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INVESTIGATIONS OF FRUIT FLIES IN HAWAII

QUARTERLY REPORT

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WORK PROJECT I-a-5 - Biology-Ecology of Fruit Flies in Hawaii - Norman E.Flitters
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SUMMARY

A preliminary test undertaken in the bioclimatic cabinets to determine the effect of fluctuating temperatures and humidities of certain simulated mainland sites upon the development of some of the introduced opiine parasites revealed the fact that at an average temperature of approximately 64° F. the following parasites were able to complete their development and emerge in a period just in excess of 1 month--Opius formosanus, O. compensans, New Caledonia, and Siam.

Of particular interest was the fact that both O. compensans and O. formosanus underwent diapause before emerging after a period of two months.

Techniques for culturing large populations of parasites were explored to have them in readiness for anticipated shipments of parasites to the Northwest for introduction into the cherry-producing areas to determine their efficiency in combatting the cherry fruit flies.

Since the conclusion of the investigations conducted to determine the susceptibility of commercial Cayenne pineapples to infestation by the oriental fruit fly--a study that was instrumental in the removal of the regulation requiring the fumigation of this fruit--another avenue of investigation has been undertaken, that of determining the susceptibility of species and varietal forms that are used as parent stocks in the hybridization of pineapples.

A collection of 50 such fruits after individual exposure to caged gravid oriental fruit flies (25) for a period of 7 days, removed and isolated, later yielded 3,690 puparia. Flies recovered from these pupae were caged, fed the standard highly vitamin-fortified diet, provided water, and their development closely followed. Development followed a near-normal pattern. Sexual maturity was reached in 8 days, the flies copulated, and viable eggs were obtained before 12 days. The eggs were incubated, hatched, and the larvae transferred to a standard rearing media of ground carrots. Every stadium of development was normal and completed in average time and the adults that ultimately developed, successfully reproduced. A similar test performed upon 50 smooth Cayenne variety of pineapples in which large numbers of eggs were deposited provided negative results again indicating that larvae were unable to develop successfully in this variety.

In an effort to determine the host status of certain exotic fruits, berries, and immature flower buds that are presently prohibited entry into the United States (Quarantine 13), an induced oviposition study was commenced. Members of this group that have provided negative results thus far are Sausage fruits, (Kigelia pinnata); Woodroses (immature forms), Ipomoea batatas; Mohogany, Mohogany swietenia; Coconuts (mature and otherwise), Cocos nucifera; Pandanus, Pandanus pacificus; Fox heads or Nipple fruits, Solanum pamosum.

The low production of Mediterranean fruit flies in the insectary presented a serious problem and in spite of experimental changes in diet and techniques little benefits were derived. It was only by the expedient of collecting and culturing field flies that the problem was alleviated. Stocks of both oriental and melon flies remained at a high production level.

The bioclimatic cabinet studies now include the following study sites--(1) Orange, Calif.; (2) Fallbrook, Calif.; (3) Santa Paula, Calif.;(4) Houma, Louisiana; (5) Tempe, Arizona; (6) Orlando, Florida; (7) Weslaco, Texas.

The simulation site of Orange (Calif.) progressed through the months of August, September, and October (1952). The first two months provided a climate suitable for the reproduction of all three species of fruit flies. The oriental fruit fly demonstrated its ability to outproduce the other two species by a wide margin in initial population build-up but the melon fly again indicated its ability to develop at a much greater rate than either the oriental or Medfly during its pre-imaginal stage.

Fruit fly development became depressed in the Orange cabinet during October with climatological conditions becoming increasingly worse as the month progressed. A decided reduction in progeny recoveries resulted and the pre-imaginal developmental period became greatly lengthened. No second generation of any of the three fruit fly species was realized during the quarter.

