UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Entomology and Plant Quarantine

ORIENTAL FRUIT FLY INVESTIGATIONS

QUARTERLY REPORT

July 1 - September 30, 1949

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This, the first quarterly report of the Oriental Fruit Fly Investigations, necessarily covers a period of organization and the coordination of activities of all agencies engaged in work on the oriental fruit fly. The foundation for this latter has been laid through the medium of a Memorandum of Understanding among the following agencies:

The Hawaii Agricultural Experiment Station
The Regents of the University of California and the California Agricultural Experiment Station
The Board of Commissioners of Agriculture and Forestry, T. H.
The Pineapple Research Institute of Hawaii
The Experiment Station of the Hawaiian Sugar Planters' Ass'n.
The Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, United States Department of Agriculture.

The Project has been singularly fortunate in these cooperative arrangements, which have already demonstrated their value and which will, without a doubt, continue to do so in an increasing measure.

The cooperation of the Washington Bureau must also be recorded at this time, because it is only through this that the gathering of a competent staff in such a short time has been achieved.

The problem of space was an acute one but this has been greatly relieved through the cooperation of the Administration of the University of Hawaii in purchasing a large surplus building and moving it to an appropriate site near the established fruit fly laboratory.

The Project has also had the advantage of taking over a small but well trained staff from the Division of Fruit Fly Investigations, so that actually three of the projects of the Investigations, namely Commodity Treatments, Biological Control and Chemical Control, were taken over as going concerns. All of these projects have been considerably strengthened and their facilities increased. The two newest projects, namely Area Control and Ecology-Biology, are necessarily in an early stage of organization, but even with these two projects considerable progress has been made in establishing fundamental concepts and the accumulation of essential preliminary data.

The Personnel Chart as of September 30, 1949, which is attached herewith, illustrates the present organization of the Investigations into five major projects. The Ecology-Biology Project is in two divisions necessitated by the physical separation of the synecological work on the islands of Maui and Hawaii. For all but the last named, line projects are available and are reported on by the division leaders on the pages that follow. The synecological work had not been organized to the point where formal division into line projects was feasible by September 30, and in this case the report is made on the basis of the working outline which heads the project leader's report.

These reports follow in the order given below:

Commodity Treatments

Biological Control

Chemical Control

Area Control

Ecology-Biology

AREA CONTROL PROJECT - WORK PROJECT - I-O-4 C. F. HENDERSON, LEADER

I-O-4-1.1.2 Effectiveness of DDT emulsion spray applied by airplane in area control studies

When the results of small-scale replicated plot tests now being conducted by the Chemical Control Project are completed, and information is available with regard to the more promising of the new organic insecticides, studies will be initiated to determine the effectiveness of these materials against the Oriental fruit fly when applied on an area basis. However, since DDT was the only insecticide available for such large-scale studies, tests were immediately undertaken to determine the effectiveness of this insecticide for use in area control. Gulches containing guava trees, and surrounded by large pineapple plantings, were selected as test areas. Such environments are conducive to high populations of the fruit fly, and are somewhat isolated with respect to adjacent infestations, since fruit fly larvae do not ordinarily mature in pineapples.

DDT was applied to the test areas by airplane, the only feasible method for this particular type of terrain. Applications were made at biweekly intervals, as tests with other insects had previously shown that the best results were achieved with this contact insecticide when a given seasonal dosage was divided into a number of small applications applied frequently. The emulsion type of spray was selected for the present tests, as the globular DDT crystals resulting from this spray were thought to weather much better than the needle-like crystals such as those from an oil solution. Furthermore, with an emulsion-type spray, less of the insecticide would be carried into the leaf tissues where its effectiveness as a contact insecticide would be lost. Dosages of 1 and 2 pounds of DDT per acre were employed in these tests. When applied at frequent intervals, these relatively low dosages are probably just as effective as much higher ones, are less expensive to apply, and may be used more widely from the standpoint of residue hazards. One and one-half gallons of spray liquid were applied per acre, as this was thought to be the smallest amount of spray that would result in a satisfactory coverage of the foliage, and, where large acreages are to be treated quickly as in area control, the lowest feasible gallonages must be employed.

