeromist (see fig. 4) on which we had installed a 4-gpm Bean high pressure pump as a replacement for the original gear types and smaller piston type previously used. The first application was made with the largest air outlet available. This failed to penetrate adequately due to insufficient air volume even when directed with the wind. Subsequent sprays were applied with the 11" outlet from one side of each row against the wind. This gave fair penetration and sufficient blow-back to get some deposition on the windward side of the fruit and foliage but is ill-suited for orchard use, particularly with mangoes. The heavy fruit, each hanging from a long stem, had to be very carefully sprayed to avoid breaking the stems. Some loss could not be avoided. However, since there was considerable drop in the unsprayed, the sprayer apparently only aggravated the wind loss and natural drop slightly. The outfit, if used again in mango plantings, should be equipped with a fishtail type air outlet. We were greatly indebted to Baldwin Packers for aid in making repairs on numerous occasions when breakdowns occurred. Without their immediate help a postponement of the sprays and disruption of sampling would have been unavoidable. Some of the mechanical difficulties encountered during the spray application were as follows:

Figure 3.--Plot arrangement--Maui mango experiments.
Variety: Haden

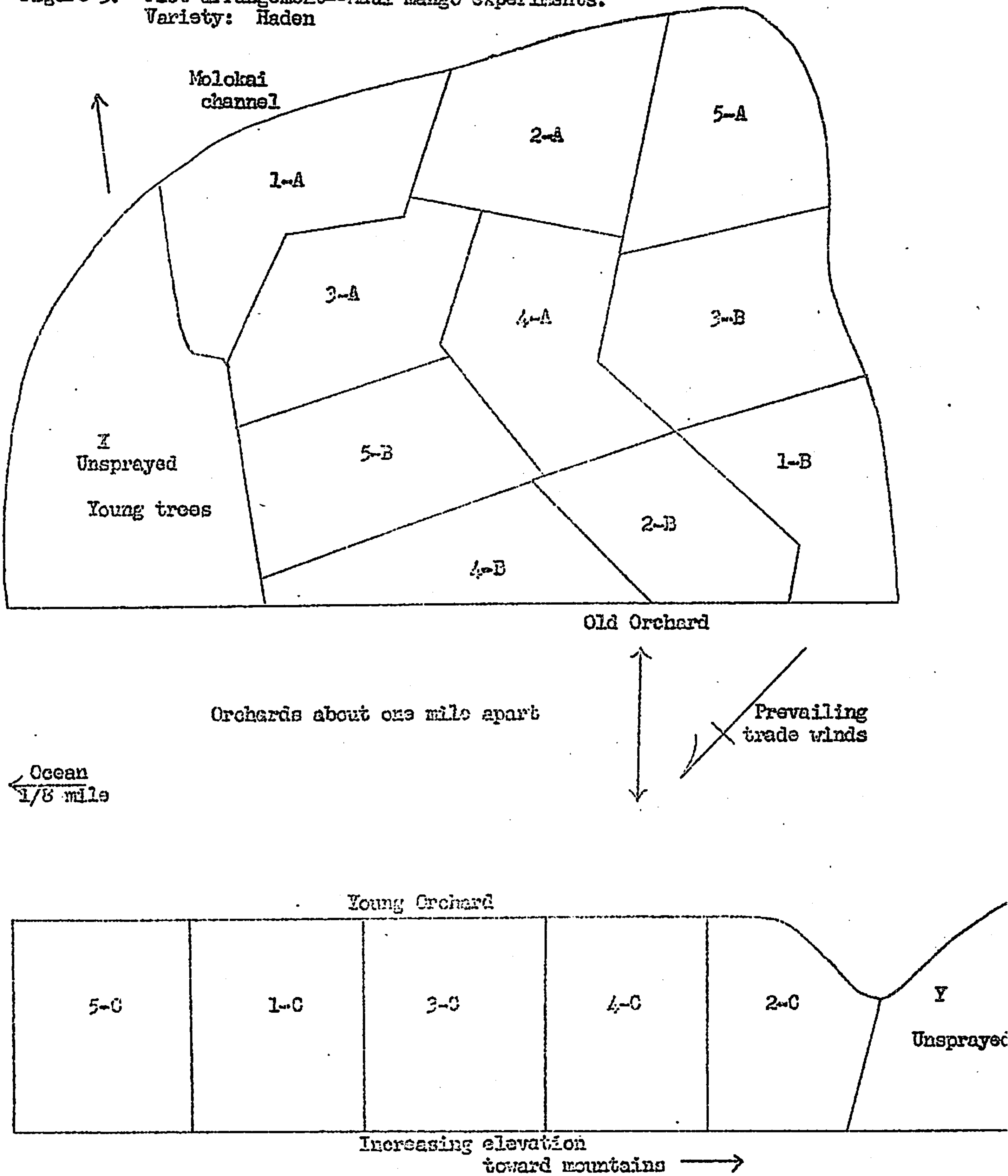


Figure 4.—Applying parathion spray with Lawrence Aeromist along north side of replicate A. Baldwin Packers orchards near Honolua, Maui.

Soft iron tank extremely subject to scaling which may have been aggravated by the concentrates used. Scale would let down and clog lines at unexpected times.

DDT-75 (1951 material) gummed valves, necessitating change to DDT-50. (Fresh 1952 material was held up because of the shipping strike.)

Tank-support welds broke, necessitating dumping nearly 50 gallons concentrate, removal of tank, rewelding and bracing of supports.

Cut-off valve snapped off. Operated with pliers at end of each row until substitute could be found.

Hose lines blew off on several occasions due to faulty pressure regulator and inappropriate type of hose couplings.

One of matched set of 6 drive belts broke. Replacement set slightly shorter necessitating use of cutting torch to permit shifting blower closer to engine.

Sprayer engine throttle cable broke necessitating continuous operation of the engine at full speed for balance of spray application.

One application had to be postponed a week when the truck's clutch facing broke loose and no replacement in the islands was available. This occurred after one treatment had been applied and again a full tank of material had to be dumped.

Although the rated capacity of the pump was 4 g.p.m. its maximum output of concentrate sprays was from 2 to 3.3 depending upon the mixtures used. Careful attention to rate of output was required in order to properly regulate truck speed and attain a uniform application rate among the treatments. Approximately 250 gallons of spray concentrate were applied to the 3 replicates (totalling 8.8 to 9.3 acres) per treatment. Total numbers of trees ranged from 480 in plot 2 to 513 in plot 3 hence the average application was 0.5 gallon per tree. The blower was oscillated vertically in passing to distribute the spray as uniformly as possible. About 20 hours were required per application to the 4 sprayed plots or roughly 35 minutes per acre.

Treatments selected for testing were all expected to be highly effective and the combinations of insecticides and application rates used were designed to control mites or prevent mite outbreaks as well as control the oriental fruit fly.

Since there was continuous ripening of fruit from June to October and since the fruit had to be picked 2 or 3 times weekly in order to avoid overripening, pickers often worked the plots within 24 hours after a spray application. The results of limited parathion analyses on picked fruit are reported under Line Project I-c-3-3 and indicate no serious danger from spray residues.

Sampling was restricted to picked fruit since we were limited as to personnel on Maui, and fallen mango fruits provide little reliable information on treatment effectiveness and have little if any commercial value. Only the Haden variety was used since no other single variety occurred in all plots. Few drops were present in the orchard until late in the season.

Two or three trees at each of 3 points within each replicate were marked to be left for us to pick. At first it was intended to sample once weekly and collect 3 samples from each replicate. Since mature fruit just breaking color was continuously being removed from the remaining trees by the orchard crew, weekly sampling on record trees would have permitted excessive ripening and concentrated the fly attack thereon. Consequently all mature fruit was removed from the record trees 3 times weekly and a random sample removed from the pooled collection from the 6 to 9 trees per replicate. The remaining fruit was turned over to the grower. The sample size varied from 12 to 20 fruit, depending upon their size. It was restricted to the maximum that could be held in one holding box. These samples were held over sand and the sand screened twice weekly. All fruit was opened after 4 weeks holding and trapped larvae or pupae recovered before the sample was discarded. To facilitate drainage of juice and escape of larvae to the sand the skin of all fruits was slit at two points on opposite sides when originally placed in the box.

Although the 3 pre-spray samples were collected at 5 to 6 day intervals the trees were cleaned of mature fruit by the orchard crew almost daily during that period and the samples obtained then averaged slightly less mature than those taken later after the picking crew understood the necessity for avoiding the record trees.

Treatments and spray application dates in the Maui tests were as follows:

Plot	Formulation	Pounds formulation per acre	Dates of spray applications			
			1	2[1/]	3[2/]	4[3/]
1	Unsprayed					
2	Parathion 25 W.P.	10	7/2	7/21	8/6	-
3	Parathion 25 W.P. Yeast hydrolysate Raw sugar } Bait spray	4 1 5	7/2	7/21-22	8/5-6	8/18
4	Dilan 80 LC Malathon 50 Em Triton B-1956	5 1.5 0.125	7/1	7/22	8/5	-
5	DDT 50 WP EPN -300	6 1.5	7/1	7/14	8/4-5	-

1/ An approximate 3-week interval for plots 2, 3, and 4 because of truck breakdown after treatment of Plot 5 on 7/14/52.
2/ An approximate 3-week interval for plot 5 and 2-week for plots 2, 3, and 4.
3/ Only plot 3 sprayed.

Table 8. Infestation data - Maui mango experiments. (Mean and maximum (red) number larvae per pound.)

Date	XY unsprayed		1 unsprayed		2 parathion		3 para.-bait		4 Dilan-Mala.		5 DDT-EPN		Inches rainfall 1/
6/19	-		2.48	7.46	17.50	30.0	14.30	21.46	1.41	4.02	5.26	8.69	-
6/24	-		0.08	0.24	2.32	4.64	1.58	3.16	8.26	21.65	0.98	1.96	0.44
6/30	5.08	8.82	1.08	1.81	0.18	0.55	3.72	8.21	4.79	9.32	2.08	5.57	0.71
7/1-2	Spray 1 - Plots 2, 3, 4, and 5. (Mean pre-spray index plots 1-5 = 4.40												0.09
7/7	0.98	1.95	0.19	0.57	0.11	0.32	0.34	1.02	0	0	0	0	0.57
7/9	15.74	29.58	0.07	0.10	0.25	0.57	0	0	0	0	0	0	0.36
7/11	6.34	10.97	1.48	4.43	0	0	0	0	1.41	2.50	1.11	2.29	0.23
7/14	3.30	6.59	2.27	6.82	1.04	2.47	0	0	0	0	0	0	0.05
7/14	Spray 2 - Plot 5 only												-
7/16	10.61	12.44	3.56	4.07	5.50	16.53	3.24	9.70	0.67	2.02	0.24	0.71	1.50
7/18	3.98	7.20	2.52	6.95	3.53	7.61	2.12	6.25	0.27	0.81	0	0	0.10
7/21	2.26	3.60	8.68	16.91	not sampled		not sampled		not sampled		0	0	0.01
7/21-22	Spray 2 - Plots 2, 3, and 4.												0.02
7/23	5.22	10.44	0.11	0.21	0	0	2.89	7.14	0	0	0	0	0.01
7/25	3.12	4.44	0.73	2.20	0.30	0.78	0	0	0	0	0	0	0.15
7/28	0.32	0.63	1.18	2.58	0.27	0.80	0	0	0	0	0.64	1.11	0.09
7/30	0	0	0	0	0	0	0	0	0	0	0	0	0.05
8/1	3.72	7.44	1.60	4.81	0	0	0	0	0.26	0.77	0	0	0.10
8/4	4.62	9.23	1.62	4.76	0	0	0.88	2.53	0.04	0.11	2.99	8.98	0.08
8/5-6	Spray 3 - Plots 2, 3, 4, and 5.												0
8/8	0.28	0.57	0	0	0.33	0.71	0.21	0.64	0	0	1.31	2.19	0.17
8/11	0.62	1.25	0	0	0.49	1.47	0	0	3.04	4.54	0.59	1.08	0.69
8/13	4.14	7.90	0.03	0.08	0	0	0	0	0	0	0	0	0.01
8/15	0	0	0.40	1.19	0	0	0	0	0	0	0	0	0
8/18	3.28	6.55	0	0	0	0	0.35	1.04	0	0	1.26	3.79	0.26
8/18	Spray 4 - Plot 3 only.												-
8/20	0	0	0	0	0.03	0.10	0	0	0	0	0	0	0.06
8/22	1.67	3.22	0.03	0.10	0.61	1.84	0	0	0	0	0	0	0.02
8/25	0	0	0	0	1.63	4.90	0.07	0.21	0	0	0	0	0.01
8/27	0	0	0	0	0.33	0.99	0	0	0.43	1.30	0	0	0.35
8/29	0	0	0	0	0	0	0	0	0	0	0	0	0
9/4	1.97	3.94	0	0	0.39	1.18	0.04	0.12	0	0	0	0	0.19
9/11	0	0	0.67	1.83	0.	0	0	0	0.24	0.73	0.59	1.76	0.36
9/19	0.24	0.48	1.40	3.90	0.49	1.47	0	0	0.29	0.44	0	0	0.20
9/25	0	0	0.60	1.80	2.14	6.33	0.30	0.89	0.41	0.69	0	0	0.17
9/25 drops	15.13	29.80	2.42	4.29	2.68	4.53	5.00	7.35	4.75	6.06	3.20	7.07	-

1/ Rainfall from company records in Honolua 1/4 mile from AB orchard. Data are accumulations between dates shown.

The mean plot infestations and the maximum among the replicates within each treatment are shown in table 8. Rainfall records are included. Except for a rain of 1.29 inches on July 15 all precipitation was in the form of light showers with measurable amounts on 26 days in July and 19 in August. The mean infestation, with all pre- and post-spray picked samples included was 0.69 larvae per pound in the A replicates, 0.78 in the B and 1.26 in the C. The 2C and 4C replicates located near the unsprayed area designated Y were apparently subject to more fly reinfestation than the other C plots. They averaged 2.04 and 1.53 larvae per pound. Unsprayed areas X and Y averaged 3.31 and 2.22 larvae per pound, each being sampled 28 times. The unsprayed areas X, below replications A and B, and Y above replication C, were close enough to the sprayed plots to be influenced by fumigation when wind direction permitted and by the leveling effect of interplot fly movement. The replicated plot 1 was so obviously affected by the sprays despite the large size of the replicates (3 acres) that it was useless for evaluating control.

Note that when the second spray had to be delayed on plots 2, 3, and 4, infestations began building up. Most of that in the July 23 sample was from eggs laid in the fruit prior to the July 21 and 22 sprays and should not be considered as an immediate post-spray infestation. Later, after discontinuance of all sprays there was a longer lag before the infestations began increasing. This was to be expected since most of the flies that were bred in the orchard prior to the first spray emerged before the second and third and were killed by these if they remained in the orchard. Thereafter the infestation increase had to come largely from flies migrating to the orchard rather than partly from flies bred therein since nearly 75 per cent of the crop produced in the two orchards was in the sprayed portions.

The most valid available estimate of effectiveness, though it is likely to be conservative, is a measure of the infestation change from the mean pre-spray level. Mean data for various time intervals after each of the first 3 sprays are compared in table 9 against the pre-spray mean of 4.4 larvae per pound.