The months of climate simulation and the year selected for commencing the cabinet study for the site of Fallbrook, Calif., was identical with that of Orange, Calif. Simulation was begun during the second week of August at which time climatological conditions were considered near optimal. During this and the month (September) that followed, excellent climatological conditions prevailed; the daily thermal peaks reached 90° F. most of the time only falling to lower values towards the latter part of the month. Minimum temperatures although occasionally falling to the low 50's was, for the most part, sufficiently high to insure fruit fly development. Initial recoveries of progeny of all three species was made during the month. The oriental fruit fly produced the greater number of progeny, followed by the melon fly, with the Mediterranean fruit fly producing but a token generation late in the month. The pre-imaginal developmental period for both the oriental and Mediterranean fruit flies was approximately the same (26 days) with the melon flies developing in just a few days under this figure.

October provided a pattern of temperatures at Fallbrook that definitely retarded pre-imaginal development particularly as the month advanced, and it was rare that the maximum temperatures crept above 70° F. with the minimum temperature for the most part below 60° F. Fruit fly emergence remained at a high plane, particularly in the case of the oriental fruit fly, but the effect of the depressed temperatures was evident in the rates of pre-imaginal development. For the oriental fruit fly it took but 27 days for complete development of the adults that were recovered during the forepart of the month, and this was extended to 31 days before the month closed. These figures reflect the minimum time required for development. The melon fly's developmental period became extended from 25 to 39 days and the Mediterranean fruit

fly's period was lengthened to about the same extent as was the period for D. dorsalis. No progeny representing a second generation was recovered during the month.

Climatological conditions in November were considerably more unwholesome for the fruit flies in general than was the preceding month. The nightly minimum temperatures seldom exceeded 50°F. as the month progressed and the maximum daily temperature seldom rose to 70° F. and during the latter days of the month the daily thermal peaks seldom reached 60° F.

These conditions materially reduced the amounts of progeny recovered and the actual percentage of emergence. However, the initial F-2 generation of both melon and oriental fruit flies was established early in the month. The minimum pre-imaginal developmental period for the oriental fruit fly was 35 days and the maximum, 52 days. Due to insufficient Mediterranean fruit fly stocks to replace earlier adult mortalities, no progeny were recovered.

Santa Paula, Calif., climate simulation was begun with the month of August which together with the following month provided conditions favorable for the establishment of the fruit flies but not of a thermal pattern that warranted a very rapid rate of pre-imaginal development. While there were days with thermal peaks of 80° F., the minimum temperatures fell below 60° F. the greater part of the time, and during the latter part of September there were a few nights in which the mercury fell just below 50° F. During this simulated period (August-September) no progeny were recovered.

The month of October at Santa Paula revealed a pattern of climate that was characterized by both lower maximum and minimum thermal values. The greater part of the month had daily peaks seldom exceeding 80° F. but rarely staying below 70° F. with accompanying minimum temperatures often ranging in the 40's. It was not of such great intensity or severity to materially affect the fruit flies much beyond that of depressing the rate of development. Progeny in strong numbers were recovered from the oriental fruit flies to a lesser extent but percentagewise higher from the melon flies and in a much reduced proportion from the Medflies. The pre-imaginal developmental period for the oriental fruit flies and the melon flies closely paralleled each other at approximately 39 days, while for the Mediterranean fruit fly it took about 41 days.

With the progression of climate into the Santa Paula November each succeeding week became more adverse to fruit fly development until by the close of the month pre-imaginal development was practically inhibited. At this period it was rare to find the daily thermal peaks much higher than 60° F. and the nightly minimums hovered in the high 40's. While some progeny were recovered from all three species, the numbers were considerably reduced from those of the preceding month and the developmental period for these adults became extended to between 47 and 52 days for the oriental, 44 to 51 days for the melon, followed by between 46-54 days for the Mediterranean fruit flies.

Houma, Louisiana

The simulation of the climate for this study site was discontinued during the present quarter with the progression of climate through the months of June and July. With near-optimal conditions prevailing it would have served no useful purpose to have contined further with the study. The rate of progeny production was such that none of the three species of fruit flies initially introduced into the cabinet study was able to perpetuate itself without replacement of parent stock but reproduction took place throughout the simulation period. There were periods when the progeny population rose to high levels but their duration was never of sufficient length or the population of such density that further generations of comparable strength could be developed. The oriental fruit fly produced several F-1 generations and finally was able to establish an F-2 generation. The melon fly followed a reproductive pattern of similar scope and was able to establish one more generation; namely, an F-3. The Mediterranean fruit fly proved to be more tolerant of conditions such as were experienced in the Houma site and was able to produce a fairly substantial F-4 generation.