Prior to the initiation of the area control studies in the Wahiawa gulches, an N-25 Stearman airplane of the Murray Aircraft Agricultural Service was calibrated to deliver 1 1/2 gallons of total spray liquid per acre on the basis of an 80-foot swath applied at an altitude of 25 feet. This involved using twenty-one 3/16-inch nozzles and a liquid pressure of 30 pounds per square inch. The spray boom was 30 feet long and the lower wings were equipped with wing-tip vortex dampeners. Several test runs were made at the Kipapa airfield, and the quality and distribution of the spray droplets observed on glass slides positioned perpendicular to the line of flight. The spray pattern and degree of recovery appeared to be very satisfactory from a visual standpoint, and it is intended

to repeat these tests when the chemical laboratory is functioning, using analyzations of paper targets as the criterion of effectiveness.

Six gulch areas having a total of 124 acres were selected for treatment, and two comparable ones of 37 acres were left untreated as checks (four additional check areas totalling 80 acres have since been added). The effectiveness of the insecticidal control operations applied in these test areas are evaluated by comparing fruit fly populations in traps installed in the treated and check gulches for this purpose, and by comparing the larval and pupal populations reared from fruit collected under trees in the same areas. The insect traps used in estimating fruit fly populations are placed in the centers of the respective gulches, in order to have a wide treated band on either side of the line of traps. It was also thought that traps placed in the bottom of a gulch were more representative of populations emerging from fruit grown within the test area than when placed along the rim, even though more total flies would be caught in the latter position. The acreages of the individual test areas, together with the numbers of traps and clearings, are shown in table 1.

Table 1 - Test areas for determining the effectiveness of DDT emulsion spray applied at biweekly intervals by airplane, Wahiawa gulches, 1949.

Name of Gulch	Treatment 1/	Acres (Approx.)	Traps (Number)	Cleared Areas (Number)
Kipapa 2	1	27	11	7
Waipio 3	1	23	14	7
Kaukonahua 5	1	17	8	8
TOTAL		67	33	22
Kipapa 1	2	17	11	6
Waipio 4	2	23	13	7
Brodie 6	2	17	12	10
TOTAL		57	36	23
Poamoho 8	-	17	6	6
Waipio 7B	-	20	9	6
TOTAL 2/		37	14	12

1/ Pounds of DDT applied at biweekly intervals in 1 1/2 gallons of total emulsion spray per acre.

2/ Five check areas (80 acres) have since been added, totalling 28 traps and 21 cleared areas.

As shown in table 1, there are 33 traps and 22 cleared areas in the 67 acres (3 gulches) receiving biweekly applications of 1 pound of DDT per acre, and 36 traps and 23 cleared areas in the 57 acres (3 gulches) receiving 2 pounds of DDT per acre. In the 37 untreated acres (2 gulches) there are 14 traps and 12 cleared areas. The insects from the traps are collected at weekly intervals for enumeration and study. In addition, recently-fallen fruits are gathered for rearing at biweekly intervals. The accurate collection of fallen fruit is made possible by previously clearing the grass and brush from large areas beneath trees selected as having fruits in all stages of development, and removing all fruits from these areas several days prior to the actual collection date. If a satisfactory DDT deposit is maintained, relatively few flies should be found in the traps within the treated gulches, and there should be a low incidence of infestation in fruits within the treated, as compared with the untreated areas. This is particularly true of fruits that had ripened after the initial spray applications were made.