Table 9. Mean infestation and its per cent change from pre-spray level of 4.4 larvae per pound.

Days after spraying	PLOT XY unsprayed	1 unsprayed	2 para.	3 para-bait	4 Dilan-Mal.	5 DDT-EPN
2-4	1.70 -61.4	0.36 -91.8	0.32 [illegible]	0.10 -97.7	0 -100	0.52 -88.2
5-7	1.52 -65.5	0.35 -92.0	0.22 [illegible]	0.08 [illegible]	0.61 -86.1	-.15 -96.6
8-10	5.52 +25.4	0.49 [illegible]	0.06 [illegible]	0 -100	0.42 [illegible]	0.28 93.6
11-14	3.73 -15.2	1.37 [illegible]	0.26 [illegible]	0.41 [illegible]	0.13 [illegible]	0.48 -89.1
15-18[1]	7.30 +65.9	3.04 -30.9	4.52 [illegible]	2.68 [illegible]	0.09 [illegible]	0 -100
Mean 2-14 days	3.12 -29.0	0.64 -85.5	0.22 -95.0	0.15 -96.6	0.30 - 93.2	0.36 -91.8

1/ Represented by 2 of the 3 periods.

These data show but little differences among the treatments. Infestations in the replicated unsprayed plot 1 were reduced an average of 85.5 per cent during the first 2 weeks after each of the 3 sprays from the general pre-spray level implying that good fly control in blocks of up to 3 acres could be obtained by using parathion sprays on larger acreages surrounding them.

The performance of the bait spray (96.6 per cent) was excellent considering that it has generally failed on smaller acreages apparently because of its attraction to flies in adjoining plots, and in this instance it had 9 acres of unsprayed plots adjacent to the areas on which it was used. Without the bait (plot 2) the parathion had to be increased to 3.5 times the strength of that in the bait spray. The Dilan (CS-708) plus malathion was the most suitable formulation for concentrate use (being an emulsion) and left almost no visible residue. Its location between or adjacent to the bait-spray plots undoubtedly favored it. Although the DDT-EPN appeared least effective during the first 2 weeks after the sprays, both it and the Dilan-malathon formula were more effective during the third week, probably because DDT and Dilan retained more residual action at that time than parathion.

These data do not indicate what per cent of the fruit was infested. In limited studies of individual fruit infestations a mean of 5 larvae per pound has occurred where 30 to 40 per cent of the fruit was infested. The fruit in these experiments averaged about 0.7 lb. each. An index of 0.15 (the mean for plot 3) would be equivalent to 1 larvae per 10 fruit or not less than 90 per cent clean fruit. Actually, if the samples taken on July 16, 18, and 23 are excluded there were 1,102 picked mangoes held from plot 3 on 23 sampling dates--from July 7 to September 25. A total of 60 larvae were reared from less than 52 of these fruits, assuming 1 larva per infested fruit in those samples having more fruit than larvae. Thus at least 95.3 per cent of the fruit sampled from plot 3 during the 2 weeks after each spray plus 3 additional weeks after the fourth produced no larvae. Before the first spray 287 larvae were reared from not more than 62 of 83 mangoes held from this plot. Mean infestations based on total fruit averaged 346 larvae per 100 mangoes from plot 3 before spraying and only 5 per 100 thereafter. Although data giving the percentages of fly-free fruit would be needed to determine the actual profit derived from spraying, such data are not essential to tests designed to compare treatment effectiveness and would be much more costly to obtain. It is impossible to accurately identify all successful oviposition attempts without cutting. It is also impossible to ascertain how many different flies laid eggs in the same site. This may be considerable in some situations. The cost of mangoes at 1952 prices would have averaged 10 cents each at the 50 per cent discount price (12.5 cents a pound) allowed us. More than 4,600 lbs. of fruit, or about 3.2 per cent of the crop was purchased and held for emergence in these tests.

Mango infestations elsewhere on Maui were high. A picked random sample of 22 fruit weighing 13.5 lbs. and of the same variety and stage of ripeness sampled in the experimental plots was collected in an unsprayed commercial Haden orchard at Pauwela on September 11. They yielded 567 larvae or 42 per pound. Similar picked fruit samples taken by Mr. Miyabara from that orchard on August 11 and 18 averaged 15 and 26 larvae per pound respectively. Mr. Miyabara also reports that dorsalis infestations in sandalwood fruit near the spray plots averaged around 200 per pound during the period of these experiments.

The spray formulas as applied to plots 2, 3, and 5 cost as follows on a per acre/application basis:

Plot 2 -	Parathion 25 WP	10 lbs.	$6.40
Plot 3 -	(Protein hydrolysate	1 lb.	$2.00
	(Parathion 25 WP	4 lbs.	2.56
	(Raw sugar	5 lbs.	.40
			$4.96
Plot 5 -	DDT 50 WP	6 lbs.	$3.60
	EPN - 300	1.5 lb.	1.88
			$5.48

The bait-spray formula applied 4 times cost approximately $20.00 per acre for materials and required 4 man hours and 2 hours use of equipment during the 11 weeks when more than 95 per cent of the fruit was fly-free. Production during this period in this plot was approximately 3,000 lbs. of picked mangoes per acre. Spray costs with the bait-spray formula therefore averaged 1 cent per pound, or $30 per acre for a crop bringing approximately $750 per acre at the orchard. Retail prices of the poor quality Pauwela mangoes on the Hilo market at the time orchard run samples averaged 42 larvae per pound was 27¢ a pound. At Mapelehu mangoes were selling at 25-35¢. On Honolulu markets Hadens of the quality produced in the Fleming orchards were never seen priced below 35¢ and were as high as 65¢ in July.

Glass invaginated traps were installed June 17 and operated throughout the season. They were initially baited with 2 ml. methyl eugenol on a 2" dental roll inside 3/16" I.D. glass tube open at one end with the opposite end imbedded in cork. With only a 3/16" diameter surface exposed this type trap (as reported after 1951 tests) was only 1/10 as attractive as the same amount of methyl eugenol fully exposed. To insure uniformity 1 ml. methyl eugenol was added to each trap July 23 and September 8. A single trap was used near the center of each replicate. Mean male oriental fruit fly catches per trap day for periods ending on the indicated dates are summarised in table 10.

Prior to the first spray the traps in plots 2 and 4 caught the most flies and those in plot 1 the least. While methyl eugenol may have pulled flies from outside the orchard directly to the traps without their contacting any spray deposits, the catches during the early part of the periods following each spray were generally much lower than before the sprays. The catches in plot 1 indicated after almost every spray that its fly population was reduced by the applications made to other plots.

Table 10. Male dorsalis captured per trap day during intervening periods ending on indicated dates.

Plot	Date of examination and number flies per trap per day																				
	6/19	6/23	6/25	7/2	7/8	7/10	7/16	7/23	7/25	7/28	8/1	8/4	8/7	8/11	8/15	8/20	8/22	8/25	8/29	9/8	9/18	9/24
X.	-	-	-	-	Installed July 31				-	-	-	47	15	37	18	11	10	10	3	7	13	5
Y	-	-	-	-		"	"	"	-	-	-	371	185	142	281	371	119	253	346	90	328	120
1	69	9	14	23	16	27	83	12	10	8	20	62	9	4	8	7	5	4	4	7	9	5
2	195	76	75	80	20	32	47	19	6	6	20	65	11	2	6	4	10	7	5	30	54	25
3	85	19	12	25	7	27	64	47	4	6	13	60	6	3	7	4	2	4	4	10	5	6
4	174	26	32	46	9	21	83	32	3	3	9	23	2	3	4	5	3	4	4	12	6	10
5	110	19	17	17	6	7	16	6	6	3	10	25	4	2	6	3	2	2	5	7	5	7

X = Unsprayed downwind from A and B replicates.
Y = Unsprayed upwind from 20.
1 = Unsprayed replicated.
2 = Parathion.
3 = Parathion bait-spray.
4 = Dilan-Malathon.
5 = DDT-EPN.

Parasitization, Maui:--Parasitization was largely by O. oophilus. It averaged as follows:

Period	Plot and percent parasitization[1/]					
	XX	1	2	3	4	5
Pre-spray	--	40	21	17	39	29
July 7-Aug. 29	26	13	12	21	0	6
Sept. 4-25	6	0	20	2	5	0

1/ Derived from pooled emergence data from all samples.

While the sprays used are unquestionably toxic to parasites hit at time of spraying they have less residual action than they do against fruit flies. The decline in parasitization after spraying started may have resulted from the lower population level or may have been seasonal. There was some indication as in previous field experiments that the DDT and Dilan treatments were more deleterious than parathion.

Relative Mite Abundance and Damage.--No noticeable mite infestation developed to a degree where differences were conspicuous or damage was of any consequence. However, on August 19-20, 2 weeks after the 3rd spray, a survey was made in the younger of the two orchards where the "C" replication was located.

The method was to examine 5 terminals from 5 to 8 feet above ground distributed evenly around each of 16 trees in each plot. The terminals used on half the trees were of new growth and on the others of old growth that had not developed further since the first spray application. Some leaves remain on mango trees for more than 12 months so that mite damage on such leaves may be up to a year old. Trees used were distributed in 2 rows extending diagonally across each plot with border trees avoided.

A hand lens was used in making the estimates of mite abundance. Both damage and abundance were arbitrarily divided into 4 categories as follows:

- O = None.
- L = Light damage or population.
- M = Moderate damage or population.
- S = Severe damage or population abundant enough to quickly cause severe damage if not checked.

The principal mite involved was Paratetranychus insularis, McG.

The results are tabulated below as number of terminals affected among 40 of each age group examined per plot.

Plot	Mite damage								Mite abundance							
	New Growth				Old Growth				New Growth				Old Growth			
	O	L	M	S	O	L	M	S	O	L	M	S	O	L	M	S
1 - Check		4	0	0		17	12	0		7	0	0		19	2	0
2 - Parathion		0	0	0		5	0	0		0	0	0		0	0	0
3 - Parathion		0	0	0		15	1	0		1	0	0		6	0	0
4 - Dilan-Malathon		0	0	0		18	5	2		0	0	0		3	0	0
5 - DDT-EPN		14	0	0		18	14	1		25	0	0		19	8	1

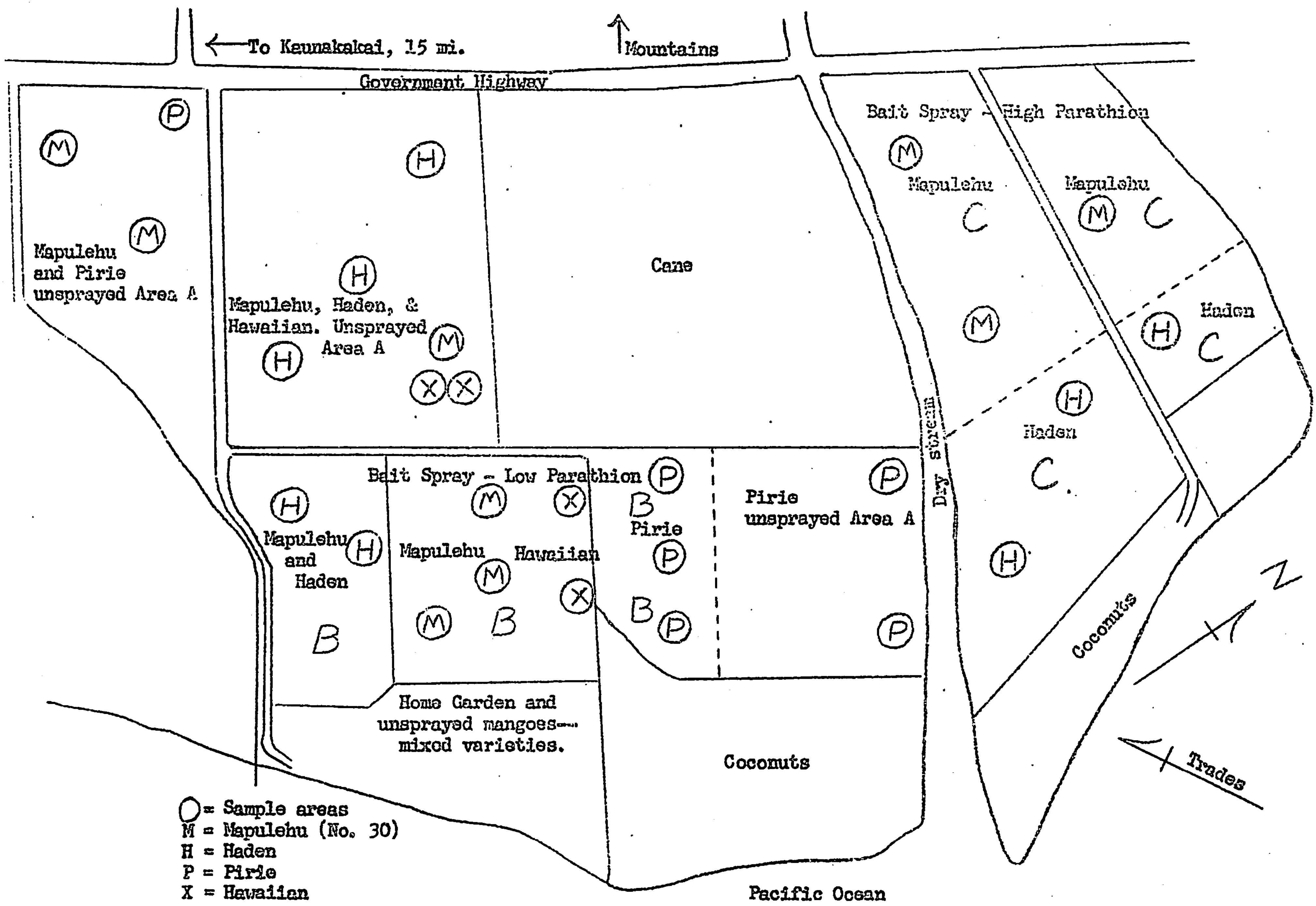
In 1951, in the Molokai tests, DDT and Dilan plots contained rather heavy mite infestations as did the unsprayed. In the 1952 tests mites were scarce on Molokai but as evident above there were treatment differences on Maui. The scarcity of injury on the old foliage of plot 2 indicates that most of that observed on the other plots occurred this summer. The full-strength parathion (2.5 lbs. toxicant per acre) effectively held mites to the lowest level. The 1 lb. per acre concentration applied to plot 3 as part of the bait spray, controlled mites on new growth. The malathon on plot 4 was also effective on new growth. EPN as used on plot 5 failed to offset the adverse effect of the DDT, and mites became more abundant than on the unsprayed plot. When applied as a concentrate from one side of the tree, at the rate of only 1/2 gallon spray per tree, it is obvious that many mites can escape direct contact for long periods. It is quite probable that much of the effect was from fumigation. EPN was used at too low a concentration to be effective in this manner.

Methods and Results on Molokai:--On Molokai the plots in the HSPA orchards at Mapulehu were not replicated since tests on areas larger than 3 acres were needed, the varietal distribution in accessible parts of the orchard did not permit replication and the experiment had to be set up so it could be sampled and sprayed by 1 person in one day to avoid interference with the Maui tests.

The plot distribution is shown in figure 5. Trees in unsprayed areas A have attained so much growth that the branches interlace in many places and penetration by the spray truck was rendered impossible. This was also true of the ocean side of the C area and of the Hawaiian mango area in B. Such areas within the B and C blocks, however, were narrow enough to permit spraying the trees directly from one side or drifting spray downwind over the trees.

The crop was more spotty on Molokai than Maui except on the Mapulehu variety (also known as Joe Welsh and No. 30). This variety attains a larger size than Haden, is lighter in color and somewhat more susceptible to fly attack. The Pirie variety, present only in the A and B areas, is very susceptible but bore a light, very scattered crop. The Hawaiian mango crop was heavy but was concentrated on only a few trees. The fruit of this variety averaged about 3 to 4 per pound compared to from 1 to 2 of Haden or Mapulehu.

Figure 5.--Plot Arrangement--Molokai, H.S.P.A. Quarantine Station.



Full holding-box samples of approximately quarter-ripe fruit were picked once weekly at random from within 3 representative areas of the Haden and Mapulehu blocks in each of the 3 treatment areas. Piries were sampled when available from 3 locations in each of the A and B plots. Hawaiian mangoes were taken from 2 points in each of these plots. Sample-size generally ranged from 12 to 15 Mapulehu to 20 to 25 Hawaiian.

Sprays were applied with the COE truck-mounted Hardie sprayer equipped with a Hurst Aqua-Jet Boom which relied entirely on pressure and volume for propulsion of the spray . (See fig. 6) Controls were arranged to permit manipulation by the truck driver. Since both treatments were bait-sprays, thorough coverage was unnecessary, however, coverage was decidedly superior to that obtained with the aeromist on Maui. The rate of output from the six nozzles was 16 g.p.m. at a pressure of 500 lb. p.s.i. and the rate of application 100 gal. per acre or about 1.4 gal. per tree.

The following treatments were each applied 3 times at 2-week intervals (July 3, 18, and 31).

Area	Acreage	Pounds formulation per acre (or per 100 gallons)
A	Unsprayed	
B	6.5	Yeast hydrolysate 1 + Raw sugar 5 + Parathion 25 WP 2
C	7.0	" " 1 + " " 5 + " " " 8

The bait sprays were tested at concentrations stronger by 2 times and another weaker by half than that applied to Plot 3 on Maui. Our preliminary tests indicated that too much parathion would reduce attraction and field tests were needed to determine if the larger amounts would offset loss of attraction by increasing residual toxicity or kill by fumigation. As used, the B and C sprays cost $3.68 and $7.52 per acre per application for materials and required about 7 minutes spraying time. The water situation at Mapulehu, however, was such that nearly 4 hours was required to draw the 1300-1400 gal. needed to spray the two plots. Fruit sampling was in all cases done before the sample areas were sprayed. Methyl eugenol baited traps of the type used on Maui were located at 3 points within each sprayed plot and 4 in the unsprayed. Trap catches are given in table 11.

Table 11. Male *dorsalis* catches during periods ending on the dates indicated. Molokai, 1952.

	Date of examination and mean number flies per trap day										
Area	6/20	6/27	7/3	7/10	7/17	7/24	7/31	8/7	8/14	no record	8/29-9/5
A	415	70	196	69	103	84	89	82	70		49
Ave.			185	86		86		76			
B	332	69	200	24	41	6	18	20	23		38
Ave.			167	33		12		22			
C	486	116	228	16	40	14	48	26	34		20
Ave.			229	28		31		30			
	Spray		1			2		3			

Figure 6. Applying parathion bait-spray at a rate of 16 gallons per minute and 6 1/2 minutes per acre to mango trees in HSPA orchards on Molokai. July, 1952.

The bait sprays cannot compete with methyl eugenol for male flies. Any male in or near the plots would most likely go directly to a methyl eugenol trap before contacting any bait-spray residue.

Since the male catches in the A (unsprayed) blocks fell off immediately after the first spray and thereafter remained fairly uniform it was concluded that the more than 50 per cent decline resulted from the sprays applied to the B and C plots. This has happened so often in field tests that it cannot be considered a coincidence. The A plots were located downwind from the B and C areas and since we are getting increasing evidence that even small amounts of fresh bait spray may attract flies from up to 100 yards it is probable that mass applications would attract from much farther. At any rate a substantial portion of the fly population in the A area nearest B could be killed by fumigation on the day of application. As in the Maui experiments, reductions in infestations from the pre-spray level therefore appear more valid for use in estimating degree of control than are comparisons with the unsprayed. In table 12 it will be noted that, in general, there was more variation on different dates within plots than between, hence, a mean of all pre-spray data for each separate variety was used.

The average per cent control indicated by this method among Mapulehu, Haden, and Pirie in Plot B ranged from 88.3 to 98.1 and was 96.0 and 99.3 per cent for the two varieties in the C area. Most of the July 17 and August 15 infestation on the Mapulehu variety in Plot B or 87 per cent of all found from July 10 to August 15 inclusive was from the sample area nearest the south corner of the plot. The excellent performance of the B formula on both Pirie and Hawaiian mangoes, farther from the possible influence of fly migration from unsprayed hosts, raises serious doubt as to whether the heavy parathion formula (C) would have any advantage over the weaker (B) if applied to areas less subject to reinfestation.

Parasitism on Molokai, as in the Maui tests, was largely by O. oophilus although an occasional sample yielded up to 50 per cent O. longicaudatus. The data, based on total emergence from all samples were as follows:

	Per cent parasitization		
	A	B	C
Pre-spray	38	27	34
During spray periods (7/4-8/15)	26	17	38
After August 15	6	5	13

Again there was no evidence that the bait sprays substantially depressed parasitization.

To obtain complete control of dorsalis in commercial mango plantings such as on Maui and Molokai it appears certain that where the sprays cannot be applied to non-isolated areas larger than 3 acres a somewhat higher concentration than used in these tests may be necessary. Where preferred resting or collecting places for flies adjoin, such as windbreaks or forested areas, the application of some insecticide on the nearest of such vegetation would be helpful, especially

Table 12.--Mean larvae per pound in Molokai mango samples.

Date	Spray number	Variety: Mapulehu			Haden			Pirie		Hawaiian	
		A	B	C	A	B	C	A	B	A	B
6/19	Pre-spray	6.13	9.23	15.90	12.75	0	15.71	3.51	25.54	Immature	
6/27	"	2.55	5.65	2.47	0.29	2.44	9.48	21.50	15.54		
7/3	"	0.20	4.00	0.90	2.13	3.26	3.01	10.71	22.36		
7/3	1										
7/10		0	0.21	0.43	9.63	0	0	9.38	0	3.63	0.80
7/17		1.95	2.11	0.67	0.42	1.82	0.15	1.45	1.25	3.88	0
7/18	2										
7/25		1.03	0	0.14	1.92	0	0.03	3.48	0.33	1.75	0
7/31		1.49	0	0	0	0	0	6.06	0	2.00	0
7/31	3										
8/8		2.93	0	0	0.08	0	0	2.66	-	7.60	0
8/15		5.37	0.28	0	0.08	2.03	0.04	18.01	0	18.00	-
8/22	Post-spray	0.22	0	0	0.70	1.25	2.47	0.24	-	-	-
8/28		0	0.26	0.72	0	0	1.75	-	-	-	-
9/5	(5 samples per plot)	2.16	3.81	4.19	-	-	-	-	-	-	-
Mean	Pre-spray (ABC)	5.23			5.45			16.53		--	
Mean	1 and 2 weeks after spraying	2.13	0.43	0.21	2.02	0.64	0.04	6.84	0.32	6.18	0.16
Per cent change from pre-spray mean		-59.3	-91.8	-96.0	-62.9	-88.3	-99.3	-58.6	-98.1	---	-
Per cent control (Based on A plots)		0	79.8	90.1	0	68.3	98.0	0	95.3	0	97.4

if parathion or EPN were used. If sprays such as parathion are applied at 2-week intervals early in the harvest period and supplemented with DDT or Dilan, the intervals between sprays could be lengthened to 3 weeks after those flies present in fruit or pupating in the soil at the time of the first spray have completed emergence. A shift to more DDT or Dilan and less parathion should also be possible. If the bait spray is used with the parathion at a low level it would seem advisable to hold the spray intervals to two weeks.

It should be easy for any grower to determine if or when a spray is needed by looking for flies on maturing fruit. At the low infestation levels attained in August, flies were rarely seen on fruit.

The failure of the replicated check plots to provide reliable information indicates that these might as well be omitted from further tests on mangoes and that more experiments utilizing the full available acreage for single spray programs should be set up, using the pre-spray and post-spray infestations as bases for comparison along with any available population data from fly hosts reasonably close but out of range of the effect of the treatment.

Large-Scale Tests of Methyl Eugenol-Poison Bait Stations for Control of *Dacus dorsalis*. (L. F. Steiner and R. Lee)

Ookala, Hawaii (Hamakua Coast)

This experiment was initiated in January, 1952, and the locale, methods and early guava infestations were reported in the last two quarterly reports (Jan.-Mar. 1952, pp. 132-138 and Apr.-June 1952, pp. 133-135).

The 175 canec feeding stations have been increased to 180 by the addition of several to increase effectiveness at the 300-ft. level near the edge of the coastal pali. Although it was intended to apply 25 cc. of the 3 per cent G-22008 in methyl eugenol to each station at monthly intervals, the amount used averaged nearer 30 cc. It was applied with pump-type oilers to both sides when dry, but if water-logged from rains, to whatever portions would most readily absorb the required amount.

The treated area, as previously indicated, includes all hosts within 6 square miles of coastal cane fields, villages, and gulches extending up to the forest line 2 1/2 to 3 miles inland at 2100' elevation on the north slope of Mauna Kea. The experiment centers around the town of Ookala and Kaula gulch. Adjacent gulches to 1 mile north and 1 1/2 miles south of Kaula are included in the treated area so as to intercept incoming males and provide a well-protected central area for evaluation purposes. Infestation indices are obtained at 5 elevations plus or minus 150 ft. in Kaula and also in comparable untreated gulches 2 to 3 miles northwest and the same southeast of the treated area. The elevations of 300, 700, 1100, 1500, and 1900 ft. are each represented by 2 samples of 50 fruits (when available). Only guava was sampled since other hosts are not sufficiently well distributed for use. During the early fruiting period when fruit was extra large some samples had to be limited to 40 fruits weighing about 10 lbs. Fifty-fruit samples usually weigh 6 to 8 lbs. Both rim and bottom locations in gulches are represented in sampling, wherever possible.

The feeding stations are distributed about 12 per mile on the windward (when accessible) side of 12-14 miles of gulch rim of which about 9 miles must be walked when servicing the stations. Thirty-seven of the stations have funnel traps underneath to provide estimates of comparative fly abundance, although many flies die outside because of being disturbed or blown off before they drop paralyzed.

Recent observations after 30 days' weathering indicate that the G-22008 causes paralysis within 75 seconds after a fly starts feeding. Tests on hundreds of flies paralyzed by month-old deposits indicate that death within 2 to 3 hours is certain. Rains of ordinary amounts and duration (up to 10 inches per month) help more than hinder effectiveness by forcing more of the absorbed solution to the surface. Male flies are attracted and feed regardless of rainfall unless it is driving enough to wash them off.

Monthly records of rainfall and temperature means since January are given in table 13. The 900' records were from near the north and south extremities of the treated area; the 450' and 1790' were near the rim of Kaula gulch.

Table 13.—Meteorological Records - Kaiwiki Sugar Co., Ookala, Hawaii.
(Temperatures read on weekdays only—21-22 per month.)

Month	Total Inches Rainfall				Mean temperatures			
	900'		1790'	450'	1790'		450'	
	South	North	Kaula	Kaula	Max.	Min.	Max.	Min.
January	12.01	11.39	15.02	10.15	70	57	75	64
February	13.02	9.06	20.01	8.36	69	56	75	63
March	21.60	19.92	32.84	16.94	70	57	76	63
Totals	46.63	40.37	67.87	35.45				
April	13.27	11.23	12.64	10.96	69	56	77	64
May	16.87	14.46	20.22	12.98	69	58	77	65
June	6.66	4.83	5.59	5.28	68	60	75	60
Totals	36.80	30.52	38.45	29.22				
July	10.01	8.92	11.84	7.05	72	63	79	68
August	7.53	6.45	9.01	6.27	69	62	76	68
September	3.68	2.60	3.68	3.27	74	65	77	65
Totals	21.22	17.97	24.53	16.59				

The past quarter has had less rainfall than either of the previous quarters. Temperatures at 1790' averaged about 5° higher than in the first quarter while at 450' the increase was only about 3°. These records are significant when considered in connection with the changing distribution of *dorsalis*, *capitata*, and *oophilus*. Both *dorsalis* and *oophilus* were present at 1500 and 1900 ft. (as well as lower down) in February, March, and April. *Dorsalis* was replaced by *capitata* at the higher elevations as warmer, drier weather came on but *dorsalis* built up at 300 ft. particularly in April and May. In this region two factors would tend to cause larger infestations at the 300' level than higher up. These are (1) the terrain above, which slopes directly down toward sunnier, warmer areas, and (2) the ocean below the 300' pali which would cause flies coming down from above to stop and accumulate at the ocean barrier. Whether virgin females came down in search of males is unknown but it appears that *dorsalis* "drained" down into the lowest portion of Kaula leaving *capitata* to increase to higher levels than it was able to do in the control areas where more *dorsalis* remained at most elevations. It is the writer's opinion that we are still underestimating the capacity of *dorsalis* to travel long distances as well as its inclination to do so particularly during the preoviposition period.

Infestation data for the summer crop, which started to ripen late in July, are summarised in table 14 for all guava collections from which emergence was completed prior to late October. Guava production reached its peak Oct. 1.

Table 14.—Infestation means for ripe guava samples collected at each site on five dates during the first half of the summer crop season. (*Dorsalis* (D) and *capitata* (C) larvae per pound.) Hamakua coast of Hawaii, 1952.

Area	Period	Elevation and larvae per pound (D=*dorsalis*, C=*capitata*)											
		300'		700'		1100'		1500'		1900'		Mean	
		D	C	D	C	D	C	D	C	D	C	D	C
Kaula treated	5/6-6/3 1/	81.8	0.3	3.7	0.3	1.4 3/	8.0	0.8	7.6	0.4 3/	9.1	17.6	6.7
	July 30	51.2	0	2.7	2.7	0.3	16.3	0	36.7	–	–	13.6	13.9
	Aug. 15	11.9	0	0.6	3.3	0.9 3/	14.5	0	0	0	0	2.7	3.7
	Aug. 26	3.1	0.1	3.0	5.1	0.4	12.9	0	0.7	0	17.5	1.3	7.3
	Sept. 4	5.5	0	0	3.6	2.0	4.7	0	5.3	0	0	1.5	2.7
	Sept. 16	3.3	0	0	0.7	1.7 3/	3.9	0.1 3/	1.9	0	0	1.0	1.5
	Mean 7/30-9/16	15.0	0.02	1.3	3.2	1.1	10.5	0.02	8.9	0	4.4	4.0	5.8
Mean of NW and SE Controls	5/6-6/3 1/	34.3	1.6	29.8	1.6	4.5	1.6	1.0	3.0	0.2	0.3	14.0	1.6
	July 30	34.6	1.4	73.4	4.2	8.8	2.2	0.6 3/	14.0	0	18.1	29.4 2/	5.6 2/
	Aug. 15	26.4	0.6	17.2	0.6	3.2	2.8	2.7	1.7	0	17.4	9.9	4.6
	Aug. 26	14.0	0.6	10.0	0.3	1.4	2.5	1.4	5.9	0	15.2	5.4	4.9
	Sept. 4	19.0	0.1	4.4	0.2	0.4	1.2	4.8	2.3	0.1 3/	8.8	5.7	2.5
	Sept. 16	15.0	0	2.6	0	0	1.5	0.2 2/	3.2	0	18.5	3.6	4.8
	Mean 7/30-9/16	21.8	0.5	21.5	1.1	2.8	2.0	1.9	5.7	0.02	15.6	10.8	4.5
Per cent increase or decrease in Kaula compared to Controls													
	5/6-6/3 1/	+138	-81	-88	+[illegible]	-69	+400	-20	+153	+100	+2000	+26	+319
	July 30	+48	-100	-96	-36	-97	+641	-100	-1[illegible]	–	–	-54	+148
	Aug. 15	-55	-100	-97	+[illegible]	-72	+[illegible]	-100	-100	–	-100	-73	-20
	Aug. 26	-78	-83	-70	+1600	-71	+416	-100	-88	–	+15	-76	+49
	Sept. 4	-71	-100	-100	+1700	+400	+292	-100	+130	-100	-100	-74	-7
	Sept. 16	-78	--	-100	?	+ ?	+160	-50	-50	–	-100	-72	-69
Differences based on mean infestations for period													
	July 30 to Sept. 16	-31	-96	-94	+191	-61	+425	-99	+56	–	-72	-63	

1/ This period included samples on May 6, 19, and June 3 representing in most instances the last of the spring crop. The summer crop began ripening in July at most elevations.

2/ 1900' elevation data excluded from mean since there was no production in Kaula on this date.

3/ 100 per cent *oophilus*—considered as *dorsalis*.

Mean fruit abundance indices for all sample areas in Kaula gulch started at 1, July 30, and increased gradually to 5.1, Oct. 1. In the northwest sample areas it increased from 1.1 to 6.2 and in the southeast from 0.8 to 6.0. Fruit abundance as previously indicated is keyed as follows:

0 = No ripe fruit.
2 = Ripe fruit found only by searching.
4 = Ripe fruit found without searching - light crop.
6 = Ripe fruit moderately abundant on most trees or heavy on scattered trees.
8 = Ripe fruit abundant on nearly all trees - heavy crop.

Part of the decline in infestation (table 14) that occurred in untreated as well as treated areas was a result of population dilution by the increased guava production. However, fruit availability was consistently greater in the untreated than treated so that the lower _dorsalis_ indices in the latter can be attributed to treatment effects.

In the treated area at 300' _dorsalis_ infestations dropped from 82 per pound in May to an average of 4 in September. In the untreated areas the means of samples from four 300' locations declined from 34 to about 17 per pound during the same period.

At 700' in Kaula the September infestation by _dorsalis_ was zero but averaged 3.5 in the controls. In Kaula at 700' no _dorsalis_ emerged after July 30 from one sample area and none after August 26 from the other, although _capitata_ alone or with _oophilus_ were recovered. It is considered significant that in September emergence was exclusively _capitata_ after high parasitization (of _dorsalis_?) in August. (Parasites again appeared in October.) This is taken as additional important evidence that _oophilus_ does not parasitize _capitata_ in guava under natural conditions except by accident and perhaps only in the presence of _dorsalis_ eggs or larvae. Two of the 4 September samples were 100 per cent clean, the others yielded 7.3 and 1.3 _capitata_ per pound. At 700' in the northwest controls there were no _capitata_ reared in September and _oophilus_ parasitization ranged from 66 to 80 per cent. In the southeast area at 700' _capitata_ at 0.5 per pound infested only 1 of the 4 September samples and parasitization of _dorsalis_ ranged from 67 to 100 per cent.

In Kaula at 1100 ft., rearings after September 4 were exclusively _capitata_ and _oophilus_. From May 19 to Sept. 16, inclusive, 14 samples at this elevation totaling about 400 guava yielded 5 _dorsalis_, 105 _oophilus_, and 721 _capitata_ from 903 puparia (92 per cent emergence).

At 1500' only one _oophilus_ and no _dorsalis_ were reared from July 30 to September 16, inclusive. At this elevation in both control areas all three insects were present. If we mistakenly attribute all _oophilus_ to _dorsalis_ when some actually developed from _capitata_, our data should show a positive correlation between high _capitata_ infestations and high indicated _dorsalis_ parasitization. This does not exist. Among the paired sample areas the highest _capitata_ infestation is associated less frequently with the highest per cent parasitization of supposed _dorsalis_ than with the lowest.

The evidence strongly indicates that the reduced competition in Kaula gulch from dorsalis has permitted capitata to increase, that high parasitization of dorsalis is a result of the reduced dorsalis population rather than the cause of it and that the methyl eugenol treatment is definitely effecting control which, if accidental parasitization of capitata could be measured, would be better than the figures now indicate.

Total puparia recovered and the species emerging from all samples taken at each elevation during the period from July 30 to September 16, inclusive, follow:

AREA		300'	700'	1100'	1500'	1900'	1900' Mar.-Apr.
Kaula - Treated	Puparia	807	320	864	87	7	105
	Dorsalis	306	38	5	0	0	27
	Oophilus	281	34	80	1	0	43
	Capitata	1	213	690	67	7	15
N. W. Control	Puparia	1876	2096	280	484	604	52
	Dorsalis	532	363	61	85	0	7
	Oophilus	949	576	93	39	1	12
	Capitata	44	34	92	256	457	16
S. E. Control	Puparia	1273	956	148	98	19	178
	Dorsalis	393	246	26	18	0	89
	Oophilus	440	476	1	3	0	41
	Capitata	1	34	103	59	16	4

These data show that dorsalis outnumbered oophilus at 300 and 700 ft. in the treated area but not in either of the controls suggesting that where there were more parasites emerging above 300 and 700 feet they, as well as dorsalis, may have tended to drain down the gulch to the warmer, sunnier 300 and 700' levels and there parasitise a higher percentage of dorsalis than in Kaula where there were plenty of capitata at 1100 ft. but few dorsalis to produce parasites. If oophilus parasitizes capitata a pertinent question here is, why the low oophilus emergence compared to capitata at 1900 ft. where earlier in the year when dorsalis was present at that level oophilus was also. For example, emergence from the March and April 1900' collections in the S. E. control area was 89 dorsalis, 41 oophilus, and only 4 capitata. During the same period emergence from the 1900' samples from the NW controls totaled 7 dorsalis, 12 oophilus, and 16 capitata, while Kaula samples from 1900' produced 27 dorsalis, 43 oophilus, and 15 capitata.

Fly mortality in the area, if based on catches in record traps, totaled about 6000 in July, 6100 in August, and 21,000 in September as emergence from, or attraction to, the new crop caused a population build-up. It was difficult to believe that the male population was as low as the data indicated although it must be remembered that many poisoned flies drop outside or are blown off the canes and not included in the estimate. During one 2-week period 5 conventional glass traps baited with methyl eugenol 2 cc. each were paired with and operated close by 5 of the regular cane record traps. The latter, although the methyl eugenol-poison had already weathered 2 weeks, caught from 3 to 25 times as many flies as the glass traps. The average was 7 times. Male flies came to traps at all elevations despite the absence of dorsalis in most of the fruit samples taken above 1100 feet.

Most of the monthly treatments required about 1 1/2 to 2 days' work in the area during which some 12 pounds of methyl eugenol was dispensed with considerable contamination of the truck and clothing. Dorsalis males appeared around the truck or workers within 1 to 5 minutes after stops made almost anywhere outside of the treated area. Less than 1 male per day was seen outside traps within the treated area on the 6 days during this quarter on which the attractant was dispersed. The male population within the area, except for occasional migrants and newly emerged individuals, was almost completely annihilated.

At prevailing wage rates, if conducted solely as a control program, this Hamakua coast operation would cost less than 25 cents per acre per year.

Kilauea Experiments at Half-Way House

This small experiment was also started in January and has been continued despite poor early results and increasing evidence of extensive fly movement. The summer crop of guavas in this area did not begin to ripen until late September and no infestation data are available. Fly catches are given in table 15 and may be compared with data from table 17, page 136, of the last quarterly report.

Table 15.--Male D. dorsalis in Kilauea methyl eugenol-poison traps.

Trap no.	Location	Flies per trap-day			Total flies per trap		
		July	Aug.	Sept.	July-Sept.	Apr.-June	Jan.-Mar.
1-12	In or near guava (treated area)	4	2	1	203	1,807	2,182
13-14	1/2 mile south of treated area	14	8	5	718	10,814	9,617
15-16	1/2 mile north of treated area (non-host area)	38	13	14	1,880	8,061	10,071
54	1 mi. north of 15-16 (non-host area, ohia on lava; 1/2 mi. from Ohaikea Valley)	35	1	25	1,852	17,912	36,238
55	3 mi. north of 15-16 (ohia on lava flow, nearest host in Ohaikea 1 mi. west)	50	13	13	2,166	11,658	9,259
52	S. rim of Kilauea caldera in Kau desert nearest host--Ohaikea Valley 3 mi. west	1	1	2	100	1,004	5,132
52A1/	NE rim of Kilauea caldera-4700' (Ohia forest)	4	1	3	213	598	-

1/ Installed March 31.

With the first appearance of ripe guava in the area late in September, fly catches began to increase but the upward trend started outside the area where no fly hosts were present and strongly indicates that fertile females as well as males from outside the treatment area were moving in to the new crop. Total September catches in the 12 centrally located traps were 584; in the 4 traps 13-16, 1347; and in 54 and 55, 1292.

Line Project I-c-3-3. Determination of Poison Spray Residues On and In Fruit at Harvest. (I. Keiser and L. F. Steiner)

Analyses were made of parathion residues on mango fruit collected from Maui after two series of sprayings. In the course of the analyses, it was determined why an orange rather than magenta color was produced on occasion, necessitating repeating the particular spoiled analysis. This was "plaguing" the former analysts here and the present one. It was found that by adjusting the pH to an acid solution (by the simple use of litmus paper), the occasional analysis not showing the proper acidity could be saved in this manner. Since then, no analyses were spoiled or required repetition.

In one test, analyses were made of mango pulp to determine whether or not there was penetration from the sprayed surface to the interior. Three individual analyses (pulp of 5 fruits each) showed parathion at the concentration of 0.1 to 0.2 parts per million of whole fruit. Extreme care was taken in first washing the fruit, removing the skin and handling the pulp. The controls (unsprayed fruit) developed no parathion color. This test should be repeated.

The parathion analyses are given in table 16. Firm nearly mature mangoes were picked from around the base of at least 10 trees per plot. Usually 2 samples were analyzed separately for each determination. Sample size was restricted to 7 to 10 fruits averaging 1/3 to 1/2 lb. each, the number being limited by size of the stripping jars.

The July 21-23 analyses indicate that the application against the wind was resulting in the deposition of at least as much parathion on the windward as the leeward side of the trees. If a tolerance close to 2 ppm. were established there would be little danger of exceeding it at the application rates used unless the most conspicuous deposits were selected soon after spraying or the fruit averaged much smaller in size. Possibly because the parathion was applied as a mist concentrate and excessive deposits would be possible where agitation of the mixture was inadequate or excessive wetting occurred, the August 6 samples from Plot 2 had unusually heavy deposits. On August 5 and 6 the applications were interrupted by frequent equipment breakdowns.

None of the Bureau personnel, or the grower's picking and packing crews, ever experienced any recognizable symptoms of parathion poisoning. The individual fruits were wiped with a damp cloth by the packing house employees at the time of packing in corrugated cartons.

Table 16.—Parathion residues on picked mango fruit from Maui spray tests.

Date	Age of residues	Plot	Pounds parathion 25 WP/acre	Parathion in PPM	
				Range	Mean
July 21	Fresh	2	10 (L)1/	0.3-1.6	1.0
	"	2	10 (W)2/	0.5-0.8	0.6
	"	3	4 (L)	0.4-0.5	0.4
	"	3	4 (W)	0.2-0.3	0.2
	"	Y	unsprayed	0	0
July 22	1 day	2	10 (L)	0.6-1.0	0.8
	"	2	10 (W)	0.5-0.5	0.5
	"	2	10 (HR)3/	1.9-2.1	2.0
	"	3	4 (L)	0.2-0.2	0.2
	"	3	4 (W)	0.3-0.3	0.3
July 23	2 days	2	10 (L)	0.9-1.0	1.0
	"	2	10 (W)	0.3-0.7	0.5
	"	2	10 (HR)	1.1-2.0	1.6
	"	3	4 (L)	0.2-0.3	0.2
	"	3	4 (W)	0.1-0.2	0.2
July 31	10 days	2	10	0.8-1.0	0.9
	"	2	10 (HR)	-	1.5
	"	3	4	0.5-0.7	0.6
Aug. 5	15 days	2	10	0.1-0.3	0.2
	"	3	4	0.2-0.3	0.2
Aug. 6	Fresh	2	10	3.5-6.5 4/	5.0
	"	3	4	0.4-1.5	0.9
	1 day	3	4 (HR)	1.1-2.0	1.5
Aug. 14	8 days	2	10	0.2-0.3	0.3
	"	3	4	0.3-0.4	0.3

1/ Leeward side of tree facing sprayer in July 21 spray.
2/ Windward side of tree opposite from sprayer in July 21 facing sprayer in first application July 2.
3/ Selected for conspicuously heavy residue.
4/ Accuracy of analyses questioned.

Line Project I-c-3-4. Development or Improvement of Treatments to Control Fruit Flies in Aircraft and Maritime Vessels. (I. Keiser, J. R. Holloway, and L. F. Steiner)

Treatments for use or for specification by Quarantine agencies which in addition to the above may include residual treatments of docks, airport facilities, or fruit packing house interiors are covered by this project.

The special study initiated in March to compare the performance of heavy residual sprays on surfaces commonly found in packing houses has been completed and is summarized herein. Further studies will be made at the first opportunity to develop additional information regarding some of the wettable powder formulations when used at lower concentrations.

As a result of this study, the Division of Plant Quarantines is currently requiring that the inside walls of plants where fruit is packed for export be sprayed with DDT-50 or 75 WP at 1/2 lb. toxicant per gallon to the point of run-off. The time interval before respraying is required has not been definitely established but a second spray after 30 days with subsequent applications at 2 or 3 month intervals would seem adequate.

The methods used in these tests were as follows: Four-inch disks that would snugly fit in Petri dishes were cut from canec unpainted and painted, plywood unpainted and lacquered, galvanized sheet iron, aluminum sheeting (roofing), galvanized hardware cloth (16 mesh), and plastic screening (16 mesh). Glass surfaces were represented by Petri dish tops. Five replicates of each surface were suspended horizontally along a wall in a random arrangement and sprayed from 10 feet away with a portable mist-type sprayer (Bean Portamist) until run-off began from the metal, painted and/or glass surfaces. The object was to simulate actual conditions and it was recognized that differences in amount of material deposited would occur among the surfaces and would depend largely upon the amount of liquid absorbed before run-off began.

Between tests, the surfaces were held on racks in a near-vertical position 8 to 10 feet above the floor of a light well-aerated laboratory room where they were free to collect the usual amount of dust.

One disk of each material for each insecticide constituted a replicate and was exposed by using it under the Petri-dish top of the standard insecticide screening cage. Flies (usually 30) were held in the cages for 24 hours and mortality counts then made. With 6 insecticides, 9 surfaces, and the controls each experiment required 60 cages and had to be limited to 1 replicate. Four of the replicates were used in succession, that is, No. 1 was first tested 1 day after the application, No. 2 at 5 days, No. 3 at 8, and No. 4 at 12 days after which the cycle was repeated. After tests on some surfaces with some of the materials showed negative results, 2 or more replicates were used on the same day. After 180 days the DDT residues on the non-porous surfaces were analyzed chemically.

The mean mortalities for the respective periods in which 4 replicates of each surface and treatment were tested are given in table 17 along with the results of the DDT analyses.

Table 17.—Comparative effectiveness of 6 insecticides on 9 surfaces at intervals after spraying.

Formulation & lbs. toxicant per gallon	Days after treatment	Surfaces and Per Cent Mortalities (Mean of 4 Replicates)									
		Iron galv.	Aluminum	Plywood painted	Plywood unpainted	Canec painted	Canec unpainted	Screen galv.	Screen plastic	Glass	All surfaces (mean)
DDT-75 WP	1-12	100	100	100	100	100	100	100	100	100	100
	15-26	100	100	100	100	100	100	100	100	100	100
0.5	29-48	100	100	100	100	100	100	100	99	100	99+
	55-83	100	100	100	100	100	100	100	99	100	99+
	91-112	100	100	100	100	100	100	100	100	100	100
	126-133	100	99	98	100	100	100	98	100	100	99+
	177	100	100	-	-	-	-	100	100	100	100
Residue DDT in mcg/cm²		285	[illegible]	-	-	-	-	240	279	663	-
DDT-Em.	1-12	99	99	95	86	88	91	66	48	98	86
	15-26	99	100	84	88	88	61	57	29	100	79
0.5	29-48	93	100	70	70	98	46	53	43	77	72
	55-83	86	98	33	64	83	14	19	18	87	56
	91-112	76	98	14	37	58	5	29	15	83	46
	126-133	75	92	15	46	63	2	5	5	50	39
	177	80	100	-	-	-	-	0	0	60	-
Residue DDT in mcg/cm²	180	615	-	-	-	-	-	240	279	254	-
Dilan 80 Em.	1-12	73	68	38	81	82	75	73	68	88	72
	15-26	55	58	12	72	62	45	26	60	81	52
0.5	29-48	49	47	5	72	63	49	22	62	67	48
	55-83	20	7	0	64	32	24	7	44	39	26
	91-112	22	10	14	67	26	40	4	44	28	28
	126-133	22	18	0	68	52	52	3	19	29	29
Lindane 20 Em.	1-12	37	28	75	100	98	99	63	56	77	70
	15-26	4	1	30	96	84	88	3	0	42	39
0.08	29-48	0	2	11	76	52	67	2	2	20	26
	55-83	0	0	0	69	14	53	0	0	0	15
	91-112	-	-	-	32	10	53	-	-	-	-
	126-133	-	-	-	7	4	41	-	-	-	-
Chlordane 40 Em.	1-12	58	74	90	99	98	100	73	57	89	82
	15-26	3	2	22	80	91	92	5	3	22	35
	29-48	1	3	9	37	58	66	2	1	1	20
0.16	55-83	1	0	1	11	33	35	0	0	0	8
	91-112	-	-	-	3	8	10	-	-	-	-
	126-133	-	-	-	7	13	18	-	-	-	-
Methoxychlor 50 Em.	1-12	33	28	16	46	24	32	2	18	62	29
	15-26	42	43	1	13	14	12	1	1	7	15
	29-48	9	8	4	24	2	8	0	2	0	6
0.5	55-83	2	3	1	3	0	0	0	0	0	1

On the basis of these tests DDT-75 WP was outstanding among the materials tested and remained essentially 100 per cent effective for about 6 months.

DDT emulsifiable rarely gave 100 per cent control but gave highly dependable performance throughout the 6-month period on aluminum and to a slightly lesser extent on galvanized iron and glass. Its effectiveness declined most rapidly on unpainted canec and the two types of screen and to a lesser extent on painted plywood.

Dilan LC-80 (CS-708) was emulsified with 3.4 per cent Triton B-1956 which was equivalent to approximately 1 qt. of the emulsifier in 100 gals. of the spray mixture. This treatment was less effective than the DDT emulsion on most surfaces but it held up better on unpainted plywood, unpainted canec, and plastic screening particularly after the first 2 months. It was least effective on painted plywood but most effective on the unpainted.

Lindane at less than 1/6 the concentration of the DDT and CS-708 treatments deteriorated rapidly on the two metals, the two types of screening, and to a lesser extent on the painted plywood and glass. It outperformed the CS-708 and DDT emulsions on unpainted canec for 112 days, on unpainted plywood for 83 days and was moderately effective on lightly painted canec for 48 days.

Chlordane at twice the concentration of lindane was slightly superior on painted canec but generally inferior on the other surfaces.

Methoxychlor at the same concentrations as DDT and CS-708 never gave good results. It was especially weak on the screens and painted plywood.

The fifth replicate was held in reserve for 155 days and then tested to determine if any substantial erosion of toxicant as a result of fly activity and repeated use had occurred. In this test the DDT suspension gave 100 per cent mortalities on all surfaces, the DDT emulsifiable averaged 46 per cent, the CS-708 65 per cent (with 100 per cent control on unpainted plywood and canec surfaces and only 3 per cent on the painted plywood. Lindane on unpainted plywood was 100 per cent effective, on unpainted canec 43 per cent, but was useless on the other surfaces. Chlordane was completely ineffective on all surfaces. Methoxychlor showed some control, 13 to 53 per cent on glass, canec, and galvanized iron surfaces. Erosion by fly activity, plus accumulations of regurgitated material and excreta apparently had some adverse influence on the duration of effectiveness of lindane, CS-708, and methoxychlor on some surfaces.

Although differences in the amount of initial deposit accounted for some of the differences in performance throughout the 6 months, it appears significant that the two toxicants (lindane and chlordane) that have some fumigant action were most effective on surfaces capable of absorbing some of the toxicant whereas, DDT emulsifiable was least effective on the most absorbent surface.

Further tests are needed in which suspensions of lindane and CS-708 are compared with both DDT formulations at lower concentrations and on zinc chromate-primed aluminum surfaces, such as found in the belly-cargo and landing gear compartments of military and some commercial planes. Tests are also needed on the duration of residual action in deposits on zinc chromate-primed aluminum.

Line Project I-c-3-5. (INACTIVE). Resistance studies are now being conducted by the Physiology Project.

Line Project I-c-3-6 and I-c-3-7. Development of Fermenting and Non-Fermenting Lures and Development of Chemical Repellents or Barriers. (Gow, Hayashi, and Steiner)

Comparative Field Tests of Lures (Gow and Hayashi)
by Gow

Field Experiment No. 67 was designed to determine whether prefermentation of soy meal with yeast No. 15-2 before culturing with bacterium No. 14 would improve the lure by removal of carbohydrates. Olfactometer tests had previously indicated some improvement as a result of such treatment. Yeast No. 15-2, one of the organisms isolated by this project, was selected since previous work with this organism indicated that it was able to hydrolyse starches and required no previous treatment of the soy meal with diastase. Previous work had indicated that the use of diastase depressed the attractiveness of the lure.

All field experiments herein described were allowed to run for 1 week unless otherwise noted. Flies were collected and water added to the lures to make up for evaporation on the fourth day.

Field Experiment No. 67

Lure	Material
A	Standard. (Raw sugar-vinegar-yeast)
B	Soy meal cultured 1 week with bacterium No. 14.
C	Soy meal prefermented 1 week with yeast No. 15-2 then cultured 1 week with bacterium No. 14.
D	Soy meal + 4 g./l. $(NH_4)_2HPO_4$ prefermented with yeast 15-2 and then cultured with bacterium No. 14.

Lure	Mean catch	Per cent of standard mean
A	58.00	100.0
B	127.25	219.4
C	122.33	210.9
D	127.25	219.4
LSD 5%	18.69	32.2

All the soy meal cultures mentioned in this report were cultured at a concentration of 10% soy meal and were diluted to 1% soy meal immediately before exposing in traps unless otherwise noted.

The diammonium phosphate was added to lure D to protect the soy meal proteins against attack by the yeast and to provide material for elaboration of additional protein by the yeast. The results show no gain in attractiveness due to prefermentation either with or without the diammonium phosphate.

Field Experiment 68 compared soy meal with a flour produced by grinding the soy meal in a Wiley mill. Olfactometer tests had showed no improvement in the lure by using the more finely divided flour, but it was thought best to check this result in the field. All efforts to preserve the soy meal lure by cold storage or quick freezing or by sterilization after culture have resulted in considerably poorer lures. Since we were anxious to find a method whereby this lure could be prepared and then shipped to other areas for testing, a treatment was included in this experiment in which the soy meal was cultured at 10% for 1 week and was then transferred to a sterile bottle in such a way as to avoid bacterial contamination. Five hundred cubic centimeters of culture were placed in a one-quart flat-sided prescription bottle having a plastic screw cap. The bottle was then packed for shipment and was held in the laboratory at room temperature. The package was disturbed and shaken two or three times a day and was held in this manner for one week. The culture was then diluted and exposed as usual.

Field Experiment No. 68

Lure	Material
A	Standard
B	Soy meal - 1 week culture with bacterium No. 14
C	Soy flour - 1 week culture with bacterium No. 14
D	Soy meal - 1 week culture with bacterium No. 14 packed for shipment and held for 1 week.

Lure	Mean catch	Per cent of standard mean
A	70.91	100.0
B	119.25	168.2
C	112.41	158.5
D	122.00	172.0
LSD 5%	21.80	30.7

No gain was found resulting from using soy flour instead of soy meal. Apparently the culture can be shipped without deterioration and without danger of breakage of the container due to gas pressure developed. (In fact, no gas pressure was noted when the bottle was opened.) More frequent disturbance of the culture during shipment than was given to the one used in this test should, if anything, result in improvement of the lure since its attractiveness is dependent on aerobic culture.

Castoreum is perhaps the most promising attractant so far discovered by olfactometer screening tests. Field Experiment 69 is a test of castoreum combined with both the standard fermenting lure and the soy meal lure.

The addition of castoreum improved neither the standard lure nor the soy meal lure in this test. This is somewhat surprising since castoreum showed up so well in olfactometer tests.

Field Experiment No. 69

Lure	Material
L_1+O	Standard
L_1+X	Standard + 1% castoreum (in ethyl alcohol).
L_2+O	Soy meal - 1 week culture with bacterium No. 14.
L_2+X	Soy meal + 1% castoreum.

Lure	Mean catch	Per cent of standard mean
L_1+O	32.33	100.0
L_1+X	26.83	83.0
L_2+O	146.33	452.6
L_2+X	130.49	403.6
LSD 5%	28.22	87.3

Lure	Mean catch	Per cent of Pure lure mean	LSD 5 per cent
L_1	29.71	100.0)	90.1
L_2	138.42	465.9)	
O	89.33	100.0)	30.0
X	78.79	88.2)	

(Note: In this type of experiment where there are four lures and two variables, means are calculated to show differences between the two variables, i.e., between Standard (L_1) and soy meal (L_2) lures, and between absence (O) and presence (X) of castoreum. Per cent values are calculated on the basis of 100% for one variable. i.e., Standard (L_1) or soy meal (L_2), and L.S.D. values are presented on the same basis. There are, therefore, two L.S.D. values and they refer to the values given in the column headed "Per cent of pure lure mean.")

Field Experiment 70 was a concentration test to determine what dilution of the original 10% soy meal culture gave best results in the field. This test was continued over a three-week period without renewal of the soy meal lures, but with renewal once a week of the standard lure. Losses of water due to evaporation were made up at each semi-weekly trap examination.

The results of this experiment again demonstrate the extended effectiveness of the soy meal lure since its superiority over the standard lure increased each week. Most of this increase in effectiveness was probably due to the seasonal effect hitherto noted, since this experiment was made at a time of year (August 7 to 28) when previous experience had led us to expect an increase in the effectiveness of the proteinaceous type of lure over the fermenting type. However, it should be kept in mind that during this period the original charge of 1/2 pint of lure to each trap was handled 5 times in the case of the 3 soy meal lures. Each time the trap contents were poured through a sieve to remove flies, loss of liquid due to evaporation was made up with water and the lure returned to the trap. Losses of lure material during such handling are inevitable and no particular effort was made to avoid them. On the, other hand, the standard fermenting lure was renewed each week.

Field Experiment No. 70

Lure	Material
A	Standard
B	Soy meal 1 week culture - 1%
C	Soy meal 1 week culture - 2%
D	Soy meal 1 week culture - 4%

Lure	Mean catch			
	1st week	2nd week	3rd week	Total
A	62.58	33.00	14.75	110.33
B	142.67	123.33	59.67	325.67
C	108.33	98.25	38.58	245.16
D	84.33	66.00	41.25	191.58
LSD 5%	24.11	22.76	15.71	50.36

Lure	Per cent of standard mean			
	1st week	2nd week	3rd week	Total
A	100.0	100.0	100.0	100.0
B	228.0	373.7	404.5	295.2
C	173.1	297.7	261.6	222.2
D	134.8	200.0	279.7	173.6
LSD 5%	38.5	69.0	106.5	45.6

These results also demonstrate that the 1% dilution is definitely better than the 2% or 4% solutions.

Apparently there are repellents as well as attractants in this lure, since we have been able to increase the effectiveness of the lure by changing conditions of culture (i.e., by increasing concentration of attractants or changing attractant-repellent ratio), but cannot increase attractiveness by increasing the concentration of the exposed lure (in which case we increase concentration of attractants and repellents in the same ratio). If the effect of increased concentration on exposure were to so increase concentration of attractants as to bring them into a repellent concentration range, change of culture conditions so as to increase attractants should have the same effect. However, if we assume the presence of repellents whose effect increases more rapidly with increase of concentration than does that of attractants present, the results of this experiment taken in conjunction with those of earlier experiments on culture condition changes are understandable. This hypothesis may prove to be of considerable importance, if true; since, if we have a system containing both repellents and attractants, operations on the lure to separate it into the various chemical constituents, or even into classes of chemical constituents may result in very considerable improvement due to elimination of repellents.

Since earlier olfactometer tests on cultures of various amino acids with bacterium No. 14 had indicated that tryptophane might be involved in the production of attractants, it was decided to see if additions of anthranilic acid or of indole to the soy meal culture would increase attractant production.

This was done both with and without prefermentation of the soy meal with yeast No. 15-2, since it was thought that if the bacteria could not utilize these materials in the production of attractants the yeast might utilize them to build proteins high in tryptophane, which the bacteria could subsequently break down. Field Experiments 71, 73, and 74 present the results of this work.

Field Experiment No. 71

Lure	Material
A	Standard
B	Soy meal 1 week culture with bacterium No. 14
C	Soy meal + 1% anthranilic acid
D	Soy meal + 1% indole

Lure	Mean catch	Per cent of standard mean
A	16.83	100.0
B	100.75	598.6
C	18.33	108.9
D	1.58	9.4
LSD 5%	18.00	107.0

It was obvious that the anthranilic acid and the indole were interfering with culture at this concentration. The cultures containing these substances failed to turn red and showed little evidence of bacterial activity. Cultures of soy meal with yeast No. 15-2 and containing these materials at this concentration level, which were prepared for Field Experiment 72, also showed little evidence of fermentation. These cultures were therefore discarded and Experiment 72 was not placed in the field. Instead, Field Experiment 73 was carried out using anthranilic acid and indole at concentrations of 0.2%.

Field Experiment No. 73

Lure	Material
A	Standard
B	Soy meal---1 week culture with bacterium No. 14
C	Soy meal + 0.2% anthranilic acid
D	Soy meal + 0.2% indole

Lure	Mean catch	Per cent of standard mean
A	16.42	100.0
B	47.08	286.7
C	27.25	166.0
D	14.58	88.8
LSD 5%	11.36	69.2

At this concentration level the anthranilic acid and indole did not appear to interfere with culture by bacterium No. 14. However, the results indicate a very considerable depression in catch due to presence of these materials.

In Field Experiment 74 the soy meal cultures were prefermented with yeast 15-2 in small flasks to produce anaerobic fermentation. After fermentation for one week the cultures were then transferred to sterile mold culture flasks for culture with bacterium No. 14. These cultures were not resterilized at this point to kill the yeast, since when this was done in earlier cultures for olfactometer tests resterilization resulted in considerably poorer catches than did subsequent culture without sterilization. Raw sugar (2%) was also added to these cultures to give the yeast a better start and diammonium phosphate was added to the soy meal culture which did not receive either anthranilic acid or indole. The prefermentation in one flask and subsequent transfer to a mold culture flask before culture with the bacteria insured the removal of the atmosphere of CO_2 due to fermentation and substitution of an atmosphere of air during culture.

Field Experiment No. 74

Lure	Material
A	Soy meal--1 week culture with bacterium No. 14.
B	Soy meal + 2% raw sugar + 0.2% $(NH_4)_2HPO_4$ prefermented with yeast 15-2 for 1 week then cultured with bacterium No. 14 for 1 week.
C	Soy meal + 2% raw sugar + 0.2% anthranilic acid prefermented 1 week and cultured 1 week.
D	Soy meal + 2% raw sugar + 0.2% indole prefermented 1 week and cultured 1 week.

Lure	Mean catch	Per cent of standard mean
A	49.92	100.0
B	45.25	90.6
C	16.92	33.9
D	2.58	5.2
LSD 5%	10.57	21.2

Not only did the anthranilic acid and indole result in much poorer catches, but the prefermentation may have depressed the catch in the soy meal although the difference here is not significant. Apparently neither of these materials can be used as a chemical precursor of the proteinaceous attractants.

Since our soy meal lures are prepared by culturing at 10% soy meal with dilution to 1% just before exposing in the field, an excellent opportunity is offered for combining the fermenting and the proteinaceous types of lure. It was decided to try several ways of making such combinations. In each case the soy meal was cultured for 1 week with bacterium No. 14 prior to dilution with standard fermenting lure. Field Experiments 75 and 76 were tests of these mixtures.

Field Experiment No. 75

Lure — **Material**

- A — Standard.
- B — Soy meal---1 week culture with bacterium No. 14.
- C — Soy meal diluted with 1 week old standard lure. Exposed immediately after dilution.
- D — Soy meal diluted with 1 week old standard lure. Mixture was held one week before exposing.

Lure	Mean catch	Per cent of standard mean
A	21.83	100.0
B	97.08	444.7
C	28.50	130.6
D	29.83	136.6
LSD 5%	12.43	56.9

Field Experiment No. 76

Lure — **Material**

- A — Standard.
- B — Soy meal---1 week culture with bacterium No. 14.
- C — Soy meal diluted with 16-hour old standard lure. Exposed immediately after dilution.
- D — Soy meal diluted with 16-hour old standard lure. Mixture was held for 1 week before exposing.

Lure	Mean catch	Per cent of standard mean
A	12.75	100.0
B	97.91	767.9
C	18.42	144.5
D	7.17	56.2
LSD 5%	14.48	113.6

Instead of resulting in an addition of attractants, the addition of fermenting lure to the proteinaceous lure resulted in all cases in reducing the attractiveness of the mixture to approximately that of the fermenting lure. Apparently the proteinaceous lure attractants are destroyed by the yeast in the fermenting lure. This would be most likely to occur were these attractants either fermentable carbohydrates or compounds containing nitrogen in a form available to the yeast. It is unlikely that bacterium No. 14 would leave fermentable carbohydrates in the culture since we know from earlier work that this bacterium will utilize dextrose added to the culture and thereby produce less attractants. The results of this experiment, therefore, indicate that the proteinaceous lure attractants are probably nitrogen containing compounds.

Analysis of Field Data Comparing the Performance of the Fermenting and Proteinaceous Lures.

With the exception of Field Experiment No. 74, each of the experiments of this group beginning May 27 and ending October 2 contained at least one standard fermenting lure and a one-week soy meal culture. In some cases the soy meal lure was allowed to continue in the traps for two or even three weeks, but little difference was shown in performance of this lure between the first, second, and third weeks. We have, therefore, calculated the ratio: soy meal catch to standard lure catch for each pair of these treatments and submitted the ratios thus obtained to analysis of variance both with respect to the mean ratios obtained for each week and to the mean ratios obtained for each location.

During the first few weeks of this period some shifting of trap suspensions to new locations was necessary as certain initial locations proved unsuitable. Two locations were changed because of very low catches and one was shifted because the tree in which the trap suspension was placed was broken in a storm. In one case a location was dropped out of the experiment for two weeks of a three-week experiment because the traps were spilled in a high wind. Therefore, only eight of the twelve locations were continued unchanged for the entire period. Because of this, our study of variation with time was restricted to these eight locations and extended over the period May 27 to July 2 with the exception of one period of 16 days when field-trapping was discontinued because of annual leave and another period of one week during which Field Experiment No. 74, which contained no fermenting lure, was in progress.

On the other hand, our study of relative response to these two lures with respect to location extends only from July 1 to October 2 with the exception of the two periods already noted since it was only during this period that all twelve locations remained the same.

Figure 7 shows the variation of the ratio: soy meal lure/standard lure with location. The continuous line shows the mean ratio while the short horizontal lines represent the 5% L.S.D. values added to the mean ratios. It is evident that there are persistent differences between locations in the relative response to the two types of lure. It is possible that this effect results from differences in the natural proteinaceous foods or natural fermenting foods available near the different locations. Figure 8 is a map of the area covered by the experimental layout. The location of each trap suspension is indicated together with the mean ratio for each location. It is evident that the highest ratios were found in the region around Punahou Street.

Figure 9 shows the mean ratio: soy meal lure/standard lure plotted against time. It will be seen that while there is considerable variability from week to week, there is a general trend upward beginning about the first of August. The same tendency was noted in 1951 with respect to the relative performance of proteinaceous and fermenting lures.

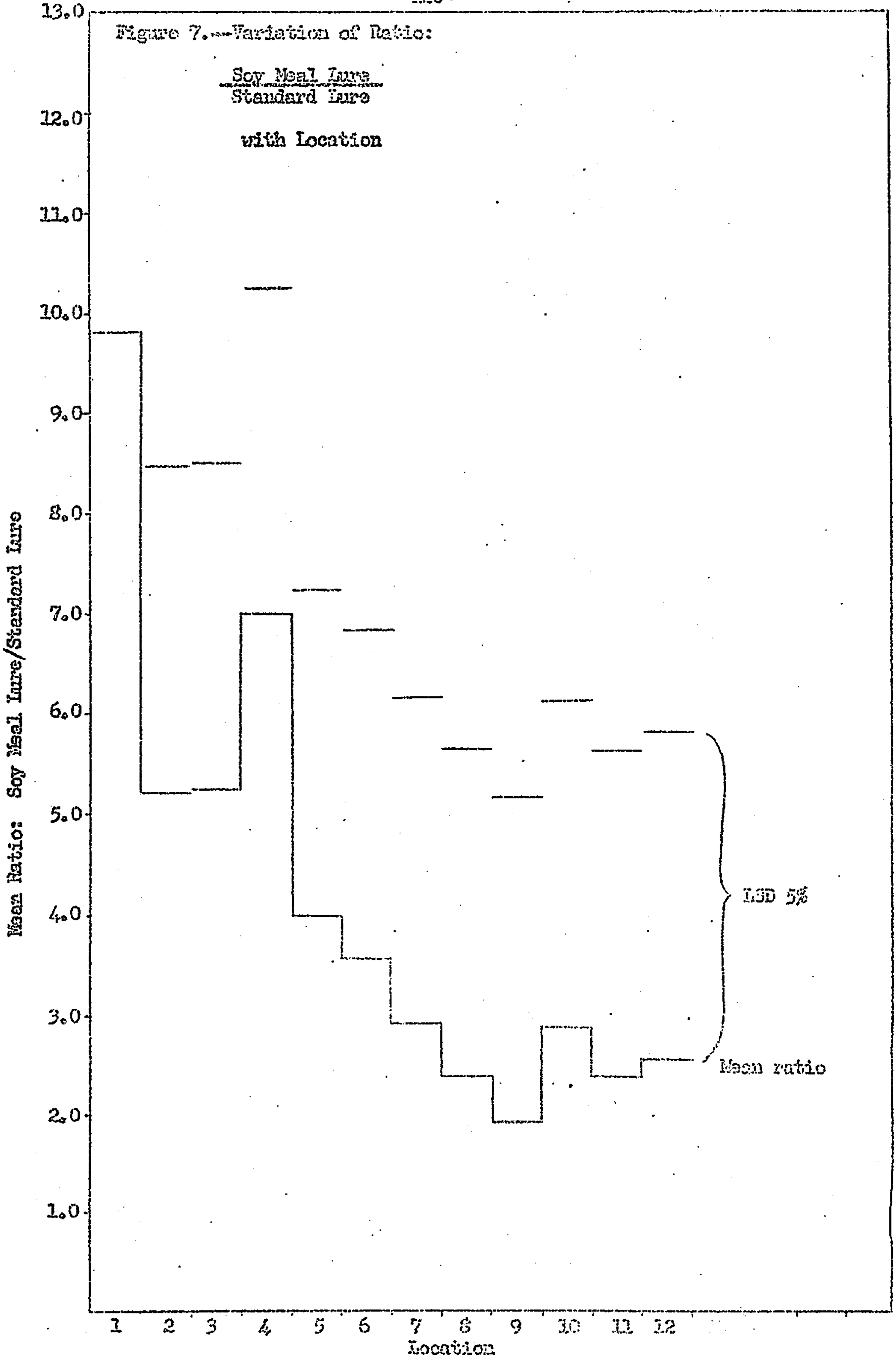
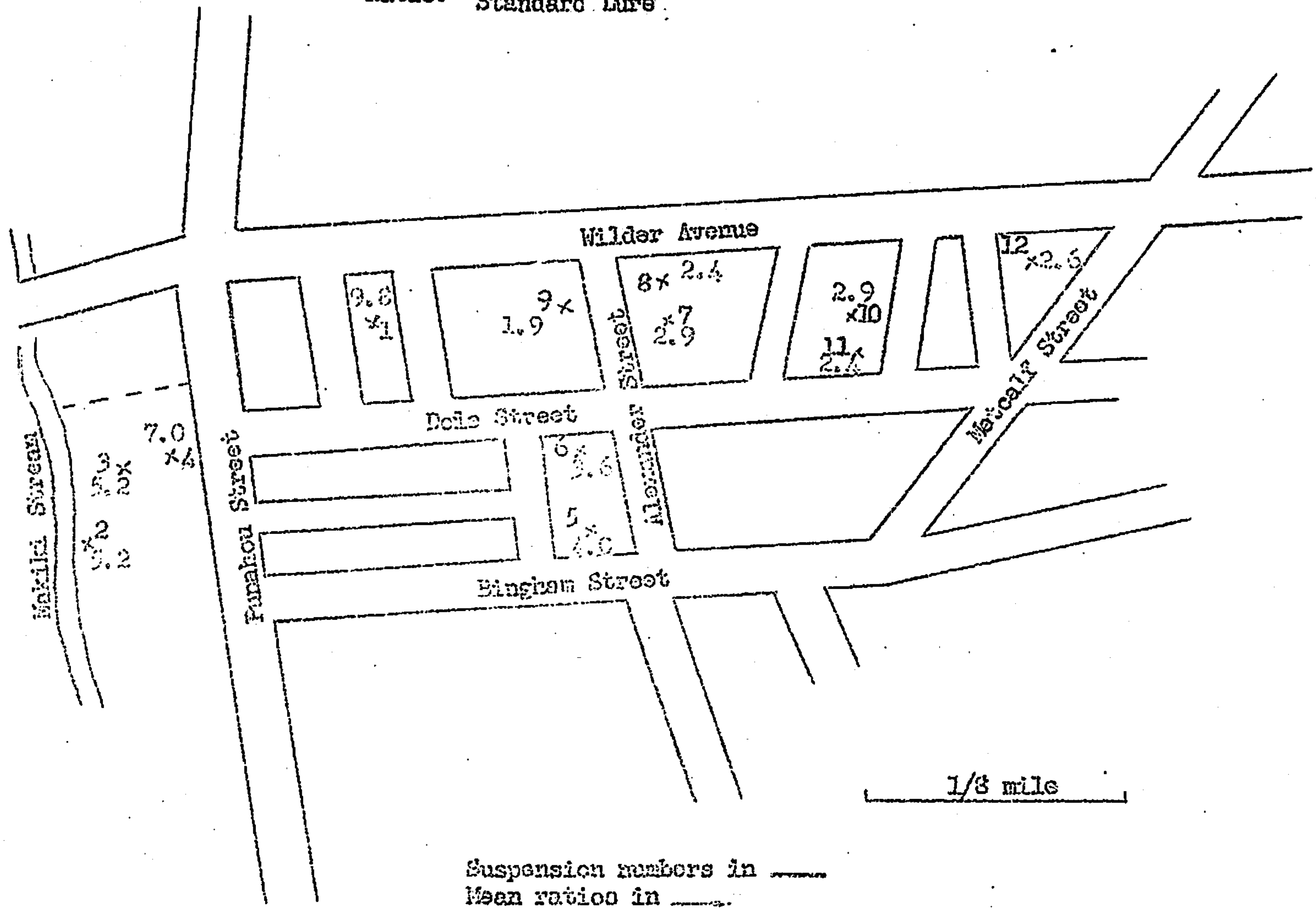


Figure 7.—Variation of Ratio: $\frac{\text{Soy Meal Lure}}{\text{Standard Lure}}$ with Location

Figure 8.

Ratio: $\frac{\text{Soy Meal Lure}}{\text{Standard Lure}}$



Suspension numbers in ____
Mean ratios in ____.

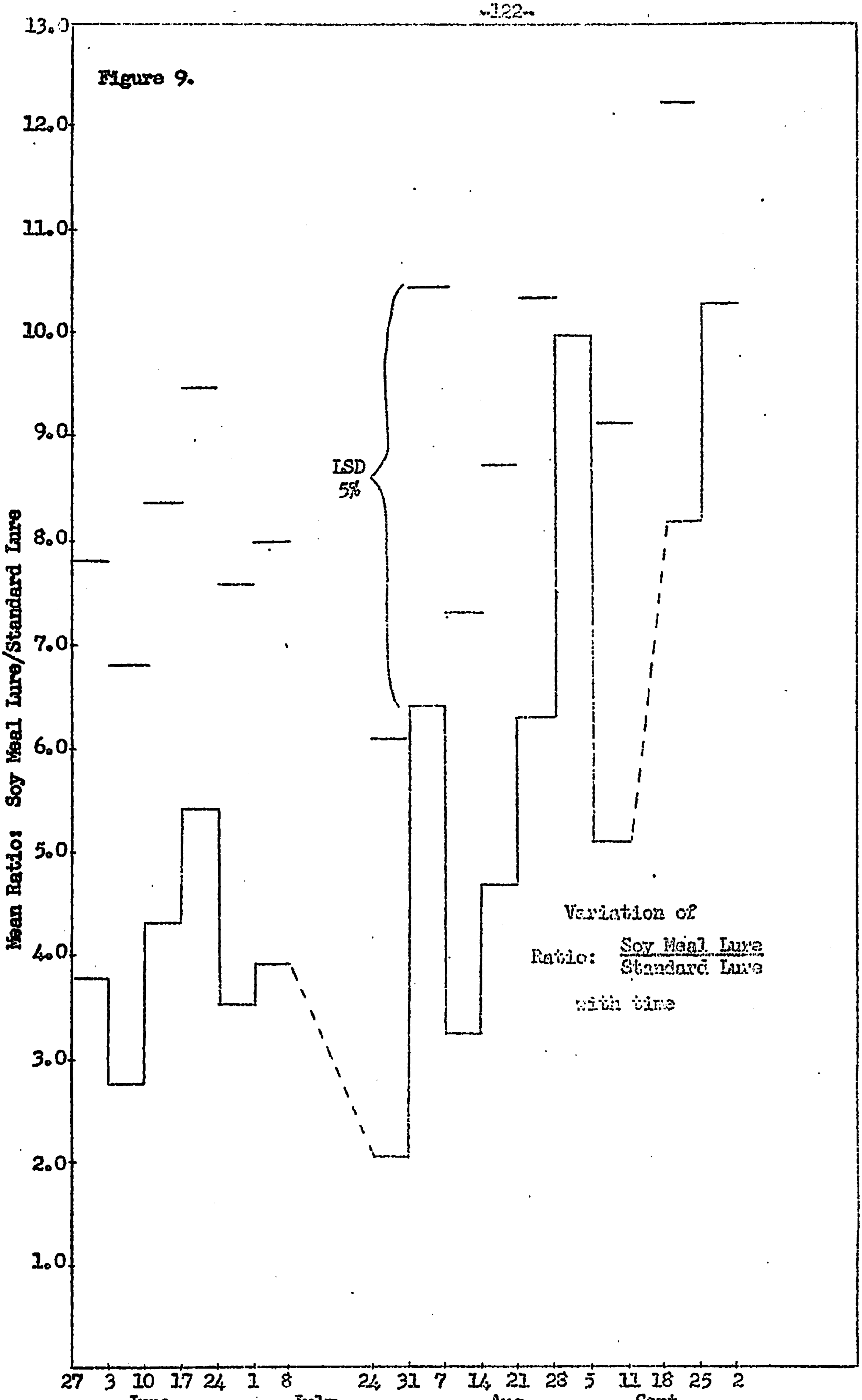


Figure 9.
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
Mean Ratio: Soy Meal Lure/Standard Lure
LSD
5%
Variation of
Ratio: Soy Meal Lure / Standard Lure
with time
27 3 10 17 24 1 8 24 31 7 14 21 28 5 11 18 25 2
June
July
Aug.
Sept.

<u>Olfactometer Screening Tests</u>

A new technique of olfactometer testing was developed following a suggestion by Dr. Haller with the end in view of considerably speeding up our screening tests in order that we might test a large number of E series coded compounds which we have received for testing as insecticides. A wheel was constructed (See figure 10) to which six pieces of paper 6 inches by 14 inches may be attached. These papers are clamped in a vertical position with the long axis horizontal on each of six sides of a hexagon with sides 17 inches long, and are supported in such a way that only the borders of the papers come in contact with the wheel. On the center of each paper sheet is placed 1/2 cubic centimeter of a ten per cent solution of the material to be tested in a volatile solvent. When possible, acetone is used as the solvent, otherwise ethyl ether, ethyl alcohol, benzene, petroleum ether, or water is used. The 1/2 cc. portion spreads out into a spot about 2 inches in diameter and the solvent is allowed to evaporate before the sheet is placed in the olfactometer. Six materials are tested at a time. Evaluation is made by visual observation of the flies clustered about the spot after 15 minutes to 1/2 hour in the olfactometer. No effort is made to make actual counts of flies.

It was found that we could readily distinguish between the levels of attractiveness displayed by methyl eugenol, oil of citronella and such low level attractants as castoreum. Since no quantitative results are obtained we decided to avoid the use of numbers in rating attractants. Attraction such as is displayed by methyl eugenol we designated by AAA, the citronella oil level by AA, and the castoreum level as A, while no attraction is indicated as O.

It was found by testing materials already shown by ordinary olfactometer trap tests to have no sex specific attraction that these materials generally appeared to be male attractants by the spot method of testing. Variation of the kind of paper used or the solvent did not change the situation. Observation of the tests while in progress lead to the conclusion that, while females were initially attracted to these materials, the male response was faster and that when the fly population on a spot became at all dense, the females tended to leave, nor would females attempt to enter a crowd of males. We therefore came to the conclusion that this type of test could tell us nothing about sex specificity of attractants. However, since this type of test enables us to test ten times as many materials in a day as does the trap type, it was decided to use it for preliminary screening since it will allow us to eliminate about 90% of materials tested to begin with. Any material that shows attractiveness by this test must be retested by ordinary quantitative olfactometer technique using traps and making sex counts. Any strong attractant that might be discovered for male <u>cucurbitae</u> or <u>capitata</u> would be extremely valuable.

Another disadvantage of this method is that it does not enable us to detect repellents. However, an advantage was found in that this method does not have the concentration sensitivity that the trap method has. The concentration gradient falls off much more sharply in the spot method than in the trap method, and it was found that when the concentration on the spot itself reached a repellent level the flies would congregate in a ring about the spot, leaving the spot itself free of flies. In grading our tests this effect is noted with the letter "C". Thus the notation "AC" indicates that the material was attractive as evidenced by a ring of flies around the spot, but that the spot itself was repellent.

Figure 10.---Demonstrating the performance of methyl eugenol using the spot test technique for screening possible attractants.

A decisive advantage of the spot method for screening the "E" series of compounds is the extremely small quantity of material necessary for such a test. One-tenth of a gram is a sufficient quantity of material. Generally the amount of "E" series materials available for all types of tests was about 1 gram.

All of the compounds, which we found to be attractive by quantitative olfactometer tests, were retested by the spot method. In many cases the spot method did not indicate any attraction. It should be remembered, however, that none of these materials with the exception of methyl eugenol, oil of citronella, eicosyl aldehyde, and castoreum have showed a level of attraction anywhere near as high as that of the standard lure. Also, some of the materials tested were undoubtedly too volatile to persist throughout the duration of the test as was indicated by rapid disappearance of the spot.

Table 18 presents the results of spot olfactometer tests on materials already shown to be somewhat attractive by olfactometer quantitative tests or by field tests. Table 19 presents results with aromatic chemicals and essential oils not hitherto tested. Table 20 presents results with the "E" series of coded compounds. Results are given for both D. dorsalis and C. capitata. Since the population of C. capitata fluctuated considerably due to irregular supply, failure to show a response by this fly may not always be due to failure to attract. At no time during the period covered by the spot tests was the population level of D. cucurbitae high enough to give a test for this fly.

It can readily be seen that the spot method of testing has a much lower sensitivity for attractants than does the quantitative method. Of 97 materials shown by other tests to be attractive to D. dorsalis, 78 showed no attraction by the spot method and only 19 showed as attractive. However, of the 78 compounds showing no attraction by spot test, none of them can be said to be more than a mild attractant, except for diethyl phthalate. Several spot tests were made with this compound but all failed to show a response. In spite of these results we believe that any material having promise as a practical attractant will show up as an attractant by this method.

Of 205 "E" series compounds screened during this period nine were found attractive to D. dorsalis and two to C. capitata. None of them indicated a high level of attractiveness. Altogether 320 new compounds and essential oils were screened of which 32 were attractive to D. dorsalis and 9 to C. capitata. The method has therefore served to eliminate about 87% of the materials tested as not having enough attractions to warrant further investigation. The materials which showed attraction will, of course, need further study by quantitative olfactometer methods and possibly field tests.

Following is a list of the "E" compounds found attractive, giving their chemical names.

No.	Name	Attractive to
3107	4-(o-chlorobenzoyl) morpholine	D. dorsalis
3108	1-(o-chlorobenzoyl) piperidine	"
3614	Phenol, o-phenyl-, acetate	"
3655	Acetylsalicylic acid, methyl ester	"

No.	Name	Attractive to
3656	Phenol, 2,4,6-trichloro-, acetate	*C. capitata*
3664	Acetanilide, o-phenyl-	*D. dorsalis*
3679	Propionanilide, o-phenyl-	"
3681	o-Propionotoluidide, 5-chloro-	"
3684	Propionanilide, N-methyl	"
3770	Benzenesulfonamide, p-chloro-N,N-dimethyl	*C. capitata*
3771	Benzenesulfonamide, p-chloro-N-ethyl	*D. dorsalis*

Quantitative Olfactometer Tests

Results of this type of test wherein traps are used and sex counts made are reported in table 21. Twelve materials were tested with 3 species of flies. For *D. dorsalis* 6 attractants, 4 obscurants, and 3 materials having no effect were found. For *C. capitata*, 4 attractants, 1 enhancer, 2 repellents, 4 obscurants, and 3 materials having no effect were found. For *D. cucurbitae* there were 3 attractants, 1 enhancer, 5 obscurants, and 3 materials with no effect.

Miscellaneous Olfactometer Tests

A test was made with the soy meal lure to determine the effect of pre-fermentation with yeast No. 15-2. These were the same lures as were used in Field Experiment 67.

Olfactometer Test 274

Lure	Material
A	Standard lure.
B	Soy meal--1 week culture
C	Soy meal - Prefermented with yeast 15-2
D	Soy meal + 4 g/l. $(NH_4)_2HPO_4$ prefermented with yeast 15-2.

Lure	Per cent of standard mean					
	D. dorsalis		*C. capitata*		*D. cucurbitae*	
	♀♀	Both sexes	♀♀	Both sexes	♀♀	Both sexes
A	100.0	100.0	100.0	100.0	100.0	100.0
B	340.0	423.1	559.3	415.0	1248.5	976.7
C	488.7	613.4	504.8	370.0	1352.6	1000.0
D	442.7	577.4	709.4	505.0	1572.6	1320.0
LSD 5%	186.6	181.4	174.6	109.3	500.1	347.9
Mean catch in standard	38.3	54.7	7.3	20.0	8.3	20.0

There were no significant gains due to prefermentation either with or without diammonium phosphate which result agrees well with the results of the field experiment.

Lures from Field Experiment 68 were tested in the olfactometer in Test 279.

Table 18.--Olfactometer spot tests of materials shown to be attractive by quantitative olfactometer tests or by field tests.

Material	Response	
	D. dorsalis	C. capitata
Methyl eugenol	AAA	0
Oil of citronella	AA	0
Diethyl phthalate	0	A
Acetic acid	0	0
Amyl benzoate	0	0
Benzyl alcohol	0	0
Amyl cinnamic aldehyde	0	0
Amyl salicylate	0	0
iso-Amyl salicylate	0	0
Anisyl alcohol	0	0
Aurantiol	0	0
p-Methyl tetrahydroquinoline	0	AAC
Furfural	0	0
Furfuryl alcohol	0	0
Vanillin	A	0
Ethyl vanillin	A	0
Coumarin	0	0
Benzylidene acetone	0	0
Bornyl acetate	0	0
n-Butyl lactate	0	0
n-Butyl oxalate	0	0
iso-Butyl phenylacetate	0	0
Butyl propionate	0	0
n-Butyl salicylate	0	0
n-Butyl tartrate	0	0
iso-Butyraldehyde	0	0
n-Butyric acid	0	0
iso-Butyric acid	0	0
Carbon tetrachloride	0	0
Castoreum	A	0
Civet (artificial)	0	0
Cholesterol	0	0
Cetyl alcohol	0	0
Cinnamyl propionate	0	0
Cyclamen aldehyde	0	0
Cyclohexyl cinnamate	0	0
Cyclohexyl phenylacetate	0	0
Diethylacetic acid	0	0
Diethyl malonate	A	0
Diethyl glycol	0	0
Diglycol laurate S	0	0
Dimethyl anthranilate	0	0
Eicosyl aldehyde	AA	0
Ethanol amine	0	0
Ethyl anisate	AC	0
Eugenol allyl ether	AA	0
iso-Eugenol allyl ether	AA	0
Ethyl decylate	0	0
Ethyl lactate	0	0

Table 18 (cont'd)

Material	Response	
	D. dorsalis	C. capitata
Ethyl oxalate	A	0
Ethyl oxyhydrate	0	0
Ethyl succinate	0	0
Ethyl butyl malonate	A	0
Ethyl cinnamate	0	0
Formic acid	0	0
Glyoxal	0	0
Guiac wood acetate	0	0
Heptadecyl aldehyde	A	0
n-Hexaldehyde	0	0
Hydroxyacetal	0	0
Hydroxycitronellal	0	0
Hydroxycitronellal dimethyl acetal	0	0
3-Indole acetic acid	0	0
Lactic acid	0	0
Linalyl butyrate	A	0
Linalyl formate	0	0
Meta home menthyl salicylate	0	0
Methyl alcohol	0	0
Methyl amyl ketone	A	0
Methyl anisate	AC	0
Methyl naphthyl ketone	0	0
Methyl nonyl acetaldehyde	0	0
Methyl nonyl ketone	0	0
Methyl propionate	0	0
Methyl iso-propyl ketone	0	0
Musk ambrette	0	0
Musk ketone	0	0
Musk xylol	0	0
Octyl alcohol	0	0
Oil of Bay	AA	0
Oil of Clove	AA	0
Oil of grapefruit	0	0
Oil of mace	AA	0
Phenyl acetaldehyde	0	0
Pivalic acid	0	0
Propionic acid	0	0
Pyruvic aldehyde	0	0
Salicylic aldehyde	0	0
Terpinyl acetate	0	AC
Trimethylene glycol	0	0
Amyl formate	0	0
Undecylenic aldehyde	0	0
iso-Valeric acid	0	0
n-Valeric acid	0	0
tert.-Amyl alcohol	0	0
pri-iso-Amyl alcohol	0	0
act-Valeric acid	0	0
Turpentine	A	0

Table 19.—Olfactometer spot tests of aromatic chemicals and oils not hitherto tested.

Material	Response	
	D. dorsalis	*C. capitata*
Acetyl choline chloride	0	0
Benzoyl choline chloride	0	0
Choline chloride	0	0
Mecholyl chloride	0	0
Dibutyl phthalate	0	0
Diamyl phthalate	0	0
Methyl heptenone	0	0
Phenyl acetaldehyde dimethyl acetal	0	A
Phenylacetic acid	0	0
Phenyl benzoate	0	0
Phenylethyl acetate	0	0
Phenylethyl alcohol	0	0
Phenylethyl butyrate	0	0
Phenylethyl iso-butyrate	0	0
Phenylethyl cinnamate	0	0
Phenylethyl dimethyl carbinol	0	A
Phenylethyl dimethyl carbinyl acetate	0	0
Phenylethyl dimethyl carbinyl iso-butyrate	0	0
Phenylethyl formate	0	0
Phenylethyl methyl ethyl carbinol	0	A
Phenylethyl phenylacetate	0	0
Phenylethyl propionate	0	0
Phenylethyl salicylate	0	0
Phenylethyl valerianate	0	0
Phenylpropyl acetate	0	0
Phenylpropyl alcohol	0	0
Phenylpropyl aldehyde	0	0
Piperitone	A	0
Piperonal	0	0
Piperonone	AC	0
Propyl acetal	0	0
Propyl acetate	0	0
Propyl propionate	0	0
Roseacetal	0	0
Rose crystals	0	0
Rose ethone	0	0
Safrol	0	0
iso-Safrol	AC	0
Santalol	0	0
Santalyl phenylacetate	0	0
Styrolyl acetate	0	A
Styrolyl alcohol	0	0
Terpineol	0	AC
Terpineoline	0	0
Terpenyl propionate	0	0
Thymol	0	0
Tolyl acetate	0	0

Table 19 (cont'd)

Material	Response	
	D. dorsalis	*C. capitata*
Triacetin	0	0
Vetiverol	0	0
Vetiveryl acetate	0	0
Yara yara	0	0
Vanillodeur	A	0
Hydrovan	A	0
Tonkarone	0	0
Benzoic acid	0	0
Citric acid	0	0
Ethylene diamine	0	0
Ethyl nitrate	0	0
a-Naphthol	AC	0
Linoleic acid	0	0
Triethanolamine	0	0
Oil of almond (bitter)	0	0
Oil of Balsam (Peru)	0	A
Oil of Amyris Balsamifera	0	0
Oil of Bay Laurel Leaves	AA	0
Oil of Bois de Rose (Brazil)	0	A
Oil of Cade	A	0
Oil of Calamus	A	0
Oil of Cananga	A	0
Oil of Caraway	0	0
Oil of Celery Seed	A	0
Oil of Cinnamon	0	0
Oil of Clary Sage	0	0
Oil of Copaiba	0	0
Oil of Coriander	0	A
Oil of Cubeb	0	0
Oil of Cajeput	A	0
Oil of Elemi	A	A
Oil of Estragon	AA	0
Oil of Fir Needle	A	0
Oil of Guiac Wood	0	0
Oil of Geranium Rose (Turkish)	0	0
Oil of Lavandin	0	0
Oil of Lemon grass (native)	0	0
Oil of Linalol (Mexican ex. seed)	0	0
Oil of Lovage	A	0
Oil of Mandarin	0	0
Oil of Nutmeg	A	0
Oil of Ocotea Cymbarum	A	0
Oil of Olibanum	0	0
Oil of Opopanax	0	0
Oil of Orange (Bitter)	0	0
Oil of Origanum	0	0
Oil of Patchouly	0	0

Table 19 (concluded)

Material	Response *D. dorsalis*	Response *C. capitata*
Oil of Pennyroyal	0	0
Oil of Petitgrain	0	0
Oil of Pimento Berries (Oil of Allspice)1/	AAA	0
Oil of Pine Needle	0	0
Oil of Rose Novo	0	0
Oil of Rosemary	A	0
Oil of Rue	0	0
Oil of Sassafras	AAC	0
Oil of Sage Dalmatian	0	0
Oil of Sandalwood	0	0
Oil of Spearmint	0	0
Oil of Spruce Needle	0	0
Oil of Styrax	0	AA
Oil of Sweet Birch	0	0
Oil of Tansy	0	0
Oil of Tar	A	0
Oil of Thyme	0	0
Oil of Turpentine	0	0
Oil of Vetivert	0	0
Oil of Wintergreen	0	0
Oil of Ylang Ylang	A	0

1/ Contains methyl eugenol.

Table 20.--Olfactometer spot tests of coded compounds of the "E" series.

Number	Response D. dorsalis	Response C. capitata	Number	Response D. dorsalis	Response C. capitata
E-1288	0	0	E-3146	0	0
3041	0	0	3154	0	0
3046	0	0	3155	0	0
3047	0	0	3156	0	0
3048	0	0	3158	0	0
3053	0	0	3187	0	0
3054	0	0	3188	0	0
3055	0	0	3189	0	0
3056	0	0	3190	0	0
3057	0	0	3192	0	0
3058	0	0	3227	0	0
3072	0	0	3230	0	0
3074	0	0	3231	0	0
3075	0	0	3520	0	0
3076	0	0	3521	0	0
3086	0	0	3522	0	0
3102	0	0	3523	0	0
3104	0	0	3524	0	0
3105	0	0	3525	0	0
3106	0	0	3526	0	0
3107	A	0	3527	0	0
3108	A	0	3528	0	0
3109	0	0	3529	0	0
3110	0	0	3540	0	0
3111	0	0	3541	0	0
3112	0	0	3542	0	0
3113	0	0	3543	0	0
3116	0	0	3545	0	0
3117	0	0	3550	0	0
3118	0	0	3551	0	0
3119	0	0	3553	0	0
3121	0	0	3555	0	0
3123	0	0	3556	0	0
3124	0	0	3559	0	0
3125	0	0	3560	0	0
3126	0	0	3561	0	0
3131	0	0	3563	0	0
3132	0	0	3564	0	0
3133	0	0	3565	0	0
3134	0	0	3566	0	0
3135	0	0	3567	0	0
3136	0	0	3568	0	0
3137	0	0	3569	0	0
3138	0	0	3571	0	0
3139	0	0	3572	0	0
3140	0	0	3577	0	0
3141	0	0	3579	0	0
3142	0	0	3580	0	0
3143	0	0	3581	0	0
3144	0	0	3582	0	0
3145	0	0	3583	0	0

(cont'd)

Table 20 (cont'd)

Number	Response: D. dorsalis	Response: C. capitata	Number	Response: D. dorsalis	Response: C. capitata
E-3584	0	0	E-3665	0	0
3585	0	0	3666	0	0
3587	0	0	3667	0	0
3588	0	0	3668	0	0
3589	0	0	3669	0	0
3590	0	0	3670	0	0
3591	0	0	3671	0	0
3592	0	0	3672	0	0
3597	0	0	3674	0	0
3598	0	0	3675	0	0
3599	0	0	3677	0	0
3600	0	0	3678	0	0
3601	0	0	3679	A	0
3602	0	0	3680	0	0
3606	0	0	3681	A	0
3611	0	0	3682	0	0
3612	0	0	3683	0	0
3613	0	0	3684	AC	0
3614	A	0	3689	0	0
3615	0	0	3690	0	0
3616	0	0	3691	0	0
3617	0	0	3702	0	0
3622	0	0	3768	0	0
3625	0	0	3770	0	A
3626	0	0	3771	A	0
3627	0	0	3772	0	0
3628	0	0	3773	0	0
3629	0	0	3774	0	0
3630	0	0	3775	0	0
3631	0	0	3776	0	0
3632	0	0	3777	0	0
3634	0	0	3780	0	0
3638	0	0	3781	0	0
3641	0	0	3784	0	0
3642	0	0	3785	0	0
3643	0	0	3786	0	0
3644	0	0	3788	0	0
3645	0	0	3789	0	0
3646	0	0	3790	0	0
3647	0	0	3791	0	0
3648	0	0	3792	0	0
3649	0	0	3793	0	0
3652	0	0	3795	0	0
3654	0	0	3796	0	0
3655	A	0	3797	0	0
3656	0	A	3798	0	0
3658	0	0	3845	0	0
3659	0	0	3862	0	0
3660	0	0	3863	0	0
3661	0	0	3865	0	0
3662	0	0	3867	0	0
3663	0	0	3868	0	0
3664	A	0	3869	0	0

(cont'd)

Table 20 (concluded)

	Response			Response	
Number	*D. dorsalis*	*C. capitata*	Number	*D. dorsalis*	*C. capitata*
E-3870	0	0	E-3920	0	0
3880	0	0	3921	0	0
3887	0	0	3922	0	0
3892	0	0	3923	0	0
3894	0	0	3961	0	0
3913	0	0	3997	0	0
3914	0	0	4000	0	0
3915	0	0	4001	0	0
			4002	0	0

Table 21.—Quantitative Olfactometer Screening Tests.

Dacus dorsalis

Material	Conc. %	Water: Indices ♀♀	Water: Indices Both sexes	Water: Mean water catch	Standard: Indices ♀♀	Standard: Indices Both sexes	Standard: Mean water catch
				Attractants			
Dimethyl phthalate	0.1	6.0	5.7	13.0	1.8	2.0	186.7
Di-n-propyl phthalate	0.1	5.5	6.0	13.0	1.7	1.7	186.7
Di-iso-propyl phthalate	0.1	6.0	5.5	13.0	1.8	1.6	186.7
Octyl butyrate	0.1	4.5	3.4	3.0	0.8	0.8	184.7
Octyl iso-butyrate	0.1	5.5	4.1	3.0	0.9	0.8	184.7
Octyl phenylacetate	0.1	-	6.0	1.0	0.4	0.4	39.3
				Enhancers			
None							
				Repellents			
None							
				Obscurants			
Nitrobenzene	0.1	-	-	3.0	0.04	0.03	184.7
Octyl crotonylacetate	0.1	-	-	1.0	0.6	0.7	39.3
Octyl formate	0.1	-	-	1.0	0.2	0.2	39.3
Octyl phenylacetate	0.1	-	6.0	1.0	0.4	0.4	39.3
				No Effect			
Oenanthic acid	0.1	-	-	9.0	-	-	64.0
Pelargol	0.1	-	-	9.0	-	-	64.0
Phenoxyethyl iso-butyrate	0.1	-	-	9.0	-	-	64.0
				Ceratitis capitata			
				Attractants			
Dimethyl phthalate	0.1	1.7	1.7	37.0	0.7	0.8	127.7
Di-iso-propyl phthalate	0.1	1.9	1.9	37.0	0.7	0.8	127.7
Octyl butyrate	0.1	1.8	1.7	21.0	-	-	343.0
Pelargol	0.1	-	2.5	9.7	0.7	1.6	43.7
				Enhancers			
Oenanthic acid	0.1	-	-	9.7	-	1.3	43.7
				Repellents			
Nitrobenzene	0.1	0.2	0.3	40.3	0.15	0.14	343.0
Phenoxyethyl iso-butyrate	0.1	0.3	0.3	9.7	-	-	43.7

(cont'd)

Table 21 (cont'd), *Ceratitis capitata*, cont'd.

Material	Conc. %	Water: Indices ♀♀	Water: Indices Both sexes	Water: Mean water catch	Standard: Indices ♀♀	Standard: Indices Both sexes	Standard: Mean water catch
	Obscurants						
Dimethyl phthalate	0.1	1.7	1.7	37.0	0.7	0.8	127.7
Di-iso-propyl phthalate	0.1	1.9	1.9	37.0	0.7	0.8	127.7
Di-n-propyl phthalate	0.1	-	-	37.0	0.8	0.8	127.7
Octyl iso-butyrate	0.1	-	-	40.3	0.7	0.8	343.0
	No Effect						
Octyl crotonylacetate	0.1	-	-	7.7	-	-	59.0
Octyl formate	0.1	-	-	7.7	-	-	59.0
Octyl phenylacetate	0.1	-	-	7.7	-	-	59.0
	Dacus cucurbitae						
	Attractants						
Di-iso-propyl phthalate	0.1	25.5	11.3	5.0	1.6	1.7	26.7
Octyl butyrate	0.1	3.4	3.6	5.0	-	-	73.7
Pelargol	0.1	-	2.8	5.3	-	-	86.0
	Enhancers						
Octyl phenylacetate	0.1	-	-	3.7	2.0	2.0	91.0
	Repellents						
None							
	Obscurants						
Dimethyl phthalate	0.1	-	-	5.0	-	0.6	26.7
Nitrobenzene	0.1	-	-	5.0	0.03	0.02	73.7
Octyl formate	0.1	-	-	3.7	0.2	0.2	91.0
Oenanthic acid	0.1	-	-	5.3	0.3	0.4	86.0
Phenoxyethyl iso-butyrate	0.1	-	-	5.3	0.4	0.4	86.0
	No Effect						
Octyl crotonylacetate	0.1	-	-	3.7	-	-	91.0
Di-n-propyl phthalate	0.1	-	-	5.0	-	-	26.7
Octyl iso-butyrate	0.1	-	-	5.0	-	-	73.7

Olfactometer Test 279

Lure	Material
A	Standard lure.
B	Soy meal--1 week culture.
C	Soy flour--1 week culture.
D	Soy meal--1 week culture packed for shipping and held 1 week.

Lure	Per cent of standard mean					
	D. dorsalis		C. capitata		D. cucurbitae	
	♀♀	Both sexes	♀♀	Both sexes	♀♀	Both sexes
A	100.0	100.0	100.0	100.0	100.0	100.0
B	477.8	540.3	300.0	245.5	2525.1	1716.7
C	441.0	550.7	300.0	318.2	2870.0	1652.2
D	357.8	433.3	314.3	300.0	2016.3	1222.9
LSD 5%	82.1	100.4	270.4	159.9	623.7	807.2
Mean catch in standard	31.7	48.0	2.3	3.7	3.7	10.3

No significant difference was found between soy flour and soy meal which agrees with field results. The poorer results with the soy meal packed for shipping found here with *D. dorsalis* did not occur in the field.

Lures from Field Experiment 69 were tested in olfactometer test 280.

Olfactometer Test 280

Lure	Material
A	Standard lure
B	Standard lure plus 1% castoreum.
C	Soy meal--1 week culture.
D	Soy meal plus 1% castoreum.

Lure	Per cent of standard mean			
	D. dorsalis		C. capitata	
	♀♀	Both sexes	♀♀	Both sexes
A	100.0	100.0	100.0	100.0
B	213.3	205.8	45.8	70.1
C	135.0	145.1	371.0	380.6
D	207.2	203.6	133.6	198.1
LSD 5%	71.8	62.7	49.3	35.5
Mean catch in standard	60.0	102.7	35.7	51.6

There were not enough C. capitata in the olfactometer cage at this time to give a test. No significant gains were found for castoreum used with the soy meal lure for D. dorsalis which is in agreement with field results. The gain for castoreum used with the Standard Lure with D. dorsalis was not found in the field. There was a significant depression with D. cucurbitae for castoreum both with the Standard and the soy meal lures. Field catches of D. cucurbitae were too small to enable us to check this result in the field.

Our bacterium No. 14, which is used in preparation of proteinaceous lures and which was isolated from a number of bacterial strains obtained in the field from proteinaceous lure traps showing a high attractiveness, was submitted to Professor O. A. Bushnell of the University of Hawaii Bacteriology Department for identification. He reports that the organism is a Proteus, probably Proteus vulgaris. He is making additional tests to confirm the species.