Orlando, Florida

The complete annual climatological cycle for this study site was successfully completed during the quarter. The fruit fly stocks in this cabinet were able to maintain themselves in entirety throughout the study and reproduction was more or less progressive throughout the entire year. Optimal climatological conditions were experienced for the major part of the year and in spite of the fact that the winter of 1929-30 was regarded by many as critical insofar as fruit flies were concerned, we found that apart from depressing the rate of pre-imaginal development no deleterious effect was pronounced on any of the three fruit fly species. Adult activity was naturally curtailed and no oviposition took place during the very cold days. The oriental fruit fly demonstrated its ability to produce much higher populations in its earlier generations but both the Mediterranean fruit fly and melon fly proved their capacities for reproducing under much lower temperature conditions than the oriental fruit fly. During the complete climate simulation the oriental fruit fly was able to establish five generations which collectively were composed of some 10,000 adults almost equal to sex. The melon fly, which was slightly handicapped by being included into the study almost one month after the other two species, was able to build up four distinct generations that together had a total of some 7,000 adults. The Mediterranean fruit flies definitely demonstrated their adaptability to the climatic conditions of this site by building up both population strength and multiplicity of generations far in excess of either of the other fruit fly species. The total progeny recovered from these Medflies consisted of adults in excess of 14,000 and represented 10 separate and distinct generations. These findings serve to substantiate the success of the Mediterranean fruit fly eradication work as performed by Bureau personnel in 1929-30.

Weslaco, Texas

This new study site was commenced with the simulated month of July. Hygrothermographic records are presently being collected at the original study site and are immediately forwarded to us for the simulation study. With six weeks of acceptable weather for initial fruit fly establishment the progeny recoveries from the parent stocks of both oriental and melon flies were substantial and small token representations of an initial F-2 generation of both fruit fly species was established. However, the climatological conditions that followed the initial two months of climate simulation were of such a nature that pre-imaginal development was greatly retarded and adult activity very restricted.

Line Project I-a-5-1 INACTIVE DURING THIS QUARTER

Line Project I-a-5-2. Host of Fruit Flies in Hawaii. (N. E. Flitters and S. Yonamine)

At the conclusion of the investigations conducted in order to determine the susceptibility of Cayenne pineapples to infestation by the oriental fruit fly, and to determine to what extent larvae could successfully develop in the fruit another avenue of investigation was undertaken, that of determining the susceptibility of varietal forms and certain species that are used in hybridization.

Through the cooperation of Dr. J. L. Collins, Senior Geneticist for the Pineapple Research Institute, arrangements have been worked out whereby collections of fruits for this purpose will be made available as they mature in the trial plots.

The initial collection consisting of some 50 fruits were representative of the species and varieties collected principally in Central America, with certain individuals coming from places throughout the pineapple-growing world.

The fruits were picked directly from the trial plots at the Pineapple Research Institute branch station in Wahiawa; the vegetative crowns of the fruits were removed in the field. Since most of these plants do not produce basal vegetative growths, the crowns have of necessity to be used for propagation purposes.

The fruits were transported to the laboratory where they were weighed and individually exposed to 25 gravid oriental fruit flies in standard rearing cages for a period of 7 days. Upon removal the fruits were divided into equal groups of each variety and half were shelled and the remainder held whole both the shells and the solid fruits were isolated individually in conventional holding boxes.

Upon inspection a few days later it was observed that in certain of the whole fruits unusual decadence was taking place and active larvae were discovered in the soft tissues. Later siftings provided a total of 3690 puparia of which 1824 were recoveries made from the shells, while from the whole fruits 1766 pupae were recovered.