To measure the DDT deposits and residues on the foliage in the treated gulches, leaf-samples for DDT analysis are collected before and after each spray application from one plot representing each treatment level. These samples are taken from the Kipapa 1 (2-pound treatment) and Waipio 3 (1-pound treatment) gulches as follows: Twenty-five leaves are gathered at random from the upper portion of three trees, and combined into a single composite sample for subsequent DDT analysis. An identical number of leaves are then taken from the lower branches of the same trees and combined into another sample. This procedure is repeated at four locations in each of the two treated gulches where samples are being taken for DDT residues. In addition, 25 leaf-samples are taken on the upper and lower portions of each of two trees in an untreated area (Waipio 7A) as a check. In each case, the leaf-samples are placed in small paper bags, properly labeled, and held for future analysis. Representative leaf-samples are also taken for the measurement of surface areas. These areas will later be compared with dry-weight figures in order to establish an index for calculating the DDT foliage residues in terms of pounds of insecticide per acre of leaf surface. Twigs are also gathered in the same treated and untreated gulches before and after treatment for biological assays which are being conducted by the Chemical Control Project.

The first and second applications of DDT emulsion spray were made in the six treated gulches on September 7-8 and 20, and trap collections were taken on September 7 (pre-treatment counts), September 13 (one week after treatment), September 20, (two weeks after the first application and pre-treatment for the second), and on September 27 (one week after the second application). The results of the counts are shown in table 2.

Table 2 - Effect of DDT treatments applied by airplane on Oriental fruit fly populations. Wahiawa gulches, September 1949.

Area	Biweekly Treatment 1/	Oriental Fruit Fly Adults Per Trap-Day			
		9/7 2/	9/13	9/20 2/	9/27
Kipapa 2	1	22	3	9	5
Waipio 3	1	9	4	4	2
Kaukonahua 5	1	7	2	4	3
Kipapa 1	2	6	1	2	1
Waipio 4	2	18	2	7	4
Brodie 6	2	65	10	1	1
Poamoho 8	-	30	34	35	63
Waipio 7B	-				29

1/ Pounds of DDT applied at biweekly intervals in 1 1/2 gallons of total emulsion spray per acre.

2/ Also treatment date.

It will be noted that fruit fly populations were reduced immediately after the first application, but in four of the six cases increased during the second week following treatment. Further reductions occurred after the second application. However, populations in the treated areas were not reduced as greatly as would have been expected from the quantity and distribution of the DDT residues visible on the foliage, even though they were much lower than populations in the checks, which showed a continual upward trend from September 7 to 27. The relatively poor results were probably due to the confinement of most of the insecticidal residue to the upper surface of the leaf, whereas fruit flies spend most of their time on the under surface. This is unfortunate from an area control standpoint, as it is difficult to visualize equipment capable of treating large areas of rough terrain quickly, and at the same time applying the DDT to the under surfaces of the leaves. It is possible that this may be accomplished by a helicopter, and tests are contemplated with this type of equipment.

Since there is a pre-oviposition period of approximately 12 days under field conditions, it is believed that most of the emerging flies might have been killed by the DDT residues before depositing any appreciable number of eggs. It is possible that, in the treated areas, the flies in the traps are caught during the pre-oviposition period, in which case the percentage with mature eggs should be much lower than in the respective untreated areas. In the future, females caught in the traps within both treated and check areas will be dissected to determine the percentage containing mature eggs. Populations of larvae and pupae

reared from those same areas should also shed further light on this subject.

I-O-4-1.2.1 Selection of most suitable lure for use in area control trapping surveys.

Traps containing a suitable lure are used to great advantage for estimating Oriental fruit fly populations in connection with the delimiting of various areas for treatment, tracing fly movements from one area to another, and evaluating the final results of control operations. Since pre- and post-treatment population figures should be on a comparable basis, even though taken one year apart, it was necessary to select the best available lure before the present trapping operations were begun. It is realized that more intensive studies with lures will be undertaken by the Chemical Control Project, and more effective attractants will undoubtedly be discovered. However, for the present it is more important to have a lure which may be used on a comparable basis this year and next, even though less effective than a newly-discovered one from the standpoint of total flies caught over a given period of time. Consequently, the following five available lures were tested during two successive 5-day exposures, using freshly mixed materials at the beginning of each exposure period. (table 3):

Table 3 - Effectiveness of different lures for attracting Oriental fruit flies. Waimanalo, September 1949.

Lure 1/ 2/	Test 1			Test 2			Average		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
1. Raw sugar, vinegar, yeast and water	248	36	284	284	149	433	266	93	359
2. Refined sugar, brewer's yeast, pyridine and water	216	33	249	259	55	312	237	44	281
3. Raw sugar syrup, vinegar, yeast and water	109	40	149	238	122	360	174	81	255
4. Refined sugar, brewer's yeast, pyridine and water 3/	134	45	179	194	97	291	164	71	235
5. Raw sugar syrup, vinegar, and water	131	30	161	145	52	197	138	41	179

1/ With exception of No. 4, all lures were prepared 24 hours prior to installation of traps.

2/ Fleischman's yeast except when otherwise indicated.

3/ Refined sugar, yeast, and water mixed 20 days previously—pyridine added 24 hours prior to installation of traps.

It will be noted that the raw sugar-vinegar-yeast formulation showed the most satisfactory catches of both male and female flies. The fresh pyridine lure was second in total flies, followed in order by the raw sugar syrup-vinegar-yeast, old pyridine, and raw sugar syrup-vinegar-without yeast.

It is of interest that a raw sugar-vinegar-without yeast formula which was also tested with the second series (but not included in the table) caught 406 flies (126 females and 280 males). This was the second best lure tested in that particular series. It might be possible to use this formula, thereby avoiding the sediment usually incurred 5 days after exposure in traps containing yeast.

On the basis of these ten replicated tests, the raw sugar-vinegar-yeast formula was selected for use in future area control trapping studies. This lure was found to be the most effective under the conditions of the tests, less expensive to prepare than the second-place pyridine formulation, and not as obnoxious from the standpoint of the odor during preparation.

In connection with the liberation of marked Oriental fruit flies on the Island of Maui to determine whether or not they were carried to Lanai, either by flight or through movement in air currents, a supplementary study was made to determine optimum trapping periods during the day. Thirteen trapping stations distributed in vegetation growing along the northeastern shore of Lanai were visited at bihourly intervals, and the insects contained within the traps enumerated. The results are shown in table 4.

Table 4 - Oriental fruit flies collected at bihourly intervals in traps positioned along northeast shore of Lanai, August 7, 1949.

Trap No.	Adult Flies Collected at Bihourly Intervals 1/ 2/					
	Morning			Afternoon		
	6 - 8	8 - 10	10 - 12	12 - 2	2 - 4	4 - 6
1	6	28	0	2	2	0
2	2	3	0	8	4	0
3	5	13	1	4	1	0
4	1	9	0	1	0	0
5	1	3	0	1	1	0
6	1	3	2	7	0	0
7	15	16	4	3	0	0
9	2	24	2	3	3	0
9	3	6	0	1	2	0
10	1	9	1	0	0	0
11	4	22	6	2	13	1
12	6	6	0	0	0	0
13	13	20	0	0	0	2
Total	60	162	16	32	26	3
Percent	20.1	54.2	5.3	10.7	8.7	1.0

1/ Citronella used as lure - all insects therefore males.

2/ In addition, 19 flies were collected between 6 p.m. and 2 a.m. the following day - an average of 5 flies per 2-hour interval.

It will be noted that the highest catches of Oriental fruit fly males occurred between 8 and 10 a.m. when 54 percent of the flies for the 12-hour period were trapped, and between 6 and 8 a.m. when 20 percent were caught. There was some renewed activity between 6 p.m. and 2 a.m. the following day, but the greatest movement to the traps occurred in the early morning.

I-0-4-2.1 Herbicides for destroying desirable food plants of no great economic importance

A representative of the Pacific Chemical and Fertilizer Company took the writer to Kunia where tests to determine the effectiveness of different 2, 4-D formulations for killing large guava trees, are now in progress. Excellent results were apparently achieved by spraying trunks up to 6 inches in diameter with the isopropyl ester of 2, 4-D, or Gaviota Hormone 4 (a 2, 4-D weed killer), dissolved in diesel oil. Aqueous preparation are not satisfactory for this purpose as they do not penetrate the bark sufficiently.

The procedure used in controlling stands of guava was to spray one side of the trunk, beginning at a height equal to four times the trunk diameter, and extending the sprayed area to the ground in one continuous stroke. A flat nozzle produces the best results, as this type of spray covers one-half the circumference of the trunk in one operation. When quicker kills are desired, areas twice the length of the trunk diameter are sprayed on opposite sides of the trunk at the base of the tree, thus completely wetting the entire circumference. For areas to be cleared immediately, the shrubs or trees should be cut down as close to the ground as possible, and the top of the cut stump thoroughly drenched with a 1 to 9 dilution of Gaviata Hormone 4 in diesel oil.

Where one application of a minimum dosage (1 liquid ounce) is made on guava trees with a trunk diameter of 4 to 6 inches, approximately 12 months are required for a complete kill. Such treatments require only a second to apply, and the cost of killing trees of this size is less than one cent each. Tests have not shown 2, 4-5-T to be any more effective than 2, 4-D for killing guavas, although the former is at least twice as expensive.

The use of 2, 4-D for killing guava trees will be tested in connection with area control operations. The effectiveness of this treatment will be determined in a rather isolated area, and the cost of the entire operation carefully analyzed. Since only one application of a herbicide is required over a period of years, it is possible that the destruction of this host by 2, 4-D will be an economical procedure for reducing fruit fly populations, especially when used to supplement other control procedures. Defruiting hormones will also be tested for accomplishing the same results on trees and shrubs that are desirable to retain.

I-0-4-4.2 Surveys to determine infestation categories for area control studies

An important phase of the area control studies is to establish and evaluate categories of infestation for future use in large-scale control operations. This includes delimiting infested areas, studying the movement of flies from one area to another, and determining relative population densities in the various infested areas. These objectives may be accomplished most feasibly by trapping flies in the areas under study.

Three types of locations are available for future area control studies in the vicinity of Honolulu. These include large guava areas in the foothills and valleys near Tripler hospital, the residential sections at Damon and Ewa villages, and the John Rogers, Hickam, and Barber's Point airfields.

Foothill and valley areas - The Tripler infestation consists of a large guava area lying northeast of the John Rogers and Hickam airfields. Although not fruiting heavily at present (September), on the aggregate a tremendous number of fruits are involved. Observations are being made on the ripening of guavas in this area, and it appears that most of the ripe fruits of the present crop have already fallen. Apparently, there will be quite a definite break before fruits of the next cycle will begin to ripen. Because of the extent of the area involved, and its proximity to the villages and airfields on the leeward side in the direct path of the prevailing winds, this area could be an important source of fruit fly infestation. Ten traps are located in the guavas, and 5 in the dry sections below the hospital. The later should intercept flies moving from the guava area towards the villages and airfields. Marked flies will be liberated at different points in the Tripler area, and attempts will be made to recover these insects in traps at Damon, Ewa, and the airfields.

The Kalihi and Moanaloa valleys are to the northeast of the John Rogers, Hickam, and Barber's Point airfields, and are of particular interest with regard to the fruit fly populations found in these airfields, and in the adjacent Damon and Ewa villages. These valleys run in a northeasterly direction from the above locations, and serve as a natural passage-way to the windward side of the island where large, heavily-infested guava areas are known to occur. In addition, the valleys themselves contain a considerable amount of guava. Flies marked with one color will be liberated on the windward side of the island, and ones with another color in the Kalihi and Moanaloa valleys. It is desired to determine whether or not flies liberated in the former area will be picked up in traps located in the Kalihi and Moanaloa valleys, Damon and Ewa villages, and the airfields; and if ones liberated in the two valleys will be found later in the villages and airfields. There are 15 traps in both the Kalihi and Moanaloa valleys, and additional traps will be installed in the respective areas to increase the chances of recovering liberated flies.

Damon and Ewa villages - Damon and Ewa villages are to the northeast of the John Rogers, Hickam and Barber's Point airfields, and in the direct path of the prevailing winds. In turn, these villages are in direct line with the

prevailing winds from the Kalihi and Moanaloa valleys. The villages contain many hosts of the Oriental fruit fly, and their proximity to the airfields makes them a potentially dangerous source of infestation to these important dissemination points.

Detailed inspections were made of the Damon Tract to observe the type and abundance of Oriental fruit fly hosts, and to study the problems and possibilities involved in using this area for large-scale control studies. Considerable time was spent by Area Control Project personnel in preparing a detailed map of the area, plotting residential and other buildings, truck gardens, fish ponds, fruit fly host plantings, etc. This map will be useful in planning area control operations when such are deemed advisable. Thirty-six traps are included in this area. Ewa has also been inspected in some detail, but no map was made. At Ewa there are more fruit fly host plantings than at Damon, and this would probably make an excellent test area for control studies. Thirty-six traps are located in the Ewa area.

Marked Oriental fruit flies will be liberated in both villages to determine whether or not these insects move to the John Rogers, Hickam, and Barber's Point airfields. Marked flies from the foothill and valley areas will also be searched for in the Damon and Ewa traps, as well as in those at the airfields. If it could be shown that female fruit flies do not move from the foothill and valley breeding areas to the villages and airfields, the villages would make excellent test areas for control studies. The effectiveness of the different control operations could be measured from trap collections, and from larval and pupal rearings from fruit gathered in the respective areas. If it were shown that the females moved to the adjacent airport from the villages, but not from the foothill and valley areas, trap collections at the airfields could also be used as a criterion of effectiveness of the treatments employed.

Trap collections were made at Ewa, Damon, and Moanaloa valley on September 29-30, and the results are shown in table 5.

Table 5 - Oriental fruit fly populations in area control surveys. September, 1949.

Area	Type of Environment	Date of Collection	Oriental Fruit Flies per Trap-day			Percent Female
			Male	Female	Total	
Ewa	Residential	9/29	15	17	33	53
Damon	Residential	9/29	7	10	17	60
Moanaloa	Valley	9/30	17	17	35	50

Populations were rather high in these areas, and approximately 50 percent of the flies caught in the traps were females. These figures will be of value as

pretreatment population estimates for comparison with post-treatment counts, if control operations are undertaken in these areas at a later date.

Rogers, Hickam and Barber's Point Airfield - Traplines are maintained at these three airfields by the Division of Foreign Plant Quarantines. The data from these surveys are available to the Area Control Project, and will be very useful in measuring the effectiveness of control operations applied in breeding areas contributing populations of fruit flies to these potentially important dissemination points.

I-0-4-6.1 A funnel-type rearing cage equipped with a juice trap.

Because of the delay in getting a sufficient number of holding boxes for rearing larvae and pupae from guavas in connection with the area control studies in the Wahiawa gulches, attention was given to the securing of some prepared container which might be substituted for the conventional box-type holding box. After different types of containers were tested, a galvanized iron funnel was selected as the most suitable for our purpose.

This funnel has a 12 x 3-inch collar on top, and slopes downward in an over-all length of 5 inches to a 4 1/2 x 2-inch collar. A 1/4-inch mesh hardware cloth screen disk placed in the funnel keeps the fruit in the upper compartment, and a piece of cheesecloth fastened to the upper collar with a rubber band serves as a top. The funnel partially filled with fruit is placed on a 1-gallon tin-can having about 1/2 inch of sand on the bottom in which the larvae may pupate.

This type of holding box is particularly advantageous, as a juice trap may be attached to the lower end of the funnel, making possible the removal of the excess liquid which often drowns the larvae and greatly interferes with sifting operations. With the juice thus removed, a smaller amount of sand may be used and the moisture content regulated as desired.

I-0-4-7.0 Area control studies on Lanai (I. Keisor)

Investigations were made of the possibilities of area control studies on the Island of Lanai. There are apparently two categories that lend themselves to this type of study - the residential parts of Lanai City, and the guava areas at the base of the mountains. While Lanai is seemingly an ideal location for evaluating the effectiveness of large-scale control operations, because of the comparatively small size of the host area involved, the problem of reinfestation from Maui makes difficult a valid evaluation of the control procedures practiced. This problem may be resolved in time, as studies are made to determine the effectiveness of such treatments under these conditions. Before any control is applied, however, it was thought advisable to make a rather comprehensive survey of fruit fly populations on this island, the movement of insects from one portion to another, the degree of reinfestation from Maui, and the

concentration of populations in different portions of Lanai with respect to food and shelter plants.

To determine the distribution of fruit flies over the island, and to study their movements, trap lines are being radiated from Lanai City in four directions. One line is in a northwesterly direction and ends at Palahinu Point, almost at the northwest tip of the island. Traps were also installed on the road from Kaumalapau Harbor towards the city, with some being placed on power line poles in a large pineapple planting. There is a small village at the harbor, with citrus, mango, and papaya trees scattered among the several houses. Some residents complained of fruit fly damage to citrus, mango, and pear fruits in their yards. Traps were also installed on the road leading from the city to Manele Beach. These were placed in kiawe trees along the beach, and in a nearby fishing camp. Kahoolawe and Maui may be seen from this point, but not from Manele Beach. The climate is comparatively hot, but no fruit fly food plants were observed. At Manele Beach a breeze comes in from the sea rather than the prevailing winds from Maui or Lanai. Therefore, any flies trapped in this area may be considered as having moved in without the benefit of the wind. Traps were also installed from the city to Halepalaoa Landing.

In addition to the above trap lines, a number of traps were installed in Lanai City. Traps were also set up on the hill above the city, in the nearby ranch village, and on the benches along the base of Lanaihale. There are now 168 traps installed on the Island of Lanai. Also, fruits have been purchased from a number of residents in Lanai City, and these will be picked from time to time as they become ripe for rearing studies.

Summary - Area Control Project

Field tests are in progress to determine the effectiveness of DDT spray applied by airplane in controlling the Oriental fruit fly on an area basis. Rather isolated gulches containing guava trees were selected as test areas, and applications were made at rates of 1 and 2 pounds of DDT applied in 1 1/2 gallons of total emulsion spray per acre. The treatments are evaluated by comparing fruit fly populations collected weekly from traps in the treated and untreated gulches, and larval and pupal populations reared from guava fruits collected biweekly from the same areas. Although populations in the treated areas following the second spray application were lower than those in the checks, they are higher than would be expected from the quantity and distribution of spray residues. However, very little DDT was found on the under surface of the leaves where the fruit fly spends most of its time. This probably accounts for the relatively poor results achieved thus far.

Traps filled with suitable lure are used for estimating fruit fly populations in delimiting areas for subsequent treatment, tracing fly movements, and evaluating the results of control operations. In order that counts made before and after application are on a comparable basis, it was necessary to select the best available lure before the present trapping surveys were initiated. Tests conducted with various lures indicated that one containing raw sugar, vinegar, yeast and water was the most satisfactory, and this lure was selected for future area control trapping studies.

Studies now in progress by the Pacific Chemical and Fertilizer Company to determine the effectiveness of 2, 4-D in killing guava trees were reviewed, and the field test plots visited. Excellent results were achieved against guava trees of 4 to 6 inches in diameter by spraying the base of the trunk for a distance of four times the trunk diameter with a solution of 2, 4-D or Gaviota Hormone 4 in diesel oil. By using a flat spray, one-half of the circumference is wet in one operation. The cost of killing trees 4 to 6 inches in diameter is less than one cent each, and, since only one application of herbicide is required over a period of several years, the use of 2, 4-D might be an economical means of reducing populations of the fruit fly, especially when used to supplement other control procedures.

To determine where area control studies may be successfully conducted, categories of infestation are being studied in the vicinity of Honolulu. Trap lines have been established in the guava areas of the valleys overlooking the harbor, in the villages lying to the leeward, and in the adjacent airfields to determine relative population densities in these different environments. Marked insects will be liberated in the various areas to study fly movement, and thus determine which areas may be used for area control studies with a minimum amount of reinfestation from outside sources. When such areas have been selected, large-scale control operations will probably be undertaken.

A funnel-type holding cage was developed for rearing larvae and pupae from fruits gathered to evaluate the effectiveness of area control operations. This cage has an advantage over the conventional holding box, as the small end of the funnel may be equipped with a trap to remove all excess juice. With the juice thus removed, a smaller amount of sand may be used, and the moisture content regulated as desired.

Because of the small size of the host areas involved, Lanai would appear to offer excellent opportunities for area control studies. However, there are possibilities that this island is being continually reinfested with fruit flies from Maui, and this would make difficult a valid evaluation of the control operations practiced. Before studies of this nature are initiated, therefore, it will be necessary to make a comprehensive survey of fruit fly populations on Lanai. Such studies are in progress, with traplines radiating from Lanai City across the island in four directions, at the base of the mountain and on the benches behind the city, and in the city itself. Larval and pupal rearings will also be made from fruits collected in the various areas to compare pretreatment with post-treatment populations if future control operations are to be conducted.

OUTLINE OF LINE PROJECTS

AREA CONTROL PROJECT, Work Project I-0-4, C. F. Henderson, Leader

I-0-4-1.0 Insecticidal Control Studies
- 1.1 Sprays and dusts
  - 1.1.1 Insecticides and formulations
  - 1.1.2 Dosages and frequency of application
  - 1.1.3 Residue hazards
- 1.2 Lures
  - 1.2.1 Testing of lures for control studies
  - 1.2.2 Practicability of lures for use in area control

I-0-4-2.0 Cultural Control Studies
- 2.1 Herbicides
  - 2.1.1 Testing new organic herbicides for control studies
  - 2.1.2 Practicability of herbicides for use in area control
- 2.2 Hormones
  - 2.2.1 Testing defruiting hormones for control studies
  - 2.2.2 Practicability of hormones for use in area control

I-0-4-3.0 Equipment and Methods for Area Control
- 3.1 Studies with existing equipment
- 3.2 Development of new equipment
- 3.3 Methods of treatment
  - 3.3.1 Residential areas
  - 3.3.2 Farming areas
    - Orchards
    - Crop land
  - 3.3.3 Outlying breeding areas

I-0-4-4.0 Surveys
- 4.1 Development of survey procedures
- 4.2 Population surveys
  - 4.2.1 Delimiting old infestations
  - 4.2.2 Determining degrees of infestation
  - 4.2.3 Tracing fly movements

I-0-4-5.0 Biological Control
- 5.1 Relationship to insecticidal control
- 5.2 Use as area control measure

I-0-4-6.0 Apparatus and Technique
- 6.1 Rearing of larvae and pupae
- 6.2 Fruit fly trapping

Area Control Project Outline - 2

I-O-4-7.0 Studies on Lanai

7.1	<u>Insecticidal control studies</u>	
7.1.1		Sprays and dusts
7.1.2		Lures
7.2	<u>Cultural control studies</u>	
7.2.1		Herbicides
7.2.2		Hormones
7.3.0	<u>Surveys</u>	
7.3.1		Population surveys
7.3.1.1		Delimiting old infestations
7.3.1.2		Determining degrees of infestation
7.3.1.3		Tracing fly movements.