

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

I-c-1 Ecology and Biology of the Oriental Fruit Fly.

BRIEF

1. Introduction
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3. Personnel
4. Physical Plant
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 - Vehicles
 - Non-expendible Equipment
5. Formulation of Plans and Initial Surveys
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 - a. Stations
 - b. Trap Lines
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 - B. Maui
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 - b. Life History Cages
6. Establishing the Insectory on Maui
7. Photographic work.
8. Inspections
9. Vanda Orchid Survey
10. Maps of Stations and Meteorological Data
11. Fruit Collections on Maui and Hawaii
12. Preliminary Findings on Dacus dorsalis Hendl.
 - A. Studies on Hawaii
 - a. Longevity Studies
 - b. Sexual Maturity
 - c. Oviposition
 - d. Hatching of eggs
 - e. Larval development
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 - g. Quantitative studies
 - h. Establishment Exp. Koanikolu
 - i. Movement studies on Mauna Loa Truck Trail
 - j. Exhibits.
 - B. Studies on Maui
 - a. Life History Cages
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 - e. A comparative study of fruit attractiveness
13. Reports Submitted
14. Summary and conclusions

1. Introduction

In this initial quarterly report which will include the beginning of this project, much of its content must necessarily deal with the formulation of plans, surveys, buildings, working facilities, and other practical considerations which appear rather distant from the actual study of the fly. These studies which have gotten under way, we are apt to find in the embryonic stage and embarrassingly incomplete. But as the work progresses, as the data is compiled, as we grapple with the problem, we become increasingly cognizant of the fact, that here indeed, is a worthy adversary.

2. Scope

The ecological and biological studies of Dacus dorsalis Hendl. are being undertaken on three islands, Oahu, Maui, and Hawaii. On Oahu, the headquarters for the Oriental Fruit Fly Investigations, the work on climate cabinets will be done. Mr. Norman Flitters, Asst. Project Leader, will cover that phase of the work in his report. Certain work being done on Oahu by Mr. Raymond Inafuku, particularly fruit collections and population trends will be reported separately. This report, then, will cover the work being done on Maui and Hawaii which is more of a synecological nature.

3. Personnel

Professional

Maui, T. H.

K. L. Mehler, P-5, Project Leader

Oahu, T. H.

H. Flitters, P-4, Asst. Project Leader

Hawaii, T. H.

C. Davis, P-3, In charge Hawaiian Studies

A. Mitchell, P-1, Asst.

Sub-Professional

Maui, T. H.

R. H. Miyabara, SP-1, Scientific Aid

G. Furtado, SP-1, Scientific Aid

M. H. Tavares, SP-1, Scientific Aid

Hawaii, T. H.

S. Hainagawa, SP-4, Scientific Aid

Oahu, T. H.

G. Sadoyama, SP-4, Scientific Aid

H. H. Feikert, Jr., SP-1, Scientific Aid

4. Physical Plant

A. Buildings

On Hawaii there are two insectories, one at Hilo, where most of the work is carried on and one at Keanakolu which is used principally for the studies concerning the orchard there. The Hilo insectory was a surplus army building which was moved into its present site in Hilo. There is also a small building which is used as a bunk house at Keanakolu.

On Maui a 60' x 20' quonset was obtained through C.A.A. and moved from the Sunnens Airport to the site selected in Kula.

B. Vehicles

On Hawaii there are two vehicles, one a jeep panel and the other a standard jeep. Maui at present has a Chevrolet Panel, 1943 model, but recently a jeep transferred from the Division of Foreign Plant Quarantine has been acquired. This vehicle when it is overhauled should leave the transportation facilities adequate.

(3.) Proposed Experiments - In addition to the survey of the stations and the placing of the trap lines the following outlined experiments were planned for Hawaii.

(a) Keanakolu Orchard - In an orchard at 5200 feet elevation where D. dorsalis does not occur, adults will be released in view of getting the following information:

1. Will the fly establish itself under these climatic conditions?
2. What will the effect be on:
 - a. Longevity
 - b. Sexual maturity
 - c. Oviposition
 - d. Egg hatching
 - e. Larval development
 - f. Fly emergence
3. Will the released flies stay in the immediate area?

Procedure

1. Establishment Experiment
 - a. Capture 1050 males and 1050 females in the field.
 - b. Dissect 50 males and 50 females to determine the percent of sexually mature flies.
 - c. Before releasing flies remove traps from the orchard and pick up the fallen fruit.
 - d. Mark thorax with Chinese lacquer after inactivating the flies with ether or cold.
 - e. A week after flies are released collect all the ripe fruit and put in holding boxes. Send half of held fruit to insectory in Hilo and retain the other half at orchard insectory. Report weekly.
2. Longevity Experiment
 - a. Cage 100 males and 100 females newly emerged and hold for longevity test. Feed with media formulae (600 cc. papaya, 20 grams yeast, 10 cc. honey).
 - b. Add a new cage of flies each month for a year to obtain relative longevity throughout year.
3. Sexual Maturity Experiment
 - a. Cage 100 males and 100 females and beginning at the 25th day and continuing until sexual maturity is established, dissect 10 males and 10 females at weekly intervals.
 - b. Duplicate experiment as a control at Hilo.
4. Oviposition Experiment
 - a. Observe released flies for oviposition.
 - b. Cage 50 flies (field collected at Hilo) and observe if they oviposit.

5. Hatching Experiment

- a. Take eggs oviposited at Hilo and divide into two portions. Take one portion to Keanakolu and retain a control at Hilo.
- b. Take eggs oviposited at Keanakolu and divide into two portions. Take one portion to Hilo and retain a control at Keanakolu.

6. Larval Development

- a. Take first, second and third instar larvae from Hilo to Keanakolu and observe development.
- b. Take first, second and third instar larvae (if available) from Keanakolu and observe development at Hilo.

7. Fly Emergence

- a. Bring pupa from Hilo and check emergence at Keanakolu.
- b. Bring pupa from Keanakolu to Hilo and check emergence.

8. Fly Travel

- a. Check trail trap for marked flies.

(b) Manna Loa Truck Trail - On a trail which is 11 miles long and offers an elevation change from 4000 to 6700 feet and at least one good host (Solanum pseudocapsicum), carry on investigations in an attempt to get the following information:

1. At what elevations will the fly occur?
2. What is the limiting factor, host availability or climate?
3. What is the fruiting season of the host?
4. How important is elevation and temperature to fruiting periodicity?
5. How far will the flies travel?
6. Is there an advance and retreat of fly population on the slope correlated with season?

Procedure

1. Place citronella traps at 1/2 mile intervals from the start of trail to 6700 feet. This preliminary survey will indicate where the flies occur.
2. Replace index trap with McPhail traps and use a fermented lure for quantitative studies. (Formula 80 gr. sugar, 1.5 gr. Brewer's yeast, 1 liter water), ferment 48 hours, then add pyridene (10% sol. in alcohol) at rate of 2% pyridene).
3. Survey host fruit range and observe fruiting and flowering and abundance correlated with elevation.
4. On marked plants use quadrat method and take samples at elevation of 4000, 5000, 6000, and 6700. Collect ripe fruit weekly and count, weigh and take volume.

5. Release marked flies at the summit (5000⁰⁰ and 5000⁰⁰) and check traps for their appearance. Duplicate the experiment releasing the flies at the start of the trail. Compare flight range at 4000 and 6700 feet.
 6. Make weekly quantitative studies using McPhail traps and compare population trends at the end of the year with meteorological data and fruiting of host.
- (c) Host Studies - To obtain information on hosts, host preference, host distribution and relative efficiency as media, collect all host material possible and keep data as to locality, fruiting or flowering condition, elevation, number, weight and volume of fruit, pupa reared, adult emergence and sex percentage. These studies will be particularly desirable on the Keanakolu trail and in the area of Puuwaawaa.
- (d) Longevity and Sexual Development Studies - At all stations where there are meteorological instruments duplicate the experiment in (a). Procedure, sub-paragraphs 2. and 3. (Page 77).

B. Maui - Having completed the survey of Hawaii the writer returned to Honolulu where several field trips were made with Mr. Raymond Inafuku who was running a number of fruiting stations and trap lines. The first part of August was concerned with getting equipment together for Hawaii and Maui. On August 8, 1949, the writer left in the company of Dr. Walter Carter for a survey of Maui. In this investigation we were accompanied by Dr. Paul F. Sharp, Director of California Agricultural Experiment Stations and W. C. Jacobson, Assistant Director, Department of Agriculture of California.

The life history stations on Maui were selected to obtain as complete a picture of the climatic variation as possible. Maui offers an unusual opportunity in this respect, for it is easy to drive from sea level to 10,000 feet elevation in about an hour. This made the selection of the following stations feasible.

Kula Farm: (3000) This station is characterized by dry summer months with moist springs and fall seasons. With an annual rainfall of 35 inches it is an area strongly reminiscent of the California Bay area.

Haleakala Station: (7030) The effect of low temperatures upon the fly will be undertaken here.

Haiku: (500) This Territorial Nursery with its mango and avocado will be used principally for quantitative studies of fly population correlated with host availability.

Waikamoi: (4250) This station, deep in the rain forest, will be used to study the effect of excessive humidity on the fly. As is indicated on the precipitation chart the mean annual ppt. is 230 inches.

Insectory Site: It was desirable that the insectory site be accessible to as many stations as possible. The upper Kula region was indicated as a good place for a building.

- (2) Life History Cages - It was planned to establish the flies in cages which would offer as natural an environment as possible. Cages were constructed 6'x6'x6' on a platform elevated about 18" off the ground so that they could be ant-proofed. They were assembled with bolts which made it possible to knock down a cage or put it together in about ten minutes. The cages were placed at different stations and comparative data compiled on the varying climatic effect on the fly. The cages will be discussed at greater length in the paragraphs concerning the initial experiments with them.

6. Establishing an Insectory on Maui

Returning to Honolulu on August 9, future planning was accomplished there and on August 17th the writer again returned to Maui. The objectives of this trip were to select a definite insectory site, obtain a building and get an estimate on the life history cages and incidentally obtain a place of residence. These objectives were accomplished and the writer returned to Honolulu on the 19th. The details regarding the building were included in a report to William Edwards, August 18, 1949. Briefly the building, a quonset 60' x 20', was obtained through the C. A. A. at the Puunene Airport and moved intact on a low-bed trailer about twenty-five miles to the chosen site at Kula.

On August 25 the writer moved his headquarters to Maui where the next three weeks were spent in establishing the insectory, surveying the station sites, getting the life history cages in place and making general preparations for the ecological studies. The quonset was moved into place on the 15th of September having been granted clearance by C. A. A. on the 14th. On September 10 the government transportation arrived having been held up at San Francisco because of priority cargo. By the end of September the laboratory was a "going concern" and the round of preliminary activities were over. Finally we were getting down to the business of the day--the Fly.

7. Photographic Work

On October 9, Mr. Clower, the photographer for the Department of California arrived and spent two days taking color movies of the beginning of the ecological work. During the first day the weather was unsatisfactory for taking pictures but the following day some good shots of a number of infested fruit were taken. Mr. Clower then left for Hawaii where he expected to take the rest of the story.

8. Inspections

Dr. Walter Carter arrived on October 4 and made a complete inspection of all the stations. The details of this are covered in my report to Dr. Carter Oct. 9. Having made a survey of the Maui facilities he left for Hawaii accompanied by the writer on the 5th. The Hawaii Stations were inspected and recommendations made. The writer left Hilo October 8 to return to Maui.

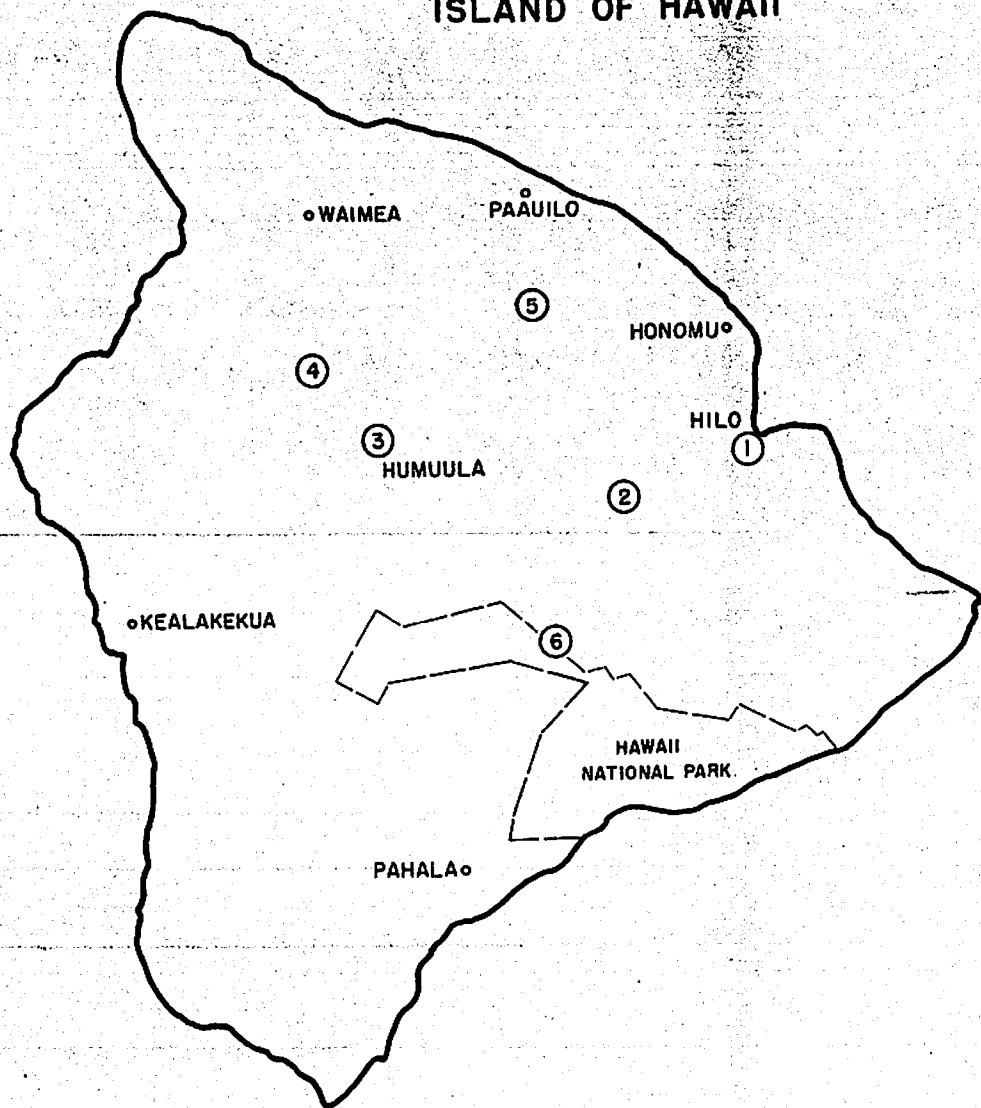
9. Vanda Orchid Survey

During the above inspection trip a check of the Vanda orchids other than Miss Joaquim were made to determine if they were being stung by the fly, ("Vanda Orchid Survey," Oct. 8, 1949). Below is a summary of the findings:

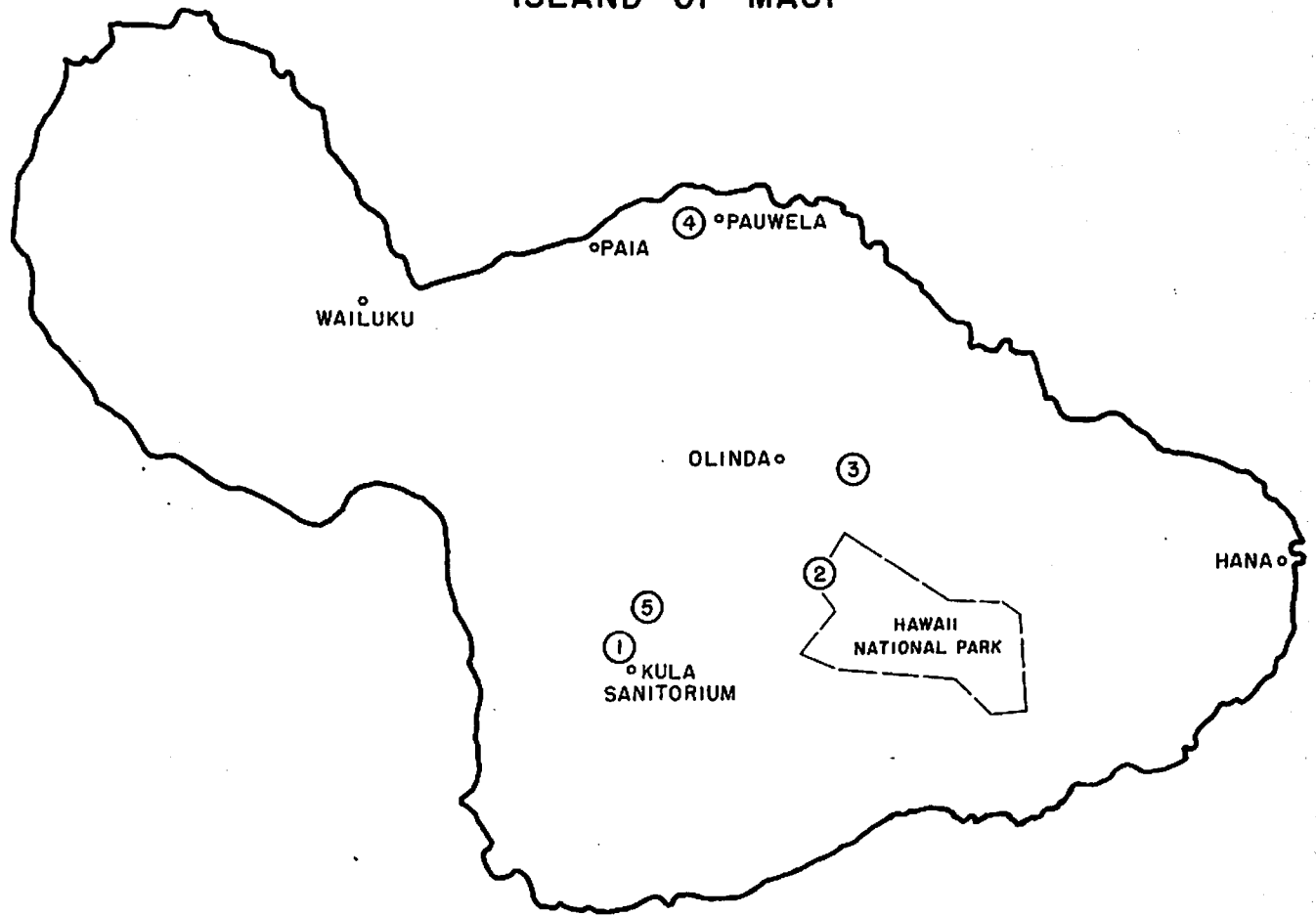
Total orchid plants inspected	102
" flowers inspected	1,861
" buds inspected	181
" units inspected	2,042
Evidence of oviposition	1 egg

The one egg was found deposited upon the bud of a Clara Shipman Fisher in Mrs. Hill's collection on Hawaii. It was not inserted in the tissue but lay upon the surface of the folded bud.

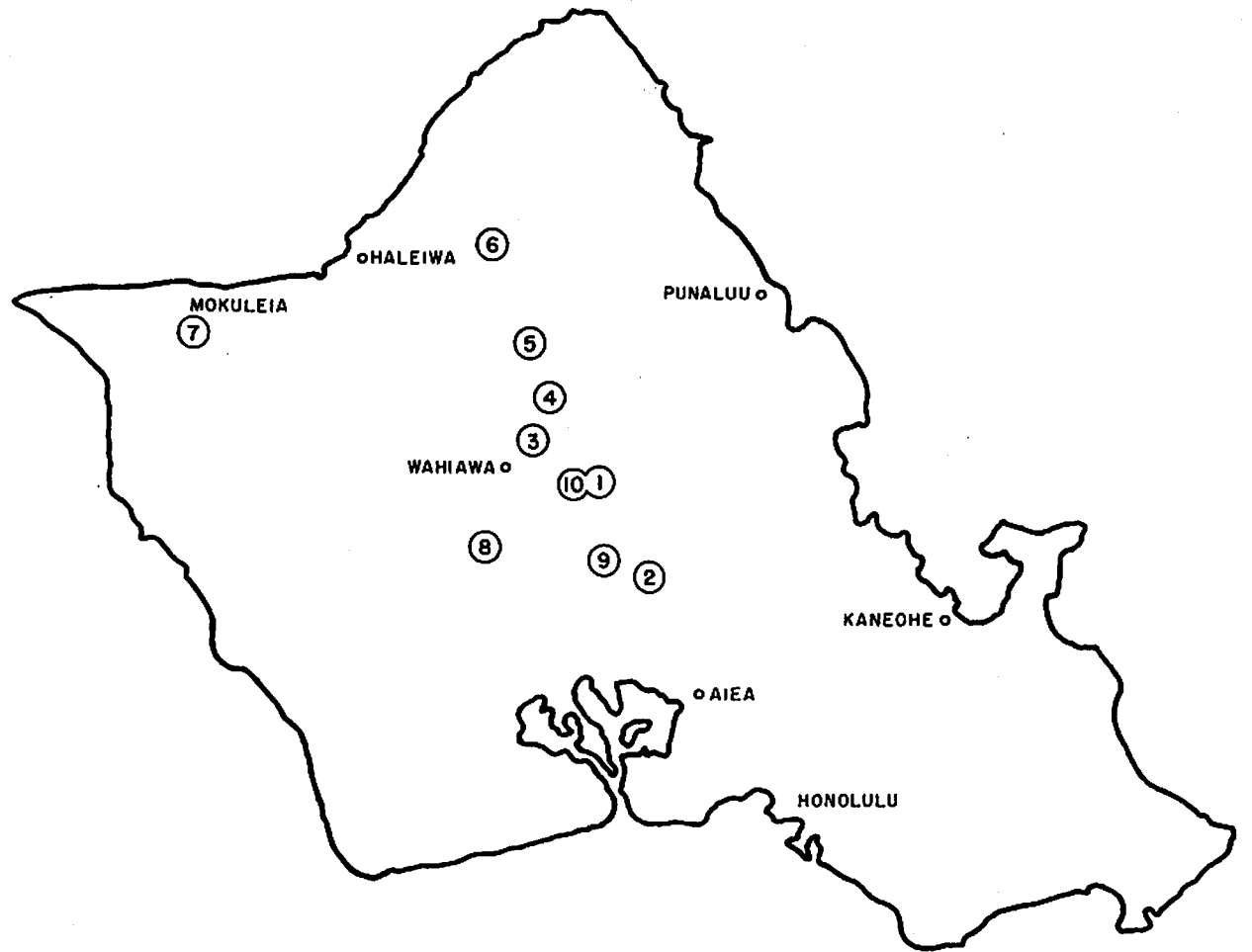
ISLAND OF HAWAII



ISLAND OF MAUI

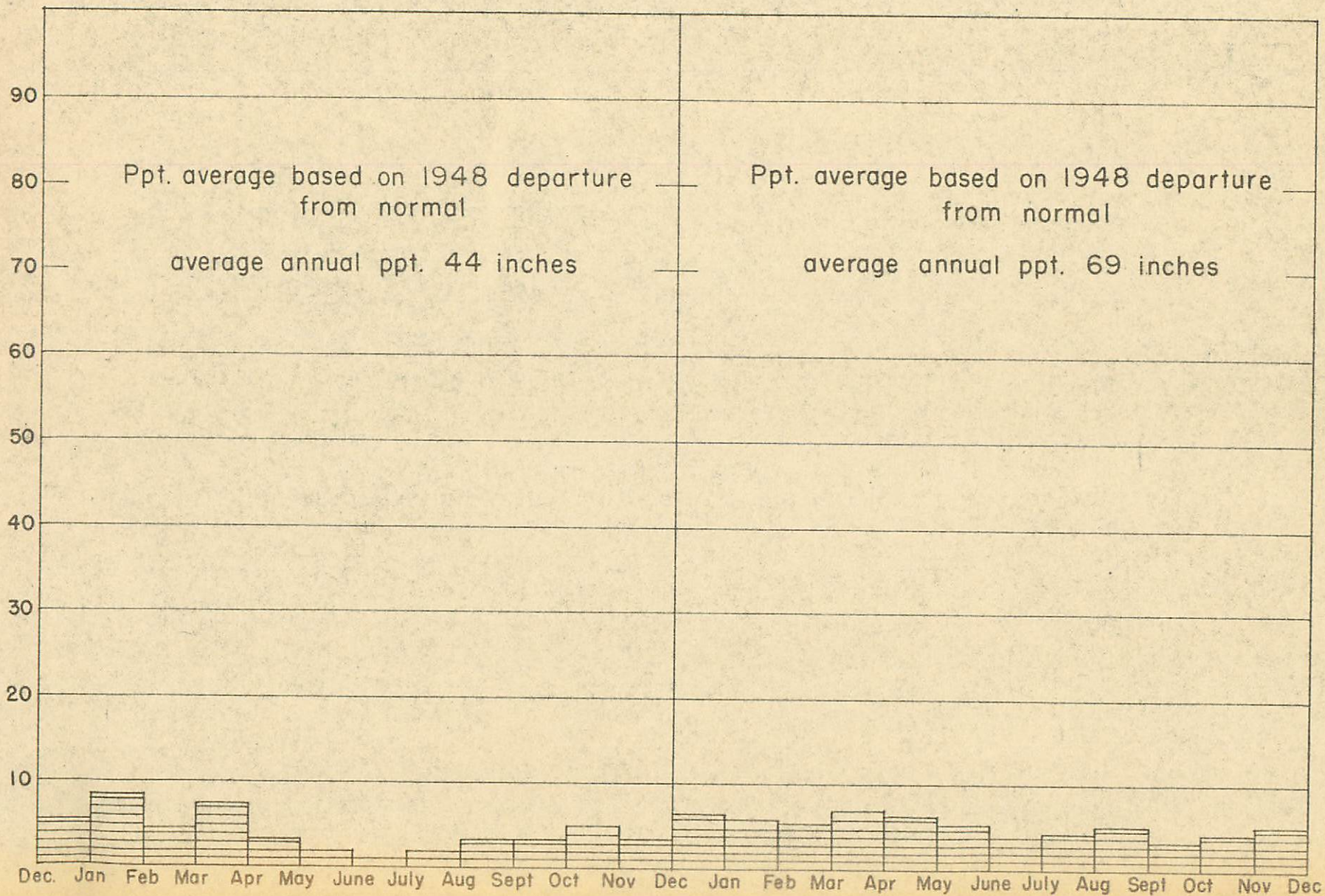


ISLAND OF OAHU



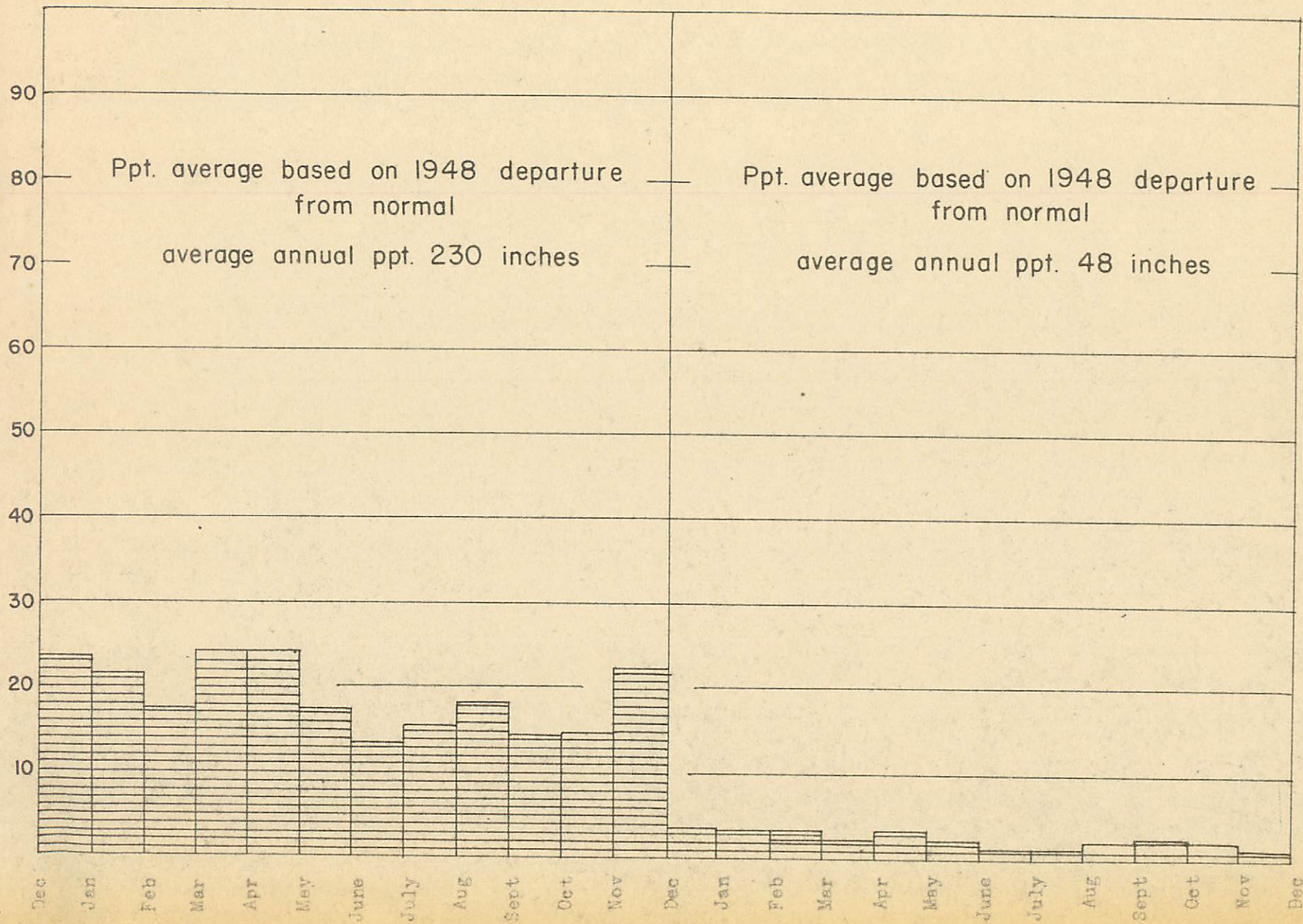
HALEAKALA STATION

HAIKU STATION



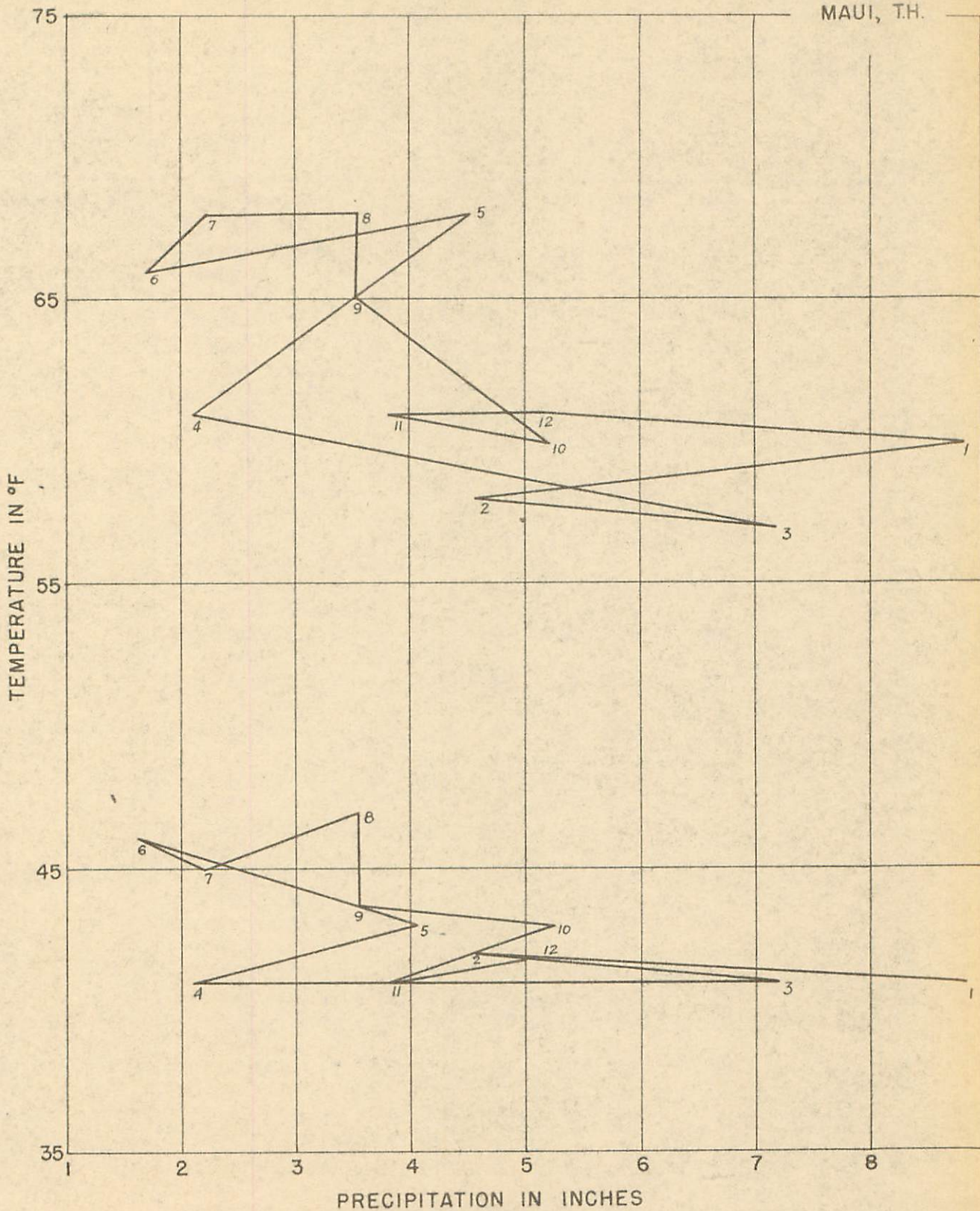
WAIKAMOI STATION

KULA STATION



CLIMOGRAPHS OF HALEAKALA STATION

ELEV. 7030'
MAUI, T.H.



Note: Ppt. based on ten year mean
Temp. based on five year mean

Oct. 17, 1949

FRUIT COLLECTIONS ON MAUI

S: Stage
W: Weight in grams
N: Number of fruit
V: Volume in cc.

No.:	Date:	Locality :	Elev.:	Fruit	S:	W :	N :	V :	Pupa :	Index
:	:	:	:	:	:	:	:	:	:	: Pupa per gr.
1.	9/17	Kula Farm	2850'	<i>Ficus carica</i> Fig (White)	R	452	32	300	160	.35
2.	"	"	"	<i>Citrus sinensis</i> Orange	R	735	10	800	0	
3.	"	"	"	<i>Musa nana</i> Banana	R	566	7	800	350	.61
4.	"	"	"	Tomato <i>L. esculentum</i>	R	1924	16	1800	21*	
5.	9/20	"	"	<i>Persea americana</i> Avocado (winter)	G	1528	29	1600	22	.01
6.	"	"	"	<i>Ficus carica</i> Fig (White)	R	792	38	590	443	.55
7.	"	"	"	<i>Citrus sinensis</i> Orange	R	849	9	600	0	
8.	"	"	"	<i>Persea americana</i> Avocado (Winter)	G	1486	6	1350	2	
9.	"	"	"	<i>Persea americana</i> Avocado (Winter)	G	566	6	550	1	
10.	"	"	"	<i>Musa nana</i> Banana	R	679	8	500	201	.29
11.	"	"	"	<i>Musa nana</i> Banana	G	2321	30	2100	81	.03
12.	"	"	"	<i>Musa nana</i> Banana	G	3170	40	2250	35	.01
13.	"	"	"	<i>Musa nana</i> Banana	G	2038	29	1900	117	.06
14.	"	"	"	<i>Citrus aurantifolia</i> Lime	R	255	7	100	1	
15.	9/20	Haihu	500	<i>Eugenia uniflora</i> Surinam-cherry	R	1811	340	1550	432	.26
16.	"	"	"	<i>Persea americana</i> Avocado (Dickey)	R	3849	16	3250	1269	.39
17.	"	"	"	<i>Persea americana</i> Avocado (Moore No. 2)	R	2773	18	2900	77	.03
18.	"	"	"	<i>Cyathodes Tameiarae</i> Pukeawe	R	85	630	180	0	
19.	9/21	Maleakala	7200	<i>Ficus carica</i> (Black)	R	721	12	800	32	.04
20.	9/27	Waiakoa	3750	<i>Citrus Limonia</i> Lemon	R	368	4	360	2	.005
21.	"	"	"	<i>Citrus aurantifolia</i> Lime	R	255	5	220	0	
22.	"	"	"	<i>Passiflora subpeltata</i> White fl.	G	318	19	490	0	
23.	"	"	"	<i>Passiflora edulis</i> Lilikoi	R	1321	45	1660	0	
24.	"	Insectory	3750	<i>Terminalia Catappa</i> False Karani	R	877	37	1080	406	.47
25.	9/29	Wailuku	200	<i>Gossypium sp.</i> Cotton	G	243	16	300	0	
26.	9/30	"	200							

Note. * Pupae of *D. cucurbitae*

FRUIT COLLECTIONS ON MAUI

No.:	Date:	Locality :	Elev.:	Fruit	S:	W :	N :	V :	Pupae :	Index Pupa per gr.
27.	10/1	Haiku	500	Mangifera indica Mango (small)	R	11528	55	6740	592	inc.
28.	10/1	Haiku	500	Citrus aurantifolia Limes	R	1431	92	1400		incomplete
29.	10/3	Haiku	500	Mangifera indica Mango (small)	R	1998	13	1860		incomplete
30.	"	"	"	Mangifera indica Mango (Hayden)	R	5598	11	3210	136	inc.
31.	"	"	"	Psidium guajava Guava	R	1034	27	1040	31	inc.
32.	"	Kailiili12/40		Psidium guajava Guava (common)	R	1027	14	1030		incomplete
33.	"	"	"	Passiflora edulis Lilikoi	R	283	18	280		incomplete
34.	"	"	"	Psidium cattleianum Guava (Lemon)	R	1330	93	1280		incomplete
35.	10/6	Waikamoi	4250	Clermontia sp	R	970	20	1010		incomplete
36.	10/6	"	"	Prunus persica Peach (White)	R	1069	25	1070		incomplete
37.	10/6	Haiku	500	Ficus sp	R	438	49	440		"
38.	10/11	"	"	Mangifera indica Mango (Hayden)	R	2735	11	2600		"
39.	"	"	"	Mangifera indica Mango (Small)	R	1686	12	1560		"
40.	"	Iao Valley	800	Psidium guajava Guava	R	1792	46	1760		"
41.	10/14	Upper Kula	3500	Pyrus sp Apple	G	1856	14	1570		"
42.	"	"	"	Diospyros kaki Persimmon	R	1686	14	1570		"
43.	10/16	Kula Sant.	3000	Persea americana Avocado	R	1446	12	1460		"
44.	"	Lower Kula	2800	Mangifera indica Mango (French)	R	2083	14	2020		"
45.	"	"	"	Mangifera indica Mango (French)	R	2678	14	2540		"
46.	"	"	"	Mangifera indica Mango (Chinese)	R	749	10	680		"
47.	"	"	"	Mangifera indica Mango	R	1006	7	1000		"
48.	"	Upper Kula	3500	Prunus persica Peach (Yellow)	R	1913	44	1920		"
49.	10/21	"	"	Cydonia oblonga Quince	R	2224	16	2525		"

Note. Many of these fruit samples have been collected so recently that complete tabulation of pupae screened has not been possible.

FRUIT COLLECTIONS ON HAWAII

D: *Dacus dorsalis*
C: *Ceratitis capitata*

W: Weight in grams
V: Volume in cc.

No.	Date	Locality	Elev.	Fruit	W	V	Pupae	D	C	Index
1.	7/30	Pohalea	1700	<i>Prunus persica</i> Peach	368	332	260	192	3	.71
2.	"	"	"	<i>Coffea arabica</i> Coffee	176	153	17		10	
3.	"	Hinole	400	<i>Psidium cattleianum</i> Strawberry Guava	460	295	75	43		.16
4.	"	"	"	<i>Citrus paradisi</i> Grapefruit	1758	1820	30	9		.02
5.	"	"	"	<i>Eugenia malaccensis</i> Mt. Apple	510	450	49	34		.09
6.	"	"	"	<i>Punica granatum</i> Pomegranate	652	435	9	6		.01
7.	"	Puuwaawa	2000	<i>Passiflora mollissima</i>	1046	1010	321	227		.31
8.	"	"	1500	<i>Opuntia vogeliana</i> Cacti	1616	1380	2		2	
9.	"	Waialea	2700	<i>Prunus persica</i> Peach	1076	1060	176	150		.16
10.	8/1	MLTT		<i>Solanum pseudocapsicum</i> Jerusalem Cherry	227	150				
11.	8/2	MLTT	4600	"	454	440				
13.	8/1	Keanakolu	2800	<i>Passiflora edulis</i> Lilikoi	227	270				
14.	7/30	Hinole	400	<i>Persea americana</i> Avocado	454	520	12	9		.03
15.	8/10	MLTT	4900	<i>Solanum pseudocapsicum</i> Jerusalem Cherry	210	262	13	2	7	
16.	8/11	Waikiki	4700	"	141	112	38	1	36	
17.	7/30	Puuwaawa	2000	<i>Santalum paniculatum</i>	170	—	34	30	2	.18
18.	7/27	Waikiki	4700	<i>Prunus</i> sp. Plum	—	—	—	6	8	
19.	7/25	Waikiki	4700	<i>Solanum pseudocapsicum</i> Jerusalem Cherry	—	—	—		48	
20.	7/27	Waikiki	4700	<i>Prunus</i> sp. Apricot					many	
25.	8/24	MLTT	4600	<i>Solanum pseudocapsicum</i> Jerusalem Cherry	38.5	34	9	5	3	
26.	8/24	MLTT	4300	<i>Dianella sandwicensis</i>	14					
27.	8/24	MLTT	5500	<i>Styphelia tameiameia</i>	75					
28.	8/24	MLTT	4300	<i>Coprosma rhynchosarpa</i>	26	25				
29.	8/24	MLTT	4300	<i>Hyopomea sandwicensis</i>	85	130				
30.	8/22	Keanakolu	6500	<i>Coprosma rhynchosarpa</i>	15					
31.	8/23	Keanakolu	3500	<i>Clermontia</i> sp. Small fruit	85	100				
32.	8/23	"		<i>Passiflora edulis</i> Lilikoi	113	200				

FIFTY COLLECTIONS ON HAWAII

No.:	Date:	Locality :	Elv. :	Fruit	U :	V :	Pupae:	D :	C :	Index:
34.	8/31	MLTT	4000	<i>S. pseudocapsicum</i> Jerusalem Cherry	21	24	22	16	4	
35.	8/31	MLTT	4300	<i>S. pseudocapsicum</i> Jerusalem Cherry	100	96	141	29	97	
36.	"	"	4600	"	101	106	26	2	20	
37.	"	"	5100	"	74	70				
38.	8/4	Koanau	100	<i>Psidium guajava</i> Guava	7757	7472	717	569		.07
40.	9/5	Waikii	4700	<i>S. pseudocapsicum</i> Jerusalem Cherry	121	105	101	5	82	
42.	9/4	Hilo	10	<i>Calophyllum inophyllum</i> Kamani	396	434	132	68	1	
43.	9/5	Waikii	4700	<i>Pyrus malus</i> Apple	554	645	1			
44.	9.7	MLTT	4300	<i>S. pseudocapsicum</i> Jerusalem Cherry	74	62	130	19	79	
45.	9/7	MLTT	4250	<i>S. pseudocapsicum</i> Jerusalem Cherry	83	81	130	3	122	
46.	9/7	MLTT	4600	"	84	80	111	7	87	
47.	9/7	MLTT	3900	<i>Vaccinium reticulatum</i> Chalo	53	40				
48.	9/7	MLTT	4300	<i>Myoporum sandwicense</i> Halo	61	56				
49.	9/7	MLTT	4300	<i>Pipturus</i> sp. Paraki	35	32				
50.	9/7	MLTT	5500	<i>Styphelia Tamoioana</i> Pukeawe	11	8				
51.	9/9	Waikii	5100	<i>S. pseudocapsicum</i> Jerusalem Cherry	160	130	20		13	
52.	9/9	Waikii	1900	<i>Wikstroemia phillyraefolia</i>	168	162				
53.	9/13	Koanakoia	3500	<i>Smilax sandwicensis</i>	86	90				
54.	9/14	MLTT	5100	<i>S. pseudocapsicum</i> Jerusalem Cherry	62	60	22		11	
55.	9/14	MLTT	4300	"	63	67	127	22	51	
56.	9/14	MLTT	4600	"	90	89	127	5	103	
57.	9/15	Waikii	5100	"	143	175				
58.	9/15	Waipoua	2700	<i>Cordylino (stricta ?)</i> Ti	99	105				
59.	9/15	Waipoua	2700	<i>Coffea arabica</i> Coffee	814	795	41	13	14	
60.	9/15	Waikii	4700	<i>Juglans (regia)</i> Walnut	5330	7206	1625	28	1550	
61.	9/15	Onouea	200	<i>Psidium Guajava</i> Guava	2216	2247	371	226		.17
62.	9/15	Kakalau	200	<i>Annona reticulata</i> Annona	379	377	10	5	1	

FRUIT COLLECTIONS ON HAWAII

No. : Date : Locality : Elev. : Fruit U : V : Pupae : D : C : Index

63.	9/15	Hakalau	200	Ficus carica Fig	156	172	10	3		.01
64.	9/15	Hakalau	200	Citrus maxima Pummelo	1030	1582	7	7		.01

Note. :MFT: Mauna Loa Truck Trail

11. Fruit Collections

To briefly summarize and evaluate the preceding data on fruit host collections, 25 different hosts have been collected which have yielded D. dorsalis. Of these, Santalum paniculatum, Passiflora mollissima and Juglans regia collected in Hawaii appear to be new host records. On Maui Cydonia oblonga (quince) has been found to have fruit fly larvae attacking it. Inasmuch as D. dorsalis and C. capitata were both observed in the area and the larvae are too small to determine this record will have to await later confirmation.

To have a basis of comparison between different hosts an index figure has been established based on the weight of the fruit and the number of pupae which the fruit yield. The factor is obtained by dividing the number of pupa by the gram weight. This figure is the fraction of larvae per gram of fruit. In cases where both D. dorsalis and C. capitata are reared from the fruit an index can be established by dividing the number of adults by the gram weight. However, where it is possible to use the pupal count, it will give a truer picture because the factor of pupal mortality is eliminated.

On Maui ripe banana gave the highest index figure, .61, which indicates 6/10 of a larva for every gram of fruit. Green banana collections had indexes of .03, .01 and .06 respectively. Indicating that ripe banana are more than twenty times as infested as green fruit.

On Hawaii the highest index, .71 was from Prunus persica (peach) but this index is slightly distorted by the presence of some C. capitata. The passion fruit, Passiflora mollissima, had a rather high index of .31 in the collections made.

Two varieties of avocado, Dickey and Moore No. 2 showed some rather significant differences. Both fruit were collected in the dead ripe stage. Lot No. 17 Dickey weighed 3849 grams and yielded 126 pupae giving an index of .39. Lot No. 18 Moore No. 2 weighed 2773 grams and yielded 77 pupae having an index of .03. For these collections it is indicated that Dickey was almost 13 times as susceptible to larval infestation as Moore No. 2. However, the data is insufficient to base conclusions on at this stage.

The index method has possibilities in statistical comparisons in host susceptibility, fly preference, and other studies in which one host must be compared with another.

12. Preliminary Findings on Dacus dorsalis Kendl.

A. Studies on Hawaii*

The insectory at Hilo is the main base of operations. Here the rearing and marking of flies, holding of fruit and other laboratory activities are carried on.

During August over 1000 males and 1000 female dorsalis were marked for liberation at Keanakolu. In October 1000 male dorsalis were marked for release on the Mauna Loa Truck Trail.

With the exception of some fruit at Keanakolu, all field collected fruit is held in the insectory after volume, weight and count is obtained. To date 154 lots of fruit have been collected.

* For this particular section of the report I have drawn freely from the quarterly report of G. Davis.

The highest elevation at which fruit was collected, and from which Dacus dorsalis has been reared, was at the Waikii Station at 4700 feet. Host fruit was plum and walnut.

Since the insectary was not ready for occupancy until August 25, rearing of flies and cage studies did not get under way until September. The studies are, therefore, very incomplete. As Hilo is a control station for most of the studies, the various studies under way are described briefly.

(1) Caged Studies

- (a) Longevity: In this study newly emerged flies are placed in 10 1/2 x 10 1/2 x 10 1/2" cages and fed on a diet of honey, yeast, orange juice and cube sugar. Water is made available by means of a wick placed in a small bottle. No host material is provided for the females. In a preliminary study started prior to the establishment of Oriental Fruit Fly Investigations on this Island, and which is continuing, flies cared for in the above manner have lived 204 days at Hilo, and 220 days at Kaumana and Pohakuloa.

Status of the present studies under way is given on chart below:

Hilo				Kaumana				Pohakuloa				Keanakolu			
Date	Days	♂	♀	Date	Days	♂	♀	Date	Days	♂	♀	Date	Days	♂	♀
10-11	1	116	104	9-29	1	120	120	9-16	1	106	106	9-12	1	100	90
10-19	8	98	59	10-3	3	120	120	9-22	6	103	102	9-19	8	98	88
				10-6	6	120	115	9-28	12	102	100	9-26	15	84	82
								10-3	17	102	100	10-3	22	71	70
								10-10	24	101	99	10-10	29	65	61
												10-15	34	49	52

- (b) Sexual Maturity: Recently cages containing 100 newly emerged males and females have been taken to all stations.
- (c) Oviposition: Field females in standard cages at Hilo readily oviposited in four apples exposed to them. It was observed that they oviposited readily in apples that were slit rather than those that were sliced. Generally, when apples were slit, eggs were deposited on the surface or in cuts made by a knife blade, and could be readily observed from day to day. Under favorable conditions fruit thus exposed could be removed the same day, usually two or three hours after exposure. Eggs laid in Hilo were taken to all stations.

Field flies collected at Hilo and taken to Keanakolu oviposited readily in apples and passion fruit after being held there for a week.

- (d) Hatching: Eggs oviposited in apples at Hilo and taken to Keanakolu hatched within a week at this station. An apple exposed to caged females on October 11 at Keanakolu was found to contain eggs which had apparently hatched prior to the 15th.
- (e) Larval Development: Apples containing first instar larvae were taken to Keanakolu on September 19 and October 3, 1949, and to Pohakuloa and Kaumana on October 3.
- (f) Fly Emergence: Mature larvae are placed in a jar a day prior to departure for field stations. On the following morning 100 new pupae are selected and taken to each station.

100 pupae were taken to Keanakolu on Sept. 12, 26 and Oct. 10.
100 " " " " Pohakuloa " " 22 and 27
100 " " " " Kaumana " " 27

There have been no emergence at Keanakolu, Pohakuloa or Kaumana.

(2) Quantitative Studies

A star fruit tree growing in Hilo and about five minutes' ride from the insectary has been selected for this study. The first collection of fruit was made on October 11, 1949, and daily collections are continuing.

(3) KAUMANA - 2000 ft.

About ten miles west of Hilo, this station receives about 250 inches of rainfall annually. A small Army billet is being used to house the max.-min. thermometer and caged studies. In previous longevity studies a high mortality of flies has taken place. Two out of 50 flies, equal sexes, have lived for 220 days at this station. There is little if any host material in the immediate area and the vegetation, predominantly native, consists of tree ferns and ohia trees.

(4) POHAKULOA - 6511 ft.

This station is about forty-two miles west of Hilo. It receives about ten inches of rain annually and has temperature extremes ranging from 27° to 85° F. The humidity is likewise variable ranging from 5% to 100%. Mean humidity is about 40%. The vegetation is predominantly native, but Menthley plum trees grow and bear well at this station.

A small building with part of the sides cut out houses a max.-min. thermometer and caged studies. These studies include longevity, sexual maturity, oviposition and pupal. There is nothing to report at this time except that the trend is toward greater longevity and delayed life history stages.

On March 7, 1949, an apple which was first exposed to gravid females at Hilo on March 4 was transferred to this station. It

was observed upon arrival at this station that some eggs had hatched. On May 2, five pupae were observed and on June 6, 1949, the first emergence of dorsalis took place. Allowing two days for the incubation of the egg, total cycle at this station was 93 days. By comparison, average cycle at Hilo is 30 days when apples are used as the host fruit. Additional pupation took place after May 5 and a total of 24 flies emerged, 11 being females and 13 males.

On July 25, 1949, six females remained at this station. Their exact age was not known, but based on the first emergence, they were approximately 49 days old. On this day a slit apple was exposed to them and, when checked a week later, no oviposition had taken place. This apple was replaced, and the following week all females were dead. (No oviposition had taken place in the second apple.)

(5) WAIKII - 4700 ft.

This station is 55 miles northwest of Hilo. Considerable host material grows here, such as walnuts, peaches, apples, plums, apricots and Jerusalem cherries. The emergence of dorsalis has been very low from fruit collected in this orchard as attested by the following figures:

Host	No. <u>dorsalis</u> emerged	No. med. flies emerged
Plums	6	8
Walnuts	28	1550
Jerusalem cherries	6	166

(6) KEANAKOLU:-- 5200 ft.

Located on the northeast slope of Mauna Kea, Keanakolu is 60 miles northwest of Hilo. It is on the edge of a fog belt and, therefore, the daily humidity at this station averages about 95%. There are three orchards in the vicinity of the insectary, and these include apples, quice, plums, nectarines, peaches and pears. The orchards are surrounded by a native forest of koa, and growing wild through this forest is a climbing passion fruit (Passiflora mollissima).

On June 21 an initial survey of the orchard disclosed no dorsalis. Plums were in fruit at the time. On July 27, fourteen index traps, with citronella as a lure, were placed in the orchards and weekly checks showed negative results. In order to determine how close dorsalis was to the orchard and what native hosts there were, if any, a trap line was run from the orchard down the Keanakolu-Ookala trail for a distance of six miles. The traps were placed every half-mile, fourteen being set. The lure was citronella, which attracts only the males. Elevations at each trap were obtained from an altimeter.

Weekly trips were made down this trail, and the population trends are shown on page 99.

With the absence of the Oriental Fruit Fly at the orchards an established fact, 1050 males and 1050 females were captured in the field at Hilo, and 1000 of each marked on the thorax with green lacquer. Fifty males and fifty females were dissected to determine sexual maturity. Twenty-four percent of the females and 42% of the males were immature, while 76% of the females and 58% of the males were mature.

These flies were taken to Keanakolu on August 29 and released on August 30, in an attempt to find out: (1) could they establish themselves under these climatic conditions, (2) what effect there would be on longevity, sexual maturity, oviposition, egg hatching, larval development, fly emergence, and (3) would released flies stay in the area. Prior to the release of the flies, all traps were removed from the orchard and all fallen fruit removed. At the time of release there was intermittent sunshine and fog. Fruit in the orchards consisted of apples, pears, plums and peaches, while mature wild fruit adjacent to the orchard consisted of Passiflora mollissima (passion fruit), Coprosma rhynchocarpa (Pilo) and Phytolacca hawaiiensis (Pokeberry).

Weekly collections of fruit were made. Half of the fruit collected was retained in the insectary at Keanakolu and the other half was taken to Hilo insectary.

The first collection of fruit was made on Sept. 5 and on Sept. 23, 1949, the first recovery of dorsalis larva and pupae was made from the Hilo portion of passion fruit (Passiflora mollissima), collected on the above date. The first fly emergence at the Hilo station took place 28 days after the flies were released at Keanakolu. A total of 17 flies emerged from the first lot and seven from a later collection.

Four pupae were recovered from peaches that were collected at Keanakolu on Sept. 27. These pupae are at this station and no emergence has taken place.

No adultmarked flies were recovered at Keanakolu, and it is believed that they drifted to lower elevations within three days after liberation.

(7) MAUNA LOA TRUCK TRAIL: 4000 - 6700 feet.

This trail is located on the northeast slope of Mauna Loa and is eleven miles long. A weather station is maintained at Kipuka Ki, 4200 feet. The vegetation is predominantly native but a D. dorsalis host, Solanum pseudocansicum (Jerusalem cherry), occurs along the trail at elevations 4000 to 5100 feet. To find where D. dorsalis populations occur along this trail, as well as the seasonal trend, index traps were placed at half mile intervals, from 4000 feet to 6700 feet. Results are shown on page 101.

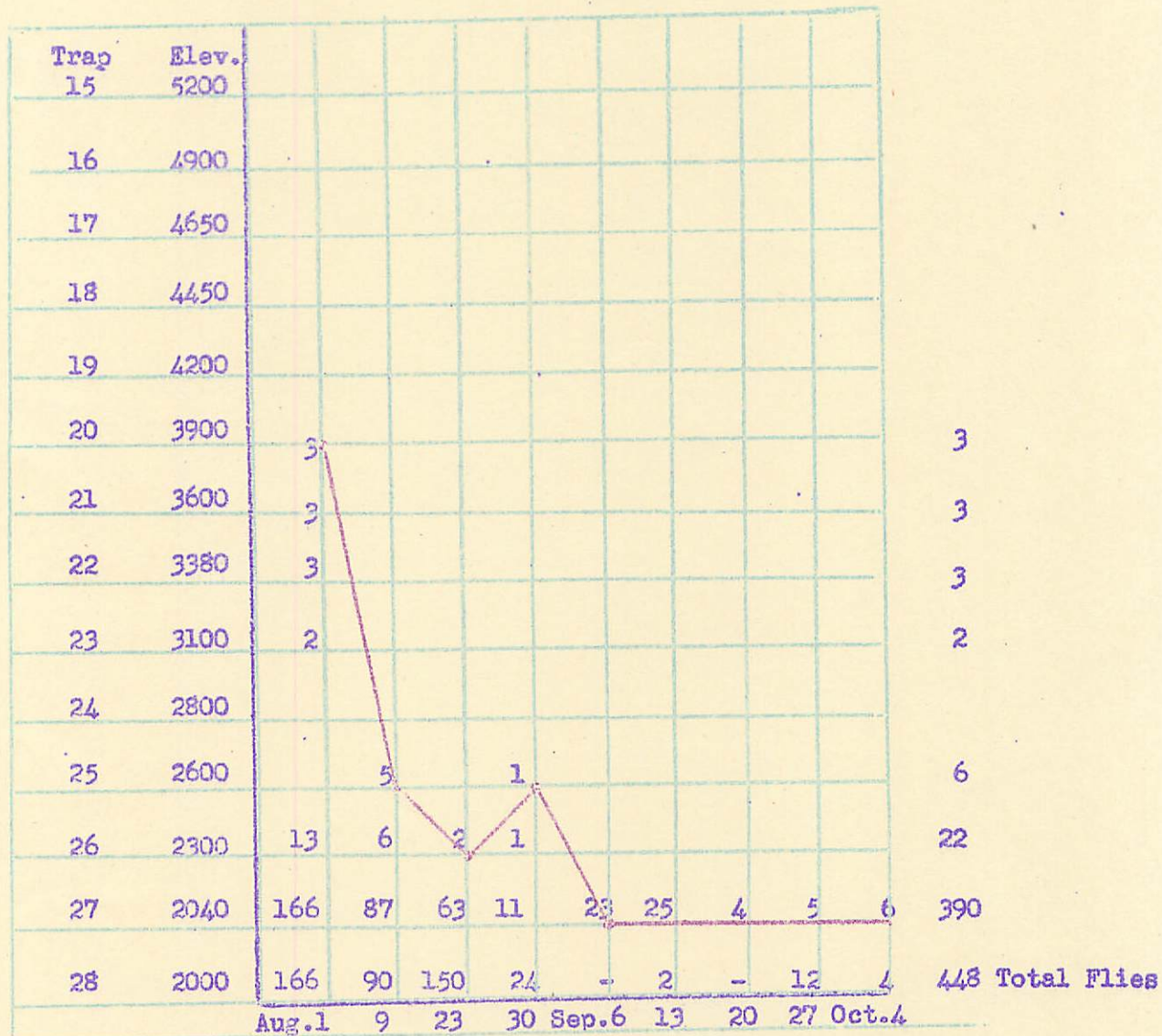
On September 30 the index traps were placed by McPhail traps. On the first check, flies were found in all traps except the next to the last. The downward trend shown by the index traps was apparently upset by the efficiency of the McPhail traps. There are insufficient checks for comparative data. For lure, citronella and water are used at the rate of 4 cc. to one-half pint water.

To determine the importance of elevation and temperature to fruiting periodicity of Jerusalem cherries, plots a yard square were established at 4000, 4300, 4600 and 5100 feet. Ripe fruit was collected weekly, and immature fruit and flowers were counted. Emergence from the ripe fruit suggests that higher elevations are limiting factors as far as dorsalis is concerned. Comparative data showing emergence of dorsalis at various elevations is on page 102.

To study drift of flies on the Mauna Loa Truck Trail, an initial release of 1000 male flies was made at the end of the truck trail (6700 feet) on October 13. The flies were marked with red lacquer on the thorax. Prior to the release a focal point was established and sixteen McPhail traps were placed in a ring 4 minutes' walk from the focal point, or a radius of about 1000 feet. The lure for each trap was 4 cc. citronella to 1/2 pint water. On October 19 only one marked fly was recovered. It was trapped in number 2 of the ringed traps, which was northeast of the point of liberation. The trail descends in a southeasterly direction. (see page 100.)

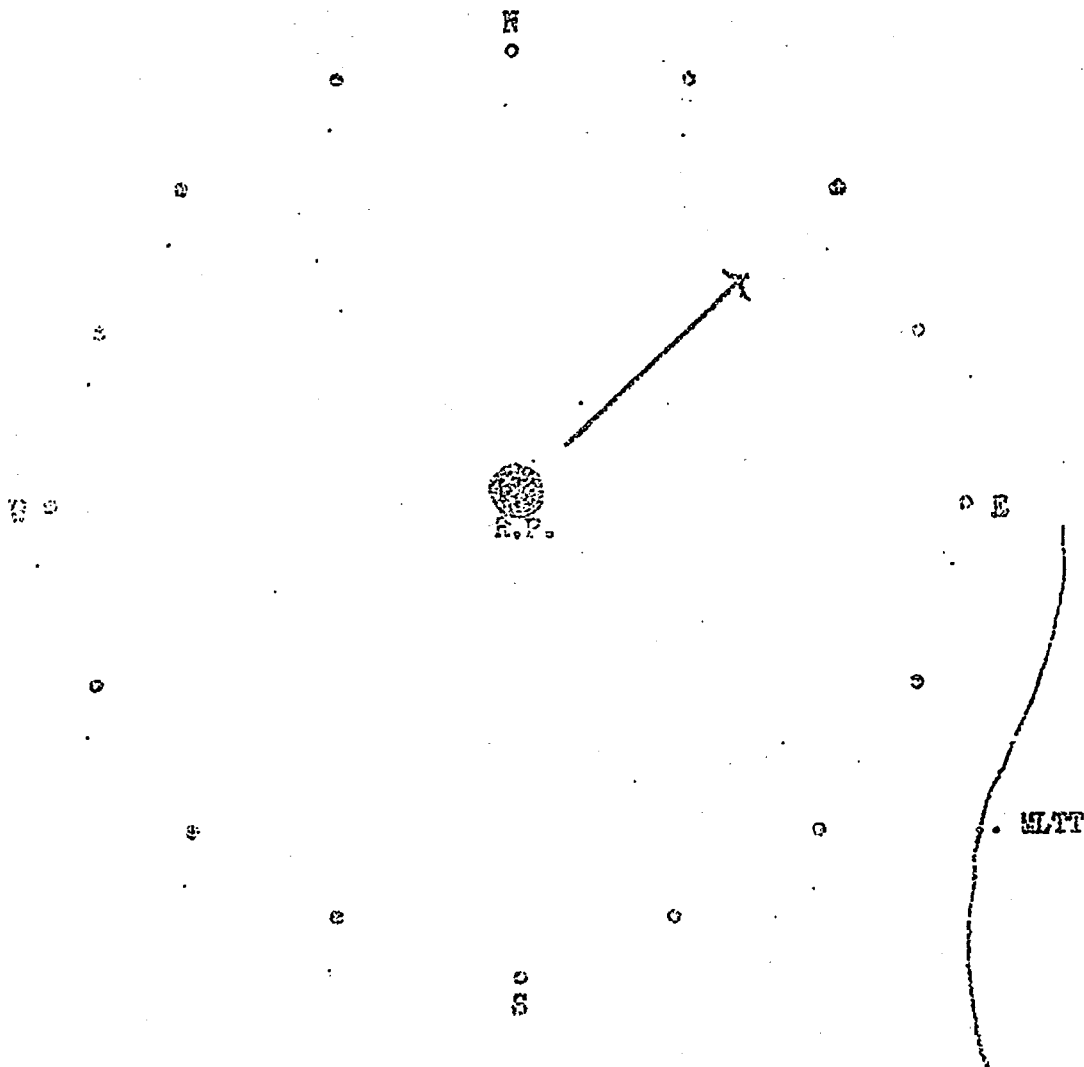
POPULATION TRENDS ON THE KEANAKOLU-OOKALA TRAIL

Traps set July 28, 1949



This population trend shows clearly a lower incidence of flies at the lower elevations and an unmistakable retreat from higher elevations as the season progresses. Whether this is an actual movement down the slope or the elimination of populations at higher elevations can only be surmised. If the condition of the trail is an index to precipitation the humidity curve might reflect the reason for this population trend.

Movement Studies of *Dacus dorsalis* on the slopes of
Mauna Loa on the Mauna Loa Truck Trail



An initial release of 1000 male *Dacus dorsalis* was made at the end of the Mauna Loa Truck Trail (6700 feet) at 2:15 p.m. on October 13. The flies were marked on the dorsal part of the thorax with red lacquer. Prior to the release a focal point was established and a ring of 16 McPhail traps were placed at a radius of about 1000 ft. or four minutes' walking distance. The lure used in the traps was citronella, 4 cc. per pint of water.

On Oct. 19 one marked fly was recovered in trap No. 2, which was northeast of the R.P.

⊙ : Trap in which fly was recovered
R.P. : Release Point
MLTT : Mauna Loa Truck Trail

Weather: Partly cloudy, cool
Wind : Moderate N.E.
Fruit Present:
Vaccinium reticulatum
Symphelia Tamelemeiae

MAUNA LOA TRUCK TRAIL

Citronella Traps Established July 26, 1949

Trap No.	Elev.	Miles	Dates of Checking and <i>D. dorsalis</i> trapped										Total	
			7/29	8/2	8/10	8/17	8/24	8/30	9/7	9/14	9/21	9/28		
23	6700	11												
22	6500	10.5			1									1
21	6200	10		1										1
20	6000	9.5												
19	5900	9							2					2
18	5800	8.5												
17	5700	8		1					2					3
16	5550	7.5	1	4	7	5	1	15	5	1	3			41
15	5260	7	1							1				2
14	5220	6.5			2									2
13	5120	6			1				1	1				3
12	5020	5.5												
11	4980	5							1					1
10	4860	4.5	1						1		1			3
9	4760	4											1	1
8	4620	3.5												
7	4520	3	17	1	4	1			31	12	38	5		109
6	4420	2.5			2					5	11			18
5	4360	2		1							2			3
4	4250	1.5	12	122	226	179	145	165	1287	594	650	681		4061
3	4150	1	54	6	21		28	13	28	96	291	187		724
2	4090	0.5	44	14	25	23	29	15	43	102	149	54		498
1	4000	0	212	387	810	344	28	431	1658	1703	1154	913		7640

Compiled by C. Davis

COMPARATIVE EMERGENCY OF DACUS DORSALIS AND CERATITIS CAPITATA

FROM SOLANUM PSEUDOCAPSICUM ON MAUNA LOA TRUCK TRAIL SAMPLE PLOTS AND RANDOM COLLECTIONS

Elevation	Locality	August 17			August 24			August 31			September 7			September 14		
		No.			No.			No.			No.			No.		
		fruit	Dac.	Cer.	fruit	Dac.	Cer.	fruit	Dac.	Cer.	fruit	Dac.	Cer.	fruit	Dac.	Cer.
4000 ft.	Sample	6	2	0	5	0	0	0			0			0		
	Random							37	16	4	0			0		
4300 ft.	Sample	47	12	13	16	0	2	5	0	7	0			3	1	8
	Random							100	29	97	100	19	79	100	22	51
4600 ft.	Sample	100	2	0	39	0	2	10	0	6	8	0	22	2	0	0
	Random				39	5	3	100	2	20	100	7	87	100	5	103
5100 ft.	Sample	13	0	0	6	0	0	0			4	0	0	0		
	Random							100	0	0	0			100	0	11

B. Studies on Maui(1) Initial Tests in Life History Cages

The purpose of the initial tests with the life history cages was to find the best manner of providing the flies with a natural habitat in which to study the flies under varying climatic conditions. It was found that Jerusalem Cherry (Solanum pseudocarpicum), guava (Psidium guajava) and Ohelo berry (Vaccinium reticulatum) could be transplanted into large metal drums while in fruit if handled carefully. The metal containers measured 18 inches high and 14 inches in diameter and provided ample room for the roots of plants four to five feet high. Four plants were put in each cage initially but the inclement weather at Waikamoi Station and Haleakala caused a heavy mortality of the flies due to inadequate protection. More vegetative protection is apparently essential in these cages.

At the lower stations at Kula and Haiku the principal problem was ant-proofing the cages. The cages had purposely been erected on a platform with legs so that they could sit in drums of oil. In spite of this precaution ants were observed in both cages. It is quite possible that they were introduced with the plants. This posed the problem of getting the plants into the cages while being certain that there were no ants in the soil. The answer to this seems to be in growing the plants on an ant-proof platform prior to introducing them into the cages. Ants, particularly Pheidole megacephala, must exert considerable pressure on the fly population. In fact this predator may be more effective than certain introduced parasites. It has been frequently observed that flies caught in traps have ants attached to their legs. The larvae also are subject to the attack in the critical period between leaving the fruit and entering the ground to pupate and even in the fallen fruit.

Station Elev.	Max Release		No. Flies	Checked		Checked		Total		% mortality
	Min	Date		Date	Dead	date	Dead	Days	Dead	
Haleakala 7030	66	10/3	255 [♂]	10/12	163	10/17	86	14	249	97%
	40	10/4	102 [♀]	10/12	48	10/17	27	13	75	73
Waikamoi 4250	66	10/6	242 [♂]	10/11	79	10/17	135	11	214	88%
	48									
Haiku 500	81	10/4	255 [♂]	10/7	45	10/17	7	13	52	20%
	64									
Kula Farm 2850	72	10/3	270 [♂]	10/12	27	10/17	8	14	35	12%
	50									

Note: The heavy mortality in the Haleakala Station was due to inadequate protection during a storm which lasted 24 hours with low temperatures and driving rain.

Hosts in Cages

Haleskala	<u>Psidium guajava</u> <u>Solanum pseudocapsicum</u> <u>Vaccinium reticulatum</u>	Waikanoi	<u>V. reticulatum</u> <u>S. pseudocapsicum</u>
Kula	<u>Ficus carica</u> <u>Psidium guajava</u> <u>Solanum pseudocapsicum</u>	Haiku	<u>Psidium guajava</u> <u>S. pseudocapsicum</u>

Water was provided in all cages as well as guava fruit.

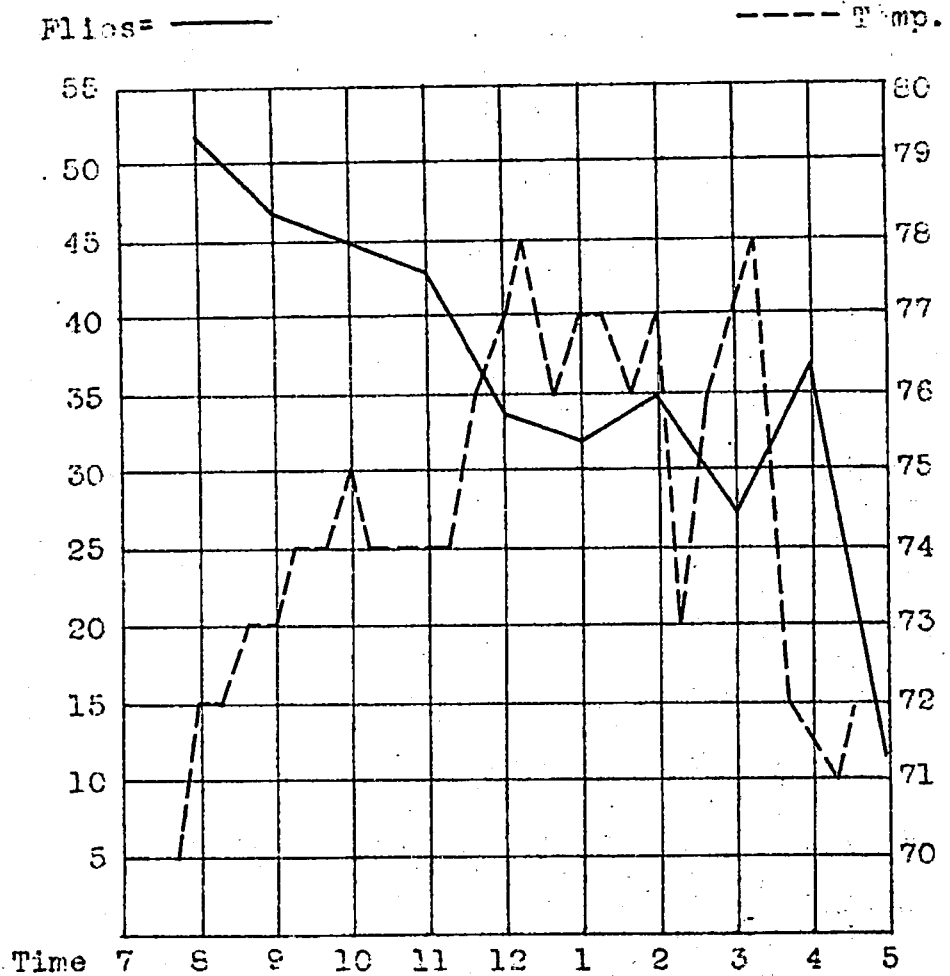
Preliminary tests indicate that precipitation and humidity may be equally important as temperature in the role of environmental resistance.

A Preliminary Study of Population Trends

	<u>Trap No.</u>	<u>Date</u>	<u>Count</u>	<u>Date</u>	<u>Count</u>	<u>Date</u>	<u>Count</u>
Kula Farm	24	10/12	60	10/17	68	10/22	65
	39	"	45	"	22	"	110
	49	"	61	"	103	"	24
	48	"	84	"	77	"	188
Nursery, Haiku	41			"	7	"	33
	67	10/10	3841	10/13	3546	10/17	4610
	70	"	851	"	797	"	966
	78	"	1702	"	1575	"	2277
	79	"	3346	"	2747	"	1991
Haiku, Mango Orchard	89	"	1573	"	1473	"	2171
	105	"	2994	10/12		10/17	1379
	107	"	2298	"	1145	"	689
	20			"	354	"	2753
	36			"	33	"	808
	65			"	180	"	69

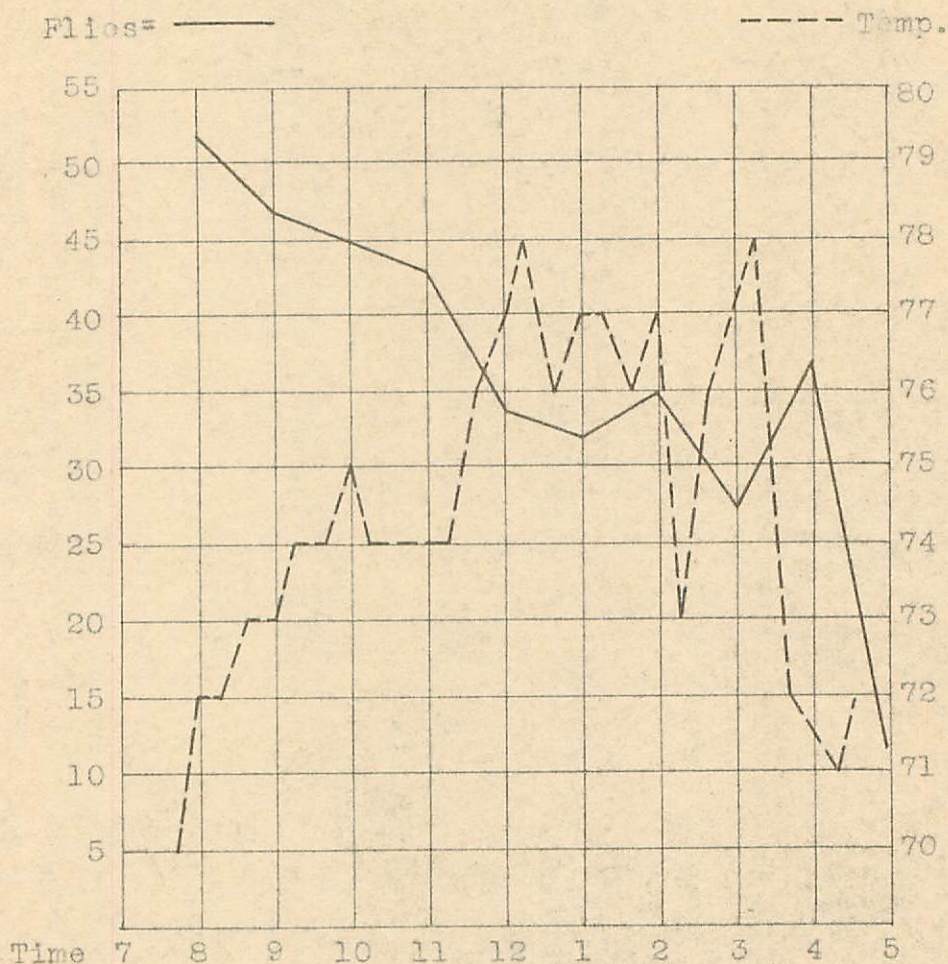
Note: Kula Farm Traps set out 10/7
Nursery, Haiku " " 10/7
Mango O, " " 10/7

A Preliminary Study of Fly Activity



This study was made at Haiku at the Territorial Nursery using five McPhail traps with a citronella lure. The traps were checked every twenty minutes from 7:00 am until 4:40 pm. On the graph the fly count per hour is indicated. Temperature is plotted from twenty minute readings. As a matter of convenience the total catch for the five traps per hour is indicated. It is interesting to note that a peak in temperature results in a corresponding depression in fly activity.

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(4) A Study in the Flight Movements of Dacus dorsalis on the Slopes of Haleakala

Introduction - While it is true that the movements of this fly in one situation do not necessarily reflect what movements may be expected under different conditions, still certain fundamental information was hoped to be gained by the following studies. Haleakala offers a unique opportunity to make a movement study on a continuous slope. There are few mountains in the United States which can lay claim to a slope, unbroken by intervening mountains or foothills as does this extinct volcano which rises from sea level to 10,000 feet. How far will the fly travel? Will they disperse generally or tend to fly in a definite direction? Will the low temperatures in this area prevent a wide dispersement? How long may one expect to pick up the released flies at the release point? The answer to these and some other questions were to be realized by this work.

Methods - Male flies were trapped by means of the McPhail Trap (glass invaginated) which was baited with citronella-soaked cotton balls suspended from the cork in the top of the trap. Initially a few traps were placed in three different areas to find a place of high fly population. Kula Sanitarium Farm (2850 ft.) showed 74⁹ flies recovered in nine traps in four days. Territorial Nursery at Haiku (500 ft.) showed 15,763 flies trapped in seven traps in two days. Baldwin's mango orchard near Haiku had a catch of 7,107 flies in two traps in two days. Evaluating the results by the use of the formula $\frac{F}{TD}$ we arrive at the following:

Kula	:	tdc	:	20
Terr.N.Haiku	:	tdc	:	1126
Baldwin's	:	tdc	:	1773 *

The index at Baldwin's mango orchard later diminished indicating a falling population. Eliminating Kula Farm the other two areas were concentrated on for the trapping of the male flies. Thirty traps were placed in each locality in an area about a half of a block. In this manner several thousand flies were obtainable within a few hours. It was noted that the flies were abundant in the traps in the morning particularly. It was also observed that frequent checking resulted in a greater total than leaving the traps for one or two days. This indicated that many of the flies escape. Ordinarily the fly is strongly positively phototropic and negatively geotropic which meant that the traps could best be emptied by covering with a dark cloth and tilting upward into the cage. However, citronella has a tendency to anesthetize the flies for many of them refuse to respond to light or gravity stimulation.

Marking - Having obtained the flies they were taken to the lab where they were marked. There are undoubtedly a number of marking techniques. I have received estimates of from 1000 a day to 250 an hour for a single man. The method used in this study was a three-man team which could mark 1000 to 1200 flies an hour. The two markers sat at opposite sides of a desk and the third man sat at the end. The two markers were passed freshly anesthetized flies on the top of petri dishes by the third man who caught them with an aspirator and blew them into test tubes which had etherized cotton in the bottom. As the two markers finished a petri dish of flies they passed them to the end of the table where the "fly catcher" recorded the number and put them in the cage. About twenty-five flies were anesthetized at a time. They were left in the test tube until the last fly just finished wiggling and

* D: days set; F: total flies caught; tdc: trap daily catch

then dumped on top of the petri dish. By the time the marker completed the twenty-fifth fly they were beginning to become active again. The sharpened end of camel hair brush handles proved to work more satisfactorily than the brushes themselves. The tip was dipped in lacquer so that a tiny sphere formed at the end. The flies were held by a pair of forceps by the wing and the tip just touched to the dorsal part of the thorax. When the lacquer was the right consistency a tiny round spot would adhere to the thorax. The petri dish of flies is placed inside of the cage until the next dish is ready. This interim period gives the lacquer an opportunity to dry. If the flies are blown off the petri dish too soon they will stick to the bottom of the cage on their backs. The mortality of the marking operations depends upon the skill of the anesthetizer and the care with which the flies are marked and handled. 300 flies were placed in holding cages 10 1/2 x 10 1/2 x 10 1/2".

Trap Pattern - The release point (RP) was indicated as the point of a triangle near the summit and the trap lines became increasingly longer as they approached the base. Those lines closest to the RP had the traps spaced farther apart to allow the fly to infiltrate down the slope. Above the RP was a string of traps whose purpose was to intercept those flies which would move upward toward the summit. The mileage from the summit to the Haleakala cut-off (3700 feet) was measured and each cut-back numbered. Traps were then placed on certain cut-backs. This eliminated a good deal of cross-country hiking over rough terrain. However, in order to extend the trap lines it was necessary to extend the cut-back lines on the left and right. In addition to the trap lines it is the intention to make spot checks at various localities after the fly has had an opportunity to disperse.

Release of Flies - It was the intention to release 10,000 flies at 9000 feet at about 9:00 a.m. on October 21. The flies were carried to the summit in 33 holding cages. At the beginning of the trip the temperature was 54 degrees and the flies were quite torpid. At 9 o'clock a cold easterly wind was holding the temperature at the 9000 foot level to 54 degrees. This is below the threshold of activity for the fly and it was pointless to release them at the temperature. The sky was slightly hazy and the sun obscured. Trying the 8000 foot level we found the temperature about 60 and the sun was climbing above the haze. The flies inside the panel-truck had become quite active as the temperature inside the closed truck was 70. At this point another check was made at the 9000 foot level and the temperature had risen to 58. The flies were finally liberated on the number 5 cut-back at about 8500 feet elevation. The sky was slightly overcast but the sun was warm enough to feel. The temperature at the beginning of the release was 64 and climbed to 66 as the last cage was emptied. There was a very slight wind from the east. A total number of 8388 flies were liberated between 10:45 and 11:15 a.m. Of the 10,072 flies which were marked between the dates of 13 and 21 October, 1684 were either crippled or had died in the interim.

Observations - Between 60 and 62° F. seems to be the threshold of activity for the fly at the time of the release. Upon release the flies flew up slightly and then veered eastward, up the slope and into the very slight wind. In all the flies released the behavior was the same with the exception of a few strays which wandered off erratically. After completing the liberation a survey of the vegetation fifty feet below the road, west of the release point was made and no flies were observed. A similar search above the road and to the east of the release point found them in goodly numbers.

Why the flies flew in this direction might be explained by the fact that the sun behind the haze appeared as a spot of light and they may have been flying toward the source of greatest light. The fact that they flew up the slope was contrary to what one might expect. Host material and climatic optimum usually would be down the slope in most areas.

Recoveries - The weather from the time the flies were released on October 21 until the first check of the traps on October 24 was clear and fairly warm. The Haleakala Station had a Max. of 69° and a Min. of 38°. The temperature up the slope at the release point was probably a few degrees colder. Weather condition on the slope was good for dispersal. At Trap No. 108 2 flies were recovered. One of them was marked. This trap was about half of a mile from the release point down the slope at an elevation of about 7600. Another recovery was made in Trap No. 21, down the slope at about 7500 feet elevation, about a half mile from the release point. This fly had apparently entered the trap recently for he was quite active and sitting on top of the water. Two unmarked flies were found at Trap 45 at 4000 ft. and an unmarked fly was found in Trap 48 at the same elevation. The unmarked fly taken at 7600 is the highest point Dacus dorsalis has been recovered on Maui. One more recovery was made in Trap 95 in the Olinda section about 6 miles from the release point.

This report includes only the first check of the trap 3 days after liberation and it is quite possible that future checks will indicate a greater dispersement. It is planned to release about 1000 more flies late in the afternoon to observe if the sun has any effect on their direction of flight.

Elevation	Cutback	Miles	No. Traps	Distance Between	Trap Numbers
9779 to 9200	1	1.8	7	.2	139, 88, 28, 103, 144, 18, 138
	Ext. L	1.2	6	.2	12, 23, 44, 55, 64, 141
8700	3	1.2	1	-	46
8500 to 7900	5	1.6	4	.4	106, 49 (R.P.) 169, 52
7500 to 7100	7	1.2	4	.4	31, 10, 21, 108
6600 to 6000	10	2.4	13	.2	39, 183, 19, 169, 140, 61, 182, 137, 37, 145, 54, 76, 32
	Ext. L	.8	4	.2	69, 75, 143, 184
	Ext. R	.8	4	.2	60, 72, 105, 121
4350 to 4000	28	.6	3	.2	154, 136, 68
	Ext. L.	1.4	7	.2	77, 13, 71, 180, 63, 181, 58
	Ext. R	2.2	11	.2	74, 25, 91, 45, 48, 94, 7, 11, 41, 123, 98
3700 to 3000	Lab to Kula San.	5.6	14	.4	157, 131, 38, 26, 2, 50, 66, 34, 167, 24, 120, 8, 22, 35
4000 to 3500	Olinda	4	11	.4	57, 95, 172, 155, 83, 51, 82, 122, 92, 29, 17

Total miles of Trap Lines :	24.8	Release Point Elevation	8500 ft.
Total Walking Trap Lines :	8.4	Date of Release	Oct. 21, 1949
Total Number of Traps :	89	Hour	10:45 a.m. to 11:15 a.m.
Approximate Sq. Mi. covered:	50.	Temp.	64 to 66 F.
Condition of Flies	Active	Weather:	Slightly overcast
Flies Released	8388	Wind:	Very slight, from East.

Note: Flies were observed to fly up the slope and East upon release.

Ext. L : Extension left of cut-back.

(5) A Comparative Study of the Attractiveness of Various Fruits to Dacus dorsalis Hendl.

This limited study was carried on in three different areas using McPhail traps. These sites were characterized by different population levels of the fly. The population at Kula Sanitarium Farm could be considered an area of low fly incidence. The limiting factor appears to be suitable host material in sufficient quantities. While there was a good variety including banana, fig, limes, oranges, lemons, avocado, there was insufficient ripe fruit to maintain a high population.

At the second site, Territorial Nursery at Haiku, a high fly population was in evidence. This appeared to be the result of a good source of summer avodado.

The third site, a mango orchard near Haiku, had a high population which was rapidly diminishing as the mangoes, which had supported it, were going out of season.

Sliced fruit was used in dry traps which were checked daily and counts taken of the flies trapped.

As a basis of comparison an index figure was established by multiplying the number of traps by the number of days they were set and dividing this figure into the total flies caught. The formula might be expressed $\frac{F}{T D} : tdc$. Broken down, T:

Traps, D: days set, F: Total flies caught and tdc indicates trap daily catch. The following data shows how the index figure may be used:

Traps	Days checked	TD	Lure	Flies		Index	
				♂	♀	♂	♀
Kula Sanitarium Farm - An area of low fly incidence							
10	3	30	Fig	9	8	.30	.26
10	3	30	Banana	89	124	2.7	4.1
10	3	30	Citronella	275	0	9.1	-
Territorial Nursery, Haiku - An area of high fly incidence							
9	2	18	Banana	81	74	4.5	4.4
10	1	10	Pineapple	16	21	1.6	2.1
5	2	10	Citronella	1712	0	171.	-
Baldwin's Mango Orchard, Haiku - An area of high but diminishing incidence							
20	2	40	Mango	-	122	-	3.0
20	2	40	Banana	-	156	-	3.9
17	1	17	Avocado	11	4	.6	.3
2	1	2	Guava	7	20	3.5	10.
Wet Citronella Traps in the above areas							
Kula 4	3	12		250		74.	
TN Haiku 4	5	20		33,456		1672.	
BMO "	5	10		10,404		1040.	

13. Reports submitted

<u>Date</u>	<u>Subject</u>	<u>To whom</u>
9/4	"Ecological Report on Hawaii	Dr. W. Carter
9/12	"Ecological Report on Maui	Dr. W. Carter
9/18	"Report on Maui Trip"	W. Edwards
10/17	"Progress Report Maui"	Dr. W. Carter
10/18	"Progress Report Hawaii"	Dr. W. Carter
11/8	"Vanda Orchid Survey"	Dr. W. Carter
11/8	Dr. Walter Carter's Inspection Trip"	Dr. W. Carter

14. Summary and Conclusions

If you have read this far you deserve a quick finish. It is too early in the studies to form any conclusions from the data we now have on hand. Some of it is suggestive but it would be presumptuous to so state them here.

Elev.

- 112 -

10,000

4 mi.

3 mi.

2 mi.

1 mi.

9000

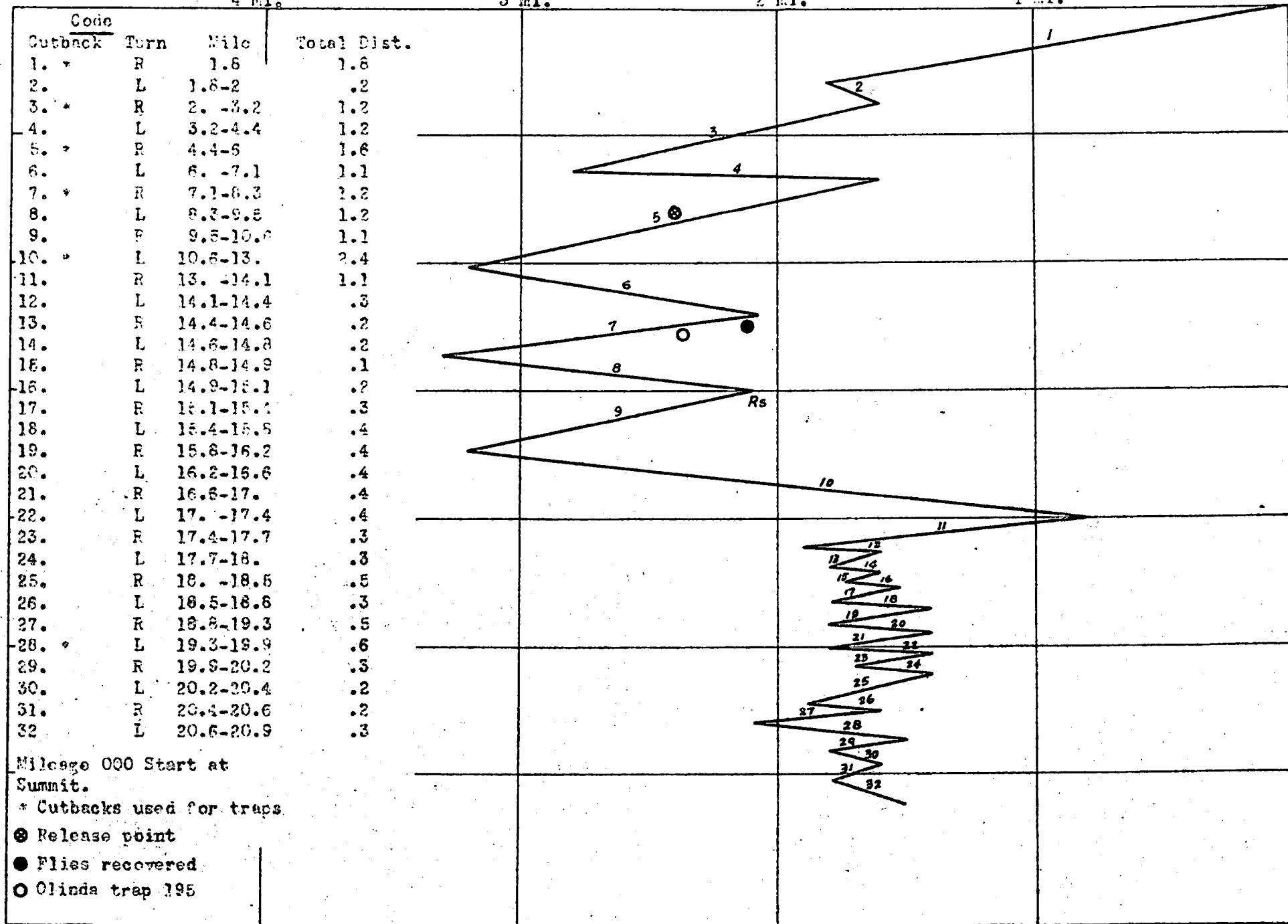
8000

7000

6000

5000

4000



Elev.

- 112 -

10,000

4 mi.

3 mi.

2 mi.

1 mi.

9000

8000

7000

6000

5000

4000

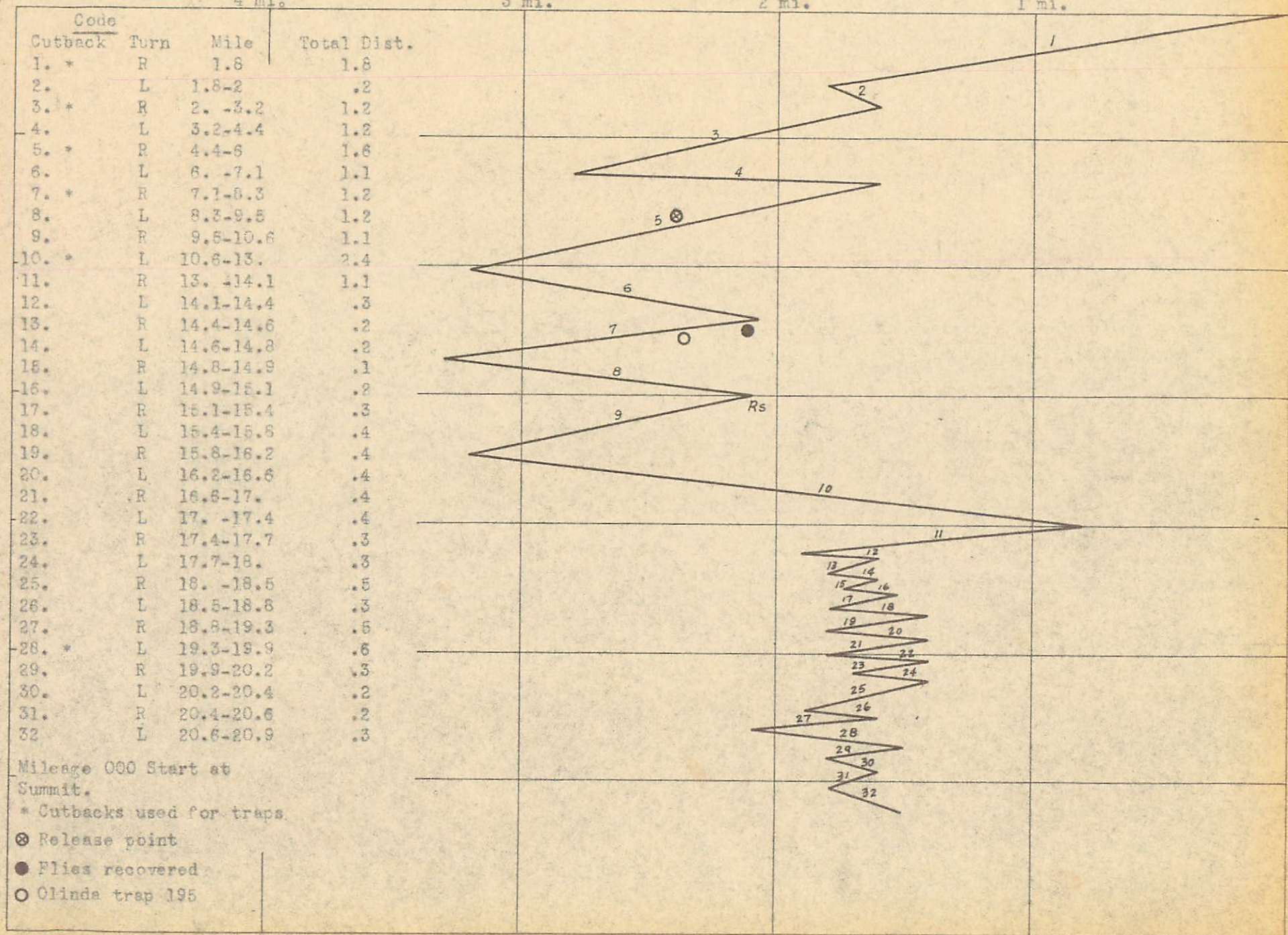


Table 5

Refrigerated 8/22/49

Age of pupae upon entering refrigerator 32°F.	Number of <i>D. dorsalis</i> flies emerging from pupae after removal to room temperature upon refrigeration for:									Date	No. of pupae
	1 da.	2 da.	3 da.	4 da.	5 da.	6 da.	7 da.	8 da.	9 da.		
5 da.	0	0	0	0	0	0	0	0	0		50
5 da.	0	0	0	0	0	0	0	0	0		"
5 da.	0	0	0	0	0	0	0	0	0		"
5 da.	0	0	0	0	0	0	0	0	0		"
5 da.	0	0	0	0	0	0	0	0	0		"
5 da.	0	0	0	0	0	0	0	0	0		"
5 da.	0	0	0	0	0	0	0	0	0		"
5 da.	0	0	0	0	0	0	0	0	0		"
5 da.	0	0	0	0	0	0	0	0	0		"
Total:	0	0	0	0	0	0	0	0	0		

Table 6

Refrigerated 8/1/49

6 da.	1	0	0	0	0	0	0	0	0	8/9/49	50
6 da.	0	0	0	0	0	1 parasite	0	0	0	8/17/49	"
6 da.	0	0	0	0	0	0	0	0	0		"
6 da.	0	0	0	0	0	0	0	0	0		"
6 da.	0	0	0	0	0	0	0	0	0		"
6 da.	0	0	0	0	0	0	0	0	0		"
6 da.	0	0	0	0	0	0	0	0	0		"
6 da.	0	0	0	0	0	0	0	0	0		"
6 da.	0	0	0	0	0	0	0	0	0		"
6 da.	0	0	0	0	0	0	0	0	0		"
Total:	1	0	0	0	0	1 parasite	0	0	0		

Table 7

Refrigerated 8/1/49

7 da.	0	0	0	0	0	0	0	0	0		50
7 da.	0	0	0	0	0	0	0	0	0		"
7 da.	0	0	0	0	0	0	0	0	0		"
7 da.	0	0	0	0	0	0	0	0	0		"
7 da.	0	0	0	0	0	0	0	0	0		"
7 da.	0	0	0	0	0	0	0	0	0		"
7 da.	0	0	0	0	0	0	0	0	0		"
7 da.	0	0	0	0	0	0	0	0	0		"
7 da.	0	0	0	0	0	0	0	0	0		"
7 da.	0	0	0	0	0	0	0	0	0		"
Total:	0	0	0	0	0	0	0	0	0		

Table 8

Refrigerated 8/1/49

8 da.	1	0	0	0	0	1	1	1	0	8/3/49	50
8 da.	0	1	0	0	1	0	0	0	0	8/7/49	"
8 da.	1 parasite	2 parasite	0	0	0	0	0	0	0	8/10/49	"
8 da.	0	0	0	1 parasite	0	0	0	0	0	8/14/49	"
8 da.	0	0	0	0	0	0	0	0	0		"
8 da.	0	0	0	0	0	0	0	0	0		"
8 da.	0	0	0	0	0	0	0	0	0		"
8 da.	0	0	0	0	0	0	0	0	0		"
8 da.	0	0	0	0	0	0	0	0	0		"
8 da.	0	0	0	0	0	0	0	0	0		"
Total:	1 parasite	2 parasite	1 parasite	1 parasite	1	1	1	1	1		

Freshly hatched first instar larvae were collected from incubation dishes and fifty were transferred to each of ten Petri dishes containing a media prepared from macerated papaya, honey and yeast. The following table shows the results obtained:

Table 12

Larvae refrigerated at 32°F.	Mortality	Pupae
1 day	16	0
2 "	38	0
3 "	47	0
4 "	49	0
5 "	49	0
6 "	50	0
7 "	50	0
8 "	50	0
9 "	50	0
Control	0	49

No larvae survived beyond five days after subjection to refrigeration at 32°F.

Nine sectioned life history cages, each containing ten D. dorsalis equal to sex, were used for each of the following groups of flies, freshly emerged and field collected. A table of the results follows:

Table 13

Number of Days Survived

Date	No. of days refrigerated at 32°F.	3 Days		4 Days		5 Days		6 Days		7 Days	
		Field Flies	Freshly Emerged Flies	Field Flies	Freshly Emerged Flies	Field Flies	Freshly Emerged Flies	Field Flies	Freshly Emerged Flies	Field Flies	Freshly Emerged Flies
8	1	5	3	0	0	0	0	0	0	0	0
9	2	2	3	1	3	All	Dead	0	0	0	0
10	3	All	Dead	All	Dead	0	0	0	0	0	0

Oviposition sections were exposed to gravid female D. dorsalis for the period of one hour on 8/24/49 and the eggs so collected held for 23 hours before refrigerating.

Eggs were randomized fifty to each of ten petri dishes lined with filter paper and moistened with a solution of 1/10 of 1% cupric chloride.

The eggs were held under refrigeration 32°F. for periods of from one day to nine days. The following table gives results obtained to date:

Table 14

Date	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9
8/26/49	33hatched	0	0	0	0	0	0	0	0
8/29/49	1 "	13hatched	17hatched	8hatched	0	0	0	0	0
8/30/49	1 "	0	0	2 "	0	1hatched	0	0	0
9/ 1/49	0	0	0	0	0	0	0	0	0
9/ 2/49	0	0	0	0	0	0	0	0	0
8/26/49	<u>Control</u> 49								

Summary

From the data obtained it appears that no pupae survive refrigeration for longer periods than is necessary to cause the death of eggs and larvae held at corresponding temperature. However, it would appear that the age of the pupae may have a direct bearing upon its ability to withstand low temperatures.

Puparia parasitized by *Opius longicaudatus* yielded adults after six days of refrigeration from pupae held nine days before being placed in the refrigerator. All parasites recovered were *Opius longicaudatus*.

Line Project - I-0-1.3

Investigations to obtain accurate data at constant temperatures at 2 1/2°C. intervals on the developmental range of D. dorsalis in all stages.

Initial test to determine incubation x hatching periods at the following temperatures: 12.5°C., 15°C., 20°C., 22.5°C., 25°C., 30°C., 35°C., 37.5°C.

Eggs were obtained by exposing a tangential section of orange rind secured to glass with paraffin, to caged flies that had previously been collected in the field. The sections were made available to the flies for a period of one hour either a.m. or p.m. depending upon the estimate of incubation and the endeavor to regulate the hatch to daylight hours.

Eggs were removed from the orange skin sections by means of a fine camel's hair brush and transferred to petri dishes lined with ink blackened filter paper. The paper was kept moist with a 0.1 percent solution of cupric chloride and covers were placed on the dishes to further prevent desiccation.

The eggs were incubated in five insulated cabinets, with light bulbs (incandescent) supplying the source of heat, open shallow dishes of saline solution the humidity, and an 8" fan providing the circulation of air. Electric thermo-regulators controlled the temperature to within $\pm 0.20^\circ\text{C}$. A hygro-thermograph and thermometer were kept in each cabinet in order to check the settings.

Observations were made every hour. The dishes containing eggs, were removed from the cabinets and examined under the binocular microscope and any hatch was recorded at that time. The results obtained are presented in the following table:

Table 1.5

<u>TEMPERATURE</u> <u>°C.</u>	<u>NUMBER</u> <u>INCUBATED</u>	<u>NUMBER</u> <u>HATCHED</u>	<u>INCUBATION</u> <u>PERIOD</u> <u>HOURS</u>	<u>HATCHING</u> <u>PERIOD</u> <u>HOURS</u>	<u>PER CENT</u> <u>HATCH</u>
12.5	152	0	428	0	0
15	231	18	182	20	7.79
20	95	67	65	6	70.53
22.5	399	174	67.50	8	43.61
25	262	78	33	6	33.58
30	232	142	26	6	63.33
35	442	21	60	2	4.75
37.5	187	0	200	0	0

The results show that the minimum time required for eggs to hatch at these temperatures was 26 hours at a temperature of 30°C. and the maximum 182 hours at 15°C. In the latter case the first hatch (2 eggs) was observed at 8 p.m., 182 hours after incubation, but no further hatch occurred until 7 a.m. the following morning 11 hours later. While at a temperature of 35°C. total hatch took place in the span of two hours, twenty eggs hatched in the first hour and only one in the second. It would appear that the thermal death point of both the high and low end of the temperature range for eggs has been neared and the critical point can be ascertained in the very near future from experiments now in progress.

When eggs were removed from the cabinets 12.5°C. and 37.5°C. and placed in cabinet 30°C., after the full incubation period listed, no hatch was obtained.

Project I-0-1.6

Outline for determining susceptibility of California fruit to infestation and development of Dacus dorsalis (Hendel.).

Fruits arriving at the laboratory will be immediately unpacked, randomized, and three representative samples segregated for exposure to the flies.

1. Cage Infestation

Sample one will be weighed, and the fruits labeled and exposed to gravid flies in standard screen rearing cages. Each cage will be designated in a number or index letter. Whenever possible fruit made available to the flies will be by variety, and standardized to weight. A standard media of macerated papaya, powdered yeast, and honey will be constantly available to the flies in each cage. Observations will be made to determine the flies reaction to the introduced hosts and oviposition and feeding preference for the fruits noted.

Hosts will remain exposed to the flies for a period of time considered to suffice for obtaining infestation data, and removed before decadence of the fruit is very advanced.

Fruits removed from the cages will be isolated in gallon cans and reposed over screened sand. Each can will be assigned the cage identification symbol. Biweekly siftings of the sand will be made to recover any pupae that may be present and these in turn will be placed in erlenmeyer flasks in moist sand and fly emergence recorded each day.

2. Cage Host Preference

One sample will be composed of mixed fruits or varieties of the same fruit. These samples will be weighed and treated in exactly the same manner as prescribed for the initial test. It is hoped that by exposing the varieties of fruit to cages of flies in this manner, that host preference may be discovered. Positional changes will be made as often as possible, so that the factor of positional attraction may be held at a minimum. Fruits will be removed, isolated, and the same procedure carried out as outlined for sample one.

3. Field Host Preference

The third sample will, whenever possible, be a duplicate of the fruits and varieties used for the caged host preference test. Fruits will be weighed, and wire cradles or slings made to support the fruits without interfering with their exposure to the flies. The fruits will then be removed outdoors and suspended from branches of preferred natural host fruits common to Hawaii. With an abundance of local fruit in all stages of development and a strong population of flies present, it is hoped to determine what attraction the introduced fruits will have upon the fruit fly and to what extent infestation takes place.

A comparison of results obtained from fruits exposed to the caged flies, when measured with data collected from those exposed in competition with local field hosts, may provide some idea of the susceptibility of California fruits to

field infestation.

Notes will be submitted on the current progress of the investigations each week and a complete report submitted at the conclusion of each test. Tests should be completed about thirty days after initial exposure of the fruit, depending upon the rapidity of host decadence and length of exposure to the flies.

Project - I-0-1.6

The susceptibility of Californian fruit to infestation and development of Dacus dorsalis.

The information contained in this report constitutes the findings at the conclusion of the initial experiment. Fruit exposed to the flies is held in isolation after removal from the cages and completion of each report is based upon the emergence of the last fly from puparia recovered from the fruit.

It was interesting to note that the cage observations on fly reaction to the introduction of the various fruits was rather significant. Upon the introduction of nectarines the flies became very interested, and females very aggressive to members of the same sex whenever they encroached upon the fruit area that she was investigating. Obviously the nectarines were considered sufficiently attractive to the females for oviposition and deposition of eggs was observed very shortly after the flies became accustomed to the host. In the case of pear it was observed that the flies exhibited greater interest in the food properties of the fruit and the females showed no great desire to oviposit.

However, many factors and their combinations can contribute in a large measure for the flies reaction. Color, skin texture, degree of ripeness and size of fruit make it very difficult to draw any comparison of true host attractiveness.

Fruits were exposed to the flies for periods of time based upon normal infestation expectancy, the rate of host decadence, and the arrival of new host material. In every case the period was considered adequate to provide host records. The primary purpose was to establish whether the fruit could become a suitable host and not what extent of infestation could be established.

Several factors contribute to low emergence of flies over puparia recovered. Insufficient food media is one of the possible reasons. High larval populations need an abundance of host media, otherwise, they migrate and consequently are forced into premature pupation. Some fruits exude great quantities of water when the cells become damaged by larval activity and surrounding pupae are in consequence drowned.

However, when the small amount of host material exposed to the flies is taken into consideration, infestation records of any degree constitute a definite standard for evaluating host susceptibility.

It is interesting to note that when Californian fruits were introduced to the flies in the field by the expedient of suspending them in close proximity to native host fruits, infestation by D. dorsalis took place. However, in reviewing the data submitted it must be remembered that in every case the records are obtained from Californian fruits exposed to D. dorsalis under Hawaiian conditions.

CAGE INFESTATION OF CALIFORNIA FRUITS BY *D. dorsalis*

Cage No.	In Date	Out Date	Type of Fruit	Quantity	Grams Each	Total Weight	Pupation and Emergence			% Emergence over Pupation	
							Date	No. Pupae	Date		No. Flies
A	8/26/49	8/31/49	Standard Tioga Nectarines	2	207	207	9/7/49	13	9/16/49	200 [♂]	41.67
								7		1♀	
							9/9/49	16	9/19/49	600 [♂]	
								0 D		499	
							9/13/49	0 D	9/20/49	299	
B	8/26/49	8/31/49	Standard Tioga Nectarines	3	210	210	9/7/49	0	9/16/49	1♀	100.0
								0			
								1			
							9/9/49	1	9/20/49	1♂	
								0	9/21/49	599	
								4		200 [♂]	
							9/13/49	10	9/26/49	200 [♂]	
								0		499	
	8 D	9/29/49	1♂								
	0 D										
	14 D										
C	8/26/49	8/31/49	Standard Tioga Nectarines	3	214	214	9/7/49	75	9/16/49	1♀	1.49
								52	9/22/49	1♀	
								6			
							9/9/49	12 D			
								0			
	1										
	0										
	0 D										

CAGE INFESTATION OF CALIFORNIA FRUITS BY *D. dorsalis*

Cage No.	In Date	Out Date	Type of Fruit	Quantity	Grams Each	Total Weight	Incubation and Emergence				% Emergence over Incubation
							Date	No. Pupae	Date	No. Flies	
D	8/26/49	8/31/49	Standard Tioga Nectarines	3	216	216	9/7/49	0	9/16/49	1♂	46.15
								0		2♀♀	
								2	9/19/49	1♀	
							9/9/49	30	9/20/49	30♂	
								19		3♀♀	
								1	9/21/49	7♂	
							9/13/49	16 D		4♀♀	
								77 D	9/26/49	1♀	
								24 D	9/29/49	1♂	
										1♀	
E	8/26/49	8/31/49	Standard Tioga Nectarines	3	200	200	9/7/49	1	9/16/49	1♀	59.57
								32	9/19/49	26♀♀	
								30		26♂♂	
							9/9/49	12 D	9/20/49	2♀♀	
								4		1♂	
								27			
							9/13/49	23 D			
								0 D			
F	8/26/49	8/31/49	Standard Tioga Nectarines	3	216	216	9/7/49	1	9/16/49	4♂♂	25.56
								6	9/19/49	14♀♀	
								54		11♂♂	
							9/9/49	3	9/20/49	3♀♀	
								63		2♂♂	
								6			
							9/13/49	0 D			
								3 D			
	3 D										

CAGE INFESTATION OF CALIFORNIA FRUITS BY *D. dorsalis*

Cage No.	In Date	Out Date	Type of Fruit	Quantity	Grams Each	Total Weight	Pupation and Emergence				% Emergence over Pupation
							Date	No. Pupae	Date	No. Flies	
G	8/26/49	8/31/49	Standard Tioga Nectarines	3	206	206	9/7/49	0	9/16/49	12 ⁰⁰	77.78
								2		19 ⁰⁰	
								2	9/21/49	6 ⁰⁰	
							9/9/49	6		3 ⁰⁰	
								1	9/22/49	1 ⁰	
								1	9/26/49	1 ⁰	
							9/13/49	15 D			
								12 D			
								39 D			
								9/16/49	42		
H	8/26/49	8/31/49	Standard Tioga Nectarines	3	202	202	9/7/49	64 D	9/16/49	29 ⁰⁰	44.00
								8		17 ⁰⁰	
								89	9/19/49	15 ⁰⁰	
							9/9/49	3		4 ⁰⁰	
								50	9/22/49	1 ⁰	
							9/13/49	0 D			
								0 D			
TOTAL									36.62		

D = Host discarded

FIELD HOST PREFERENCE OF CALIFORNIA FRUITS BY *D. dorsalis*

Native Host Tree	Date Exposed	Date Iso-lated	Type of Fruit	Grams Each	Total Weight	Pupation and Emergence				% Emergence over Pupation
						Date	No. Pupae	Date	No. Flies	
Mango (<i>Mangifera indica</i>)	8/29/49	9/2/49	Local Royal Purple Nectarine	87	87	9/7/49	0	9/19/49	2♀♀	83.33
						9/9/49	1	9/20/49	1♀	
						9/13/49	25 D	9/23/49	1♂	
						9/20/49	5		1♀	
"	8/29/49	9/2/49	Local Royal Purple Nectarine	82	82	9/7/49	11			0
						9/9/49	0			
						9/13/49	0 D			
"	8/29/49	9/2/49	Standard Tioga Nectarine	41	41	9/7/49	6	9/19/49	1♂	21.43
						9/9/49	22	9/20/49	3♂♂	
						9/13/49	0 D		1♀	
								9/21/49	1♀	
"	8/29/49	9/2/49	Standard Tioga Nectarine	43	43	9/7/49	34	9/19/49	11♂♂	24.00
						9/9/49	41		7♂♂	
						9/13/49	0 D			
"	8/29/49	9/2/49	Bartlett Pear	207	207	9/7/49	0	9/19/49	2♂♂	9.68
						9/9/49	13		1♀	
						9/13/49	18			
						9/21/49	23 dead larvae			

D = Host Discarded

CAGE INFESTATION OF CALIFORNIA FRUITS BY *D. dorsalis*

Cage No.	Date	Date	Type of Fruit	Quantity	Grams Each	Total Weight	Pupation and Emergence				% Emergence over Pupation
							Date	No. Pupae	Date	No. Flies	
1	8/26/49	8/31/49	Local Royal Purple Nectarines	2	120	250	9/7/49	54	9/16/49	1200	
								93		1100	
							9/9/49	3	9/19/49	1700	
								3		1500	
							0 D				
							6 D			35.95	
2	8/26/49	8/30/49	Local Royal Purple Nectarines	2	126	236	9/7/49	7	9/16/49	1800	
								84		2100	
							9/9/49	47			
								6			
							0 D				
							6 D			27.08	
3	8/26/49	8/30/49	Local Royal Purple Nectarines	2	122	122	9/7/49	2	9/16/49	900	
								15		400	
							9/9/49	5	9/20/49	100	
								7	9/22/49	200	
							4 D		200		
							0 D			62.07	
4	8/26/49	8/30/49	Local Royal Purple Nectarines	2	112	228	9/7/49	2	9/16/49	200	
								0	9/19/49	700	
							9/9/49	5		400	
								0 D	9/21/49	200	
							9/13/49	6 D	9/23/49	10	
							16			69.57	

CAGE LIFE STATION OF CALIFORNIA FRUITS BY *D. dorsalis*

Cage No.	Date	Date	Type of Fruit	Quantity	Grams Each	Total Weight	Pupation and Emergence				Emergence over Pupation
							Date	No. Pupae	Date	No. Flies	
5	8/26/49	8/30/49	Local Royal Purple Nectarines	2	117 131	248	9/7/49	4	9/16/49	600	
								0		900	
							9/9/49	0	9/22/49	10	
								37		200	
							2 D				
							31 D			43.90	
6	8/26/49	8/30/49	Local Royal Purple Nectarines	2	114 135	249	9/7/49	38	9/16/49	1200	
								7		1400	
							9/9/49	3			
								13			
							0 D				
							0 D			42.62	
7	8/26/49	8/30/49	Local Royal Purple Nectarines	2	120 117	237	9/7/49	159	9/16/49	900	
								6		1100	
							9/9/49	159			
								13			
							0 D				
							0 D			5.93	
TOTAL										24.37	

D = Host discarded

Note: 20 larvae dead from drowning on 2nd. sifting - 9/9/49 Cage No. 6

CAGE INFESTATION OF CALIFORNIA FRUITS BY *D. dorsalis*

Cage No.	In Date	Out Date	Type of Fruit	Quantity	Grams Each	Total Weight	Pupation and Emergence			% Emergence over Pupation
							Date	No. Pupae	No. Flies	
1	8/30/49	9/2/49	Bartlett Pears	1	128	128	9/9/49	0		
							9/13/49	0		
							9/16/49	0		
							9/21/49	0		
							9/23/49	0	D	
2	8/30/49	9/2/49	Bartlett Pears	1	206	206	9/9/49	0		
							9/13/49	0		
							9/16/49	0		
							9/21/49	0	D	
3	8/30/49	9/2/49	Bartlett Pears	1	263	263	9/9/49	0		
							9/13/49	0		
							9/16/49	0		
							9/21/49	0	D	
4	8/30/49	9/2/49	Bartlett Pears	1	98	98	9/9/49	1		
							9/13/49	0		
							9/16/49	0		
							9/21/49	1	D	0
5	8/30/49	8/31/49	Bartlett Pears	2	111	242	9/9/49	0		
					131		9/13/49	0		
							9/16/49	0		
							9/21/49	0		
							9/23/49	0	D	

CAGE INFESTATION OF CALIFORNIA FRUITS BY *D. dorsalis*

Cage No.	In Date	Out Date	Type of Fruit	Quantity	Grams Each	Total Weight	<u>Pupation and Emergence</u>				Emergence over Pupation
							Date	No. Pupae	Date	No. Flies	
6	8/30/49	9/2/49	Bartlett Pears	1	263	263	9/9/49	1	10/10/49	400 10	35.71
							9/13/49	12			
							9/16/49	0			
							9/21/49	0 D			
7	8/30/49	9/2/49	Bartlett Pears	1	191	191	9/9/49	0			
							9/13/49	0			
							9/16/49	0 D			
TOTAL										35.71	

D = Host discarded

CAGE INFESTATION OF CALIFORNIA FRUITS BY *D. dorsalis*

Cage No.	In. Date	Out Date	Type of Fruit	Quantity	Grams Each	Total Weight	Pupation and Emergence				Emergence Over Pupation
							Date	No. Pupae	Date	No. Flies	
A	9/2/49	9/6/49	Bartlett Pears	1	175	175	9/13/49	0			
							9/16/49	0			
							9/21/49	0	D		
B	9/2/49	9/6/49	Bartlett Pears	1	164	164	9/13/49	5	9/27/49	1♂	
							9/16/49	1		1♀	
							9/21/49	1			
							9/23/49	0			
							9/29/49	19	D		23.57
C	9/2/49	9/6/49	Bartlett Pears	1	162	162	9/13/49	0			
							9/16/49	0	D		
							9/21/49	0			
							9/23/49	0			
							9/29/49	2	D		
D	9/2/49	9/6/49	Bartlett Pears	1	135	135	9/13/49	0			
							9/16/49	0	D		
E	9/2/49	9/6/49	Bartlett Pears	1	221	221	9/13/49	0			
							9/16/49	0	D		
F	9/2/49	9/6/49	Bartlett Pears	1	202	202	9/13/49	0			
							9/16/49	0	D		
G	9/2/49	9/6/49	Bartlett Pears	1	124	124	9/13/49	0			
							9/16/49	0	D		

CAGE INFESTATION OF CALIFORNIA FRUITS BY *D. dorsalis*

Cage No.	In Date	Out Date	Type of Fruit	Quantity	Grams Each	Total Weight	<u>Pupation and Emergence</u>			% Emergence over Pupation
							Date	No. Pupae	No. Flies	
H	9/2/49	9/6/49	Bartlett Pears	1	116	116	9/13/49	0		
							9/16/49	0		
							9/21/49	0 D		
I	9/2/49	9/6/49	Bartlett Pears	2	221	221	9/13/49	0		
							9/16/49	1 D		
TOTAL									23.57	

D = Host discarded

CAGE INFESTATION OF CALIFORNIA FRUITS BY *D. dorsalis*

Cage No.	In Date	Out Date	Type of Fruit	Quantity	Grams Each	Total Weight	Pupation and Emergence				Emergence over Pupation
							Date	No. Pupae	Date	No. Flies	
1	9/2/49	9/6/49	Kelsey Plum (Jap. Var.)	3	242	242	9/13/49	0			
							9/16/49	0			
							9/21/49	6 D			
2	9/2/49	9/6/49	Late Duarte Plum	3	120	120	9/13/49	4	9/22/49	10	
							9/16/49	0		10	
							9/21/49	0	9/20/49	200	
							9/23/49	12		600	
							9/29/49	14 D			62.50
3	9/2/49	9/6/49	Late Duarte Plum (Jap. Var.)	3	124	124	9/13/49	0	9/27/49	10	
							9/16/49	3			
							9/21/49	5 dead larvae			33.33
4	9/2/49	9/6/49	Kelsey Plum (Jap. Var.)	3	216	216	9/13/49	0			
							9/16/49	0			
							9/21/49	0 D			
5	9/2/49	9/6/49	Giant Plum	3	171	171	9/13/49	0			
							9/16/49	1			
							9/21/49	0 D			0
6	9/2/49	9/6/49	President European Var. Plum	3	141	141	9/13/49	0			
							9/16/49	0			
							9/21/49	0 D			
7	9/2/49	9/6/49	President European Var. Plum	3	134	134	9/13/49	3	9/26/49	200	
							9/16/49	20	9/29/49	600	
							9/21/49	42 D		900	73.91
										TOTAL	62.79

D = Host discarded

CAGE INFESTATION OF CALIFORNIA FRUIT BY *D. dorsalis*

Cage No.	In Date	Out Date	Type of Fruit	Quantity	Grams Each	Total Weight	<u>Pupation and Emergence</u>				Emergence over Pupation
							Date	No. Pupae	Date	No. Flies	
A	8/31/49	9/2/49	Late Santa Rosa Plum	3	69	203	9/9/49	0	9/26/49	200	80.00
					65		9/13/49	1		19	
					69		9/16/49	21 D		19	
							9/21/49	4			
B	8/31/49	9/2/49	Kelsey Plum (Jap. Var.)	2	140	264	9/9/49	0	9/26/49	10	100.00
					124		9/13/49	0		19	
							9/16/49	1 D			
							9/21/49	2			
C	8/31/49	9/2/49	Giant European Var. Plum	3	62	186	9/9/49	0			
					63		9/13/49	1			
					61		9/16/49	0 D			
D	8/31/49	9/2/49	Giant European Var. Plum	3	62	190	9/9/49	0			
					65		9/13/49	0			
					63		9/16/49	3 D			
E	8/31/49	9/2/49	Giant Plum	3	58	171	9/9/49	0			
					57		9/13/49	0			
					56		9/16/49	6 D			
F	8/31/49	9/2/49	Late Duarte Plum	3		135	9/9/49	0	9/22/49	19	100.00
							9/13/49	0		19	
							9/16/49	2			
							9/21/49	28 D			

CAGE INFESTATION OF CALIFORNIA FRUITS BY D. dorsalis

Cage No.	In Date	Out Date	Type of Fruit	Quantity	Grams Each	Total Weight	<u>Emergence and Pupation</u>			$\frac{\%}{}$ Emergence over Pupation
							Date	No. Pupae	Date	
G	8/31/49	9/2/49	President European Var. Plum	3	55	164	9/9/49	0		
					56		9/13/49	1		
					53		9/16/49	3		
							9/21/49	3		
							9/23/49	37 D	0	
H	8/31/49	9/2/49	Late Santa Rosa Plum	3	69	203	9/9/49	0		
					65		9/13/49	0		
					69		9/16/49	0		
							9/21/49	4 D		
I	8/31/49	9/2/49	Kelsoy Plum (Jap. Var.)	2	139	264	9/9/49	0		
					126		9/13/49	0		
							9/16/49	0		
							9/21/49	0		
							9/23/49	0 D		

TOTAL - 47.06

D = Host discarded

FIELD HOST PREFERENCE OF CALIFORNIA FRUITS BY *D. dorsalis*

Native Host Tree	Date Exposed	Date Iso-lated	Type of Fruit	Grams Each	Total Weight	Pupation and Emergence				
						Date	No. Pupae	Date	No. Flies	
Surinam Cherry (<i>Eugenia uniflora</i>)	8/29/49	9/2/49	Local Royal Purple Nectarine	82	82	9/7/49	0			
						9/9/49	3 D			
"	8/29/49	9/2/49	Local Royal Purple	89	89	9/7/49	0			
						9/9/49	0			
						9/13/49	13 D			
"	8/29/49	9/2/49	Standard Tioga Nectarine	41	41	9/7/49	0	9/20/49	800	
						9/9/49	52		1000	
						9/13/49	2 D	9/21/49	300	
									400	43.08
"	8/29/49	9/2/49	Standard Tioga	42	42	9/7/49	0	9/20/49	1400	
						9/9/49	35		1400	
						9/13/49	2 D	9/22/49	10	82.86
"	8/29/49	9/2/49	Bartlett Pear	150	150	9/7/49	0			
						9/9/49	0			
						9/13/49	0			
						9/16/49	1			
						9/23/49	23			0
"	8/29/49	9/2/49	Bartlett Pear	184	184	9/7/49	0			
						9/9/49	0			
						9/13/49	0			
						9/16/49	0			
						9/21/49	4			0

D = Host discarded

CAGE INFESTATION OF CALIFORNIA FRUITS BY *D. dorsalis*

SUMMARY

<u>Cage No.</u>	<u>Type of Fruit</u>	<u>Total Number of Pupae</u>	<u>Total Number of Flies</u>	<u>% Emergence over Pupation</u>
A - H	Standard Tioga Nectarines	669	245	36.62
1 - 7	Local Royal Purple Nectarines	788	192	24.37
1 - 7	Bartlett Pears	14	5	35.71
A - I	Bartlett Pears	7	2	28.57
1 - 7	Plums	43	27	62.79
A - I	Plums	17	8	46.06

FIELD HOST PREFERENCE OF CALIFORNIA FRUITS BY *D. dorsalis*

SUMMARY

<u>Native Host Tree</u>	<u>Type of Fruit</u>	<u>Total Number of Pupae</u>	<u>Total Number of Flies</u>	<u>% Emergence over Pupation</u>
Mango (<i>Mangifera indica</i>)	Local Royal Purple Nectarine	6	5	83.33
"	Local Royal Purple Nectarine	11		0
"	Standard Tioga Nectarine	28	6	21.43
"	Standard Tioga Nectarine	75	18	24.00
"	Bartlett Pear	31	3	9.68
Surinam Cherry (<i>Eugenia uniflora</i>)	Local Royal Purple Nectarine			0
"	Standard Tioga Nectarine	52	25	48.08
"	Standard Tioga Nectarine	35	29	82.86
"	Bartlett Pear	24		0
"	Bartlett Pear	4		0

Line Project - I-0-1.7

An experiment to determine the indices of Dacus dorsalis infestation in Vanda orchid variety, Miss Joaquin, was undertaken and from the findings, tabulated below, table 16, it would appear that infestation in the field is very light at this particular season. However, investigations will be continued and flower examination made biweekly. It is hoped that a field inspection can be made monthly in order that fly populations can be observed and buds examined for oviposition punctures. From initial experiments conducted in the laboratory it would appear that infestation occurs in the buds, and oviposition on an open flower is very rare.

When flowers of commercial shipping grade were exposed to cages of gravid flies in an attempt to induce oviposition the results were negative.

In order to determine the infestation occurring under nursery conditions, blooms are being sent in by Mr. Robert Warne, Honolulu and Flowers of Hawaii from Hilo, Hawaii, there are carefully examined in the laboratory and infestation recorded.

Other Vandaceous orchids will be examined in the course of this study and the findings reported when complete.

Index of D. dorsalis infestation in Vanda Joaquin orchids obtained from Robert Warne, Honolulu, and Flowers of Hawaii, Hilo, Hawaii is shown in the following table:

Table 16

INFESTATION INDEX OF DACUS DORSALIS IN VANDA JOAQUIM

DATE	SOURCE	GRADE	NUMBER EXAMINED	NUMBER INFESTED	PETAL	PARTS		EGGS			LARVAE		TOTAL UNHATCHED
						STEM	PISTIL	COLLAPSED	HATCHED	UNHATCHED	DEAD	ALIVE	EGGS & LIVE LARVAE
4/ 6/49	Robert Warne	Culls	386	2			X	4				2	
4/ 6/49	Flowers-Hawaii	A	360	1			X		7				
4/ 7/49	Robert Warne	Culls	516	4	X			6	7			4	
							X		1			1	
4/ 7/49	Flowers-Hawaii	A	252	2	X			3					
							X	2					
4/ 8/49	Flowers-Hawaii	Culls	283	2	X				2				
							X		2				
4/ 9/49	Robert Warne	A	494	4	X			1	5	1		4	1
							X		4				
		Culls	648	13	X			5	1	1		1	1
					X			2	2	1			1
							X		4			5	
4/ 9/49	Flowers-Hawaii	A	786	9	X				4	4		1	5
							X		2				
							X	5	7				
4/12/49	Robert Warne	Culls	1,135	10	X				7	2		2	2
								X	4				
								X	3			4	
4/12/49	Flowers-Hawaii	A	283	4	X			6	1				
							X	1			2		2
7/23/49	Robert Warne	Culls	1,067		X						1		1
8/11/49	Robert Warne	Culls	1,290	5	X				5		4		4
8/25/49	Robert Warne	Culls	1,000	4	X						11		11
8/26/49	Robert Warne	Culls	1,000	3	X						5		5
9/15/49	Robert Warne	Culls	960	1	X						1		1
9/22/49	Hilo, Hawaii	Culls	500	0	X								
9/22/49	Hilo, Hawaii	A	500	0									
10/ 7/49	Hilo, Hawaii	Culls	500	0									
10/ 7 /49	Hilo, Hawaii	A	500	0									
10 8 /49	Robert Warne	Culls	435	0									
10/12/49	Robert Warne	Field	3,100	1	X			1					
		Inspection											
	TOTAL		16,055	65				44	67	33	23	1	34
	PERCENTAGE			405%						49.25%		4.35%	

It will be noted that of the blooms examined 65 out of 16,055 or under 1% were at some time or other actively infested with D. dorsalis. Although the total infestation based on eggs found was 144 individuals, actually the potential danger from this source could be safely calculated on the basis of the 34 individuals in the last column comprising 33 apparently sound un-hatched eggs and 1 live larva.

OUTLINE OF LINE PROJECTS

BIOLOGY-ECOLOGY PROJECT, Work Project I-0-1, N. E. Flitters Asst. Project Leader

- I-0-1.1 General Outline
 Specific Objective: To duplicate and to determine the effect of temperature and humidity from certain zones of continental United States on the development of D. dorsalis in all stages.
- I-0-1.2 General Outline
 Specific Objective: To determine the effect of low temperatures on the development of all stages of D. dorsalis.
- I-0-1.3 General Outline
 Specific Objective: To obtain accurate data on the effect of constant temperatures on all stages of D. dorsalis.
- I-0-1.4 General Outline
 Specific Objective: To determine the thermal death point of D. dorsalis at minimum and maximum temperatures.
- 4.1 Specific Objective: To determine the threshold of development of immature stages of D. dorsalis and minimum and maximum temperature at which eggs fail to hatch.
- I-0-1.5 General Outline
 Specific Objective: To determine age of sexual maturity of D. dorsalis in the field.
- 5.1 Specific Objective: To determine age of sexual maturity of male flies of D. dorsalis.
- O-0-1.6 General Outline
 Specific Objective: To determine the susceptibility of California fruit and vegetables to infestation and development of D. dorsalis.
- I-0-1.7 General Outline
 Specific Objective: To determine the indices of infestation in Vanda orchid, Miss Joaquim by D. dorsalis.

- I-0-1.8 General Outline
Specific Objective: To determine the indices of infestation by D. dorsalis in commercial fruits produced in the Islands.
- I-0-1.9 General Outline
Specific Objective: To determine the fertilization potential of male D. dorsalis.
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Walter Carter

Walter Carter, Director
Oriental Fruit Fly Investigations

Honolulu, T. H.
November 14, 1949.