The pupae were held in small flasks in which moist sand had been placed and upon fly emergence careful examination of the adults was made in an effort to determine whether any physical differences in their size or morphological variations were evident. However, for the most part they appeared to be normal. There were minor differences in size but these were insignificant. When these flies were held in the conventional manner in rearing cages and fed the standard hydrolyzed yeast media, they developed normally, attained sexual maturity in from 6 to 8 days, copulated and produced viable eggs in from 8 to 12 days in most cases. These eggs were held in incubation until hatch began at which time the larvae were collected and transferred to the standard carrot medium used for fly cultures. Every stadium of development was normally and successfully completed and the adults that finally emerged developed and reproduced.

This experiment provided valuable substantiation of the techniques, values, and conclusions of the recently completed Cayenne pineapple study demonstrating that the techniques employed in determining the host properties were adequate and strengthening the conclusion that the enzymatic action of bromelin does not inhibit larval development.

In another test, 50 pineapples of the smooth Cayenne variety of comparable ripeness and size were selected in the field and treated in a similar manner to that provided the hybrids. The tops were removed from the fruits at the cultural site. They were transported to the laboratory and held in the identical manner described for the hybrids. The fruits exhibited no premature decadence, failed to produce any pupae either from the shells or whole fruits and were discarded 10 weeks later when it was positively established by careful dissection that no immature stage of the fruit flies was present in the remains of the fruit and shells.

The study of varietal susceptibility to infestation by the oriental fruit fly will be continued whenever fruits are available.

In an effort to determine their host status, certain exotic fruits, berries, and flower buds that are presently prohibited entry into the United States (Quarantine 13) have been exposed to caged oriental fruit flies in an induced oviposition study.

Representative samples of the following fruits that were exposed have provided negative results: (1) Sausage fruits (Kigelia pinnata), (2) Woodroses (immature forms) Ipomoea tuberosa,(3) Mahogany, Mahogany suletenia, (4) Coconuts, Cocos nucifera,(5) Pandanus, Pandanus pacificus,(6) Nipple fruits, Solanum mamosum.

The nipple fruits were exposed to both oriental and melon flies but examination of the epidermis of the fruit after such exposures revealed no visible ovipunctures. This fruit is presently receiving some limited commercial interest because of its unique but attractive yellow fruit that matures just prior to the Christmas season and exhibits unusually good keeping qualities. An illustration of this latter quality can be qualified by our experience with it in our studies. Fruits that were isolated in January still have the same golden color, turgidity and attractiveness four months later, and only a minimum amount of decadence is present on those fruits that unavoidably became bruised. This particular fruit does not contain the properties usually associated with acknowledged hosts of the oriental fruit fly. It has, in the first place,a very heavy "rag" much like that found in certain citrus fruits. The presence of this somewhat spongy tissue makes it extremely doubtful whether any larval development could take place in the event egg deposition did take place.

In an effort to re-evaluate those fruits presently accredited as hosts of the oriental fruit fly an experiment has been begun and as these hosts become available and time permits they will be collected, the total weight of the whole fruit recorded, and the size measured with calipers. Each fruit will be halved, the seed or seeds removed, and the flesh separated from the skin. The seed, skin, and pulp will be weighed and the percentage of each taken. It is hoped that a new concept of host determination can be accomplished by the application of paper separation or permatographic studies to determine the amino acids, etc., that are present in the fruit and determine

which are necessary in order to provide sufficient larval nutrition and insure normal development. It is remarkably significant that certain fruits (sandalwood, mock orange, kamani, etc) containing a minimum amount of pulp can support large larval populations which in turn produce normal flies. In contrast to this, other fruits such as breadfruit, certain plums, apples, etc., that have an exceptional supply of medium apparently do not possess adequate food properties for normal larval development except in instances when the fruits are allowed to become over-ripe before removing them from their parent plants.

Since these fruits are attractive to the flies, and oviposition is known to take place, it would appear that certain food properties that are highly important for the successful development of larvae are absent, and in the compilation of a reliable host list these dietary factors should be discovered if at all possible. Much valuable information regarding the general properties of certain tropical and subtropical fruits has been published by both Ouida D. Abbot and A. L. Stahl of the Agricultural Experiment Station, Gainesville, Florida, but the pectins, glucosides, enzymes, vitamins, and amino acids are among the constituents not determined in their analysis.

The results from the initial test to determine the available amount of skin, pulp, and seed of hosts exposed in cages for induced oviposition are presented below:

Host	Source	Date 1953	Ave. Weight from	(gm.)	%skin	%pulp	%seed
Achras sapota	Koko Head	1-14	6	258.6	9.7	86.0	4.3
Carissa grandiflora	Tantalus	1-15	25	15.3	5.5	89.5	6.0
Eugenia jambolana	Bd. of Agriculture Honolulu, T.H.	1-15	19	7.2	12.0	69.9	18.2
Psidium guajava	Manoa Valley	1-15	8	16.4	85.6		22.8
Carica papaya	Waimanalo U.of Hawaii Experimental Farm	1-16	6	3680.5	14.2	54.6	43.4

Line Project I-a-5-3. Effect of Climate and Other Factors on the Development of Fruit Flies in Hawaii Under Field Conditions.

The 30-day methyl eugenol traps located on the Island of Kauai reflect a close similarity of population fluctuation with that recorded on the other islands, which might indicate that the ecological factors affecting biomasses of host fruits are general throughout the islands and in consequence both reproduction and nutrition of the insects are affected.

The three trapping sites on Kauai yielded high fly recoveries in all traps in January and February but there was a definite decrease in March which reduced the total fly recoveries almost by half.

To augment the trapping on this island and to provide some information on the movement of fruit flies at the higher elevation a small glass invaginated trap baited with methyl eugenol was established at the 3400 ft. Territorial camp site at Kokee. This area while not rich in host material does have an abundance of certain seasonal fruits of which the methly plum is perhaps the most prolific, other deciduous fruits are found such as Malus and Pyrus species.

Complete trapping returns are appended below:

Site	Date	Flies
Wainiha	Jan. 1953	24,272
	Feb. 1953	15,456
	Mar. 1953	6,160
Wailua	Jan. 1953	12,580
	Feb. 1953	11,616
	Mar. 1953	5,880
Waimea	Jan. 1953	11,248
	Feb. 1953	16,800
	Mar. 1953	8,120

Line Project I-a-5-4. The Effect of Temperature and Humidity on the Development of Fruit Flies in Hawaii Under Controlled Conditions. (N.E.Flitters, B.E.P.Q., and P. S. Messenger, U. of Calif. Agr. Expt. Stn.)

Cabinet No. 1 - Orange, California (Aug., Sept., Oct., 1952)

Simulated climatological conditions representative of the month of August were such that uninterrupted development of all stages of the fruit flies could take place. There were very few nights (9) in which the minimum temperatures fell lower than 60° F.; the absolute minimum was 55° F. Daytime thermal peaks were never lower than 75° F. and often rose above 80° F. with a maximum of 90° F. being recorded on two occasions. However, since this cabinet had just been put into operation and the stocks of flies initially introduced, sufficient time had not elapsed for the complete development of the pre-imaginal stages of the fruit flies; consequently, no progeny were recovered during the month.

The month of September provided a slight decrease in temperatures, but for the most part the climatic conditions were such that no retardation of insect development took place. The lowest minimum temperature was 48° F., but it was indeed rare that temperatures below 50° F. were experienced. The greater part of the month found them on or about 60° F. There were three occasions during the month that the maximum temperature just exceeded 90° F., but for the most part they ranged about 80° F. Emergence of adults representing the F-1 generation of each of the three species of fruit flies took place during the month.

The oriental fruit fly produced 3160 adults from a total of 4919 puparia. The developmental period ranged from 22 to 34 days, the average about 26 days. The Medfly, which was not as heavily stocked with parent flies as the other two species, produced progeny in the sum of 440 from a pupal total just in excess of this figure. The exact count was nullified by an error in computation when closing out the pupal returns after final adult emergence. The period of development for the Medflies ran from a minimum of 26 days up to 38 days for the last emergence; however, the average was just under 30 days.

The Melon fly recoveries for September totaled 1086 which represents the emergence from 1180 puparia. The elapsed developmental period was upon the average about 27 days; the minimum time was 22 days; the maximum, 33 days.

The month of October commenced with climatic conditions more or less about the same as those experienced during the latter part of the preceding month. An increase of daily thermal peaks followed and in place of maximum temperatures averaging just in excess of 70° F. the maxima soared to the high 80°'s. However, after one week of such conditions a significant decrease was evidenced in the thermal peaks with little change taking place in the nightly minimum temperatures. The decrease in thermal peaks brought the average maximum temperature to a value just short of 70° F. and towards the end of the month there were occasions when the maximum temperature did not exceed 64° F.

Fruit fly development became depressed from the early part of October and became increasingly worse as the weeks progressed. A decided reduction in recovery of progeny resulted and the developmental period became measurably lengthened.

From a total of 3456 oriental fruit fly pupae, adults in the amount of 2308 were recovered during October. The elapsed time for development ranged from a minimum of 26 days at the beginning of the month to a minimum of 32 days at the end of the month. The maximum time required for development was 39 days with an average of about 34 days. The Medfly produced but 5 adults which took upon an average of 36 days for the pre-imaginal development.

The melon fly returns fell to a low of 414 flies which represented the yield from 714 pupae. Pre-imaginal development ranged from a minimum of 22 days up to a maximum of 39 days. No second generations of any of the fruit flies was established during the three months of simulation.

Cabinet No. 2 - Fallbrook, California (Aug., Sept., Oct., Nov., 1952)

Since the period of simulation for the site of Fallbrook was commenced on the 15th of August, the biological data for this month is negative except for the observations which established the fact that activity and egg deposition took place. The climatic conditions were such that pre-imaginal development could proceed at an accelerated rate.

The month of September provided excellent climatological conditions insofar as fruit fly development was concerned the average minimum temperature was about 60° F. even though there were a few nights in which the temperature fell into the low fifties. The daily thermal peaks in the fore part of the month reached or exceeded 90° F. quite frequently, and it was only during the latter few days of the month that they fell to values lower than 80° F. (on one occasion 70° F.).

Relative humidity was for the most part fairly constant in pattern even though minimums of 40 were experienced during the daily thermal peaks; no exceptionally dry periods were encountered. The diurnal fluctuations were very pronounced during the first and last periods of the month but the average was about 70% which illustrates that no pronounced extremes were of long duration.

Initial emergence of progeny was recorded for all three species during September. The oriental fruit fly returns were prolific from the 9th through until the end of the month. The melon fly produced from the 4th of the month on but its population fell much below that of the aforementioned species. The Medfly produced only a token first generation since the first recovery was made late in the month. The oriental fruit fly from 2915 pupae yielded 1715 adults which had an average pre-imaginal developmental period of 26 days. The minimum elapsed time for development was 23 days; the maximum, 30 days. The Mediterranean fruit fly commenced its F-1 generation with a total of 51 adults which emerged from 739 pupae. The period for development ranged from 26 to 31 days. From a total of 570 pupae the melon fly produced 224 adults. Pre-imaginal development was very similar to that of the oriental fruit fly. From a minimum of 18 days development ran to a maximum of 27 days with average falling at approximately 25 days.

A decided drop in temperatures affecting both the daily thermal peaks and the nightly minima took place in October. This trend became increasingly more defined as the month progressed. Peaks in excess of 80° F. were evidenced in the early part of the month but from the middle onwards it was only on extremely rare occasions that the temperature exceeded 75° F. Minimum temperatures for the most part fell below 60° F. but only on occasional instances did they reach 50° F. This decrease in temperature definitely retarded development as is clearly demonstrated in the records of pre-imaginal development appended for each species. The number of oriental fruit fly recovered clearly indicates the high infestation and suitable developmental conditions for this species. Neither the Medfly nor the melon fly reproduced in any measure comparable to dorsalis.

The total oriental fruit fly emergence in October was 2055 adults from a total of 3137 pupae. Medfly yielded 413 adults from a total of 846 pupae and melon fly recoveries were but 430. No F-2 generation was established for either of the three fruit fly species. Pre-imaginal development for the oriental fruit fly required a minimum of 27 days for the first recovery of the month, and 31 days by the end of the month. The longest period for development was in excess of 40 days for recoveries during the second week of October and continuing on to the closing days of the month. The Medflies took from 29 to 38 days to develop and the melon flies from 25 to 39 days.

The month of November was heralded by one week of weather that provided maximum temperatures of 86° F. and minimum temperatures falling as low as 50°F. only in one isolated instance. In the days following, there was considerable deterioration in climatic conditions. Minimum temperatures began falling below 50° F. and on occasion reached a low of 40° F. It was indeed rare to discover a night temperature above 50° F. The maximum temperatures seldom rose to 70° F. and during the latter part of November the maximum thermal peaks were just below 60° F. These conditions had an adverse effect on both adult fruit fly activity and pre-imaginal development. The recovery of progeny was materially reduced and the percentage of emergence fell appreciably. However, the initial F-2 generation of oriental fruit fly was established early in the month together with a second generation of melon flies. A total of 431 adult oriental fruit flies were recovered from the parent stock but the percentage of emergence was extremely low when we take into account the fact that these adults represented the total emergence from almost 2700 pupae. The first generation (F-1) of oriental fruit flies provided a total of 273 adults, these recovered from 861 pupae. Pre-imaginal development for the oriental fruit fly progeny averaged about 42 days with a maximum of 52 days and a minimum of 35 days. Recoveries of melon fly progeny totaled 367, the emergence figure from puparia collected in excess of 700 from the parent stock. The F-1 produced only 15 adults from a total of some 60 puparia. No Medflies were recovered, largely as a result of the lack of adults to replace the mortalities that occurred earlier in the parent cages.

Since but less than one week of simulated climatological conditions for the month of December was completed during this quarter, details of climate and biological findings for this month will be reserved until the next reporting period.

Cabinet No. 3 - Houma, Louisiana, (June-July, 1949)

With the progression of the simulated period for this site into the month of June, near optimal climatic conditions were experienced. A more or less uniform meteorological pattern was evidenced throughout June. Minimum temperatures seldom fell lower than 65° F. and daily thermal peaks, while for the most part in excess of 80° F., very rarely climbed into the upper 80's and only on four occasions were they higher than 90° F. Relative humidity remained for the most part comparatively low, seldom exceeding 70%, yet very often falling to 40%. Only on three occasions did the relative humidity rise to the upper limit of the scale. Apparently precipitation was heavy for two consecutive days, and again later in the week another wet day occurred. However, since the fruit fly stocks were extremely low in both the Mediterranean and melon fly cages no progeny were recovered, but from the oriental fruit fly F-1 generation, 536 adults were recovered. The rate of development was quite accelerated, ranging from 19 to 28 days.

July produced higher temperatures with thermal peaks frequently in excess of 90° F. and nightly temperatures very rarely falling below 70° F. Relative humidity remained rather low for this site. Since the pattern of climate to be followed in subsequent weeks was similar to others already explored and biological information already accrued seemed to be adequate, the simulation of this site was discontinued. Progeny were recovered from the oriental fruit fly which added 1142 more adults to the F-2 population. The elapsed pre-imaginal developmental period was, upon an average, 25 days.

Since the simulation of climate for this site has been satisfactorily concluded, a complete recapitulation of the biological findings and the direct influence of climate upon each of the three species of fruit flies under study will be dealt with in detail in a later report.

Cabinet No. 4 - Tempe, Arizona (March, April, and May 1937)

This climate simulation was begun in January a few weeks in advance of favorable weather in the late winter and early spring months. It was decided to simulate this period of the year first and so build up enough progeny to determine the effects of the high temperatures in the summer months characteristic of this site.

The minimum temperatures for the entire month of March were for the most part in excess of 40° F. and the three periods when temperatures were low than 38° F. were of short duration. Daily thermal peaks for the first half of March often exceeded 80° F., but during the last weeks they rarely reached 70° F. although consistently exceeding 60° F. Insect development was able to proceed at a moderate rate during March but there was not sufficient time for complete development.

April provided climatological conditions of a much improved nature, with both the maximum and minimum temperatures rising perceptibly and a very uniform pattern of humidity prevailing.

The initial F-1 generations of both oriental fruit and melon flies were recovered during April; the elapsed time for complete pre-imaginal development was from 42 to 47 days for the oriental fruit fly and from 41 down to 36 days for the melon fly. The Mediterranean fruit fly which was not introduced into the cabinet until two weeks after the introduction of the other two species of fruit flies did not have time to yield any progeny. The total recoveries were 481 oriental fruit flies and 44 melon flies.

May provided a pattern of temperatures that, from a near optimal thermal pattern for fruit fly development in the early part of the month (60-92° F.), changed within a period of 1 week to lethal heights when temperatures of 104° F. were experienced for three successive days. This period was followed by one of moderate temperatures for the remainder of the month during which time the peaks never again reached 100° F. and for the most part rarely exceeded 95° F. with the minimum night temperatures between 50 and 60°F. Relative humidities during that period in which extreme temperatures were experienced were between 20 and 30%. Total mortality of all three species took place during this high temperature period.

Emergence of progeny from all three species of fruit flies took place during the month but the initial F-1 generations were killed off during the short heat wave. From the oriental fruit fly parent stocks a total of 1800 progeny were recovered and the effect of increased average temperatures can be readily recognized in the acceleration of pre-imaginal development which in the forepart of the month took 43 days but was reduced to but 20 days at the close of the month. This accelerated development was also graphically demonstrated by both the Mediterranean and melon fly. In the case of the former, complete development took 50 days for adults recovered early in the month but those recovered during the latter part of May took but 26 days. The melon fly which further demonstrated its ability to develop at a faster rate than either of the other two species began with an elapsed pre-imaginal period of 26 days and had further reduced this to but 15 days at the close of the month. Recoveries of progeny from the last two species was 763 adults recovered from melon fly and 373 from the Mediterranean fruit fly.

Cabinet No. 5 - Santa Paula, California (August, September, October, November, 1952)

Since the simulation of the climatological conditions for this site were commenced during the closing days of the last quarter mention of it was held in abeyance until this report when both the climatic conditions and the biological findings would have progressed to the point that their inclusion would be of interest. Climate simulation began with the month of August which together with the following month provided climatological conditions favorable for the establishment of progeny before the onset of winter.

The second week of August which was simulated first provided an even pattern of climate. The minimum temperatures never fell quite as low as 50° F. and for the most part they averaged approximately 55° F. The daily thermal peaks ranged from 75 to 80° F. with a pattern of relative humidity never falling lower than 50° F. during the daylight hours but rising steadily as the day waned.

The entire month of August provided a pattern of climate uniformity consistent with that simulated during the initial week. The only exceptions, and these were rare, was the fact that the daily thermal peaks did, on occasions, exceed 80° F. during the latter days of the month and there were two nights that had temperatures just below 50° F. On the whole climatological conditions were such that adult fly activity and pre-imaginal development could take place readily. However, the thermal levels were not sufficiently high or of sufficient magnitude to accelerate pre-imaginal development to the point that progeny recoveries were possible during this or the following month.

The climatological conditions experienced at this site during the month of September were almost a counterpart of those simulated during the previous month. No adult emergence was recorded.

October began with reduced temperature limits (45° to 75° F.). This was followed by temperature peaks in excess of 90° F. with nightly minima in the low 50's, which was followed in turn by a general pattern of reduced thermal peaks, seldom exceeding 80° F. but rarely falling lower than 70° F. The minimum temperatures also fell to lower values, for the most part ranging in the high 40's. Progeny were recovered from all three species of fruit flies during the month, the initial recoveries being made during the first week of October.

Adults recovered from the fruits exposed to the flies in August all had a rather slow rate of development. In the case of the oriental fruit fly it required about 39 days for development; the melon fly approximately the same; and for the Medfly, about 41 days. However, the number of adults recovered during the month was quite high particularly in the case of the oriental fruit fly, 2283 adults emerging from 7431 puparia. Percentage-wise the melon fly provided the best average production, a total of 691 puparia producing 469 adults. The Mediterranean fruit fly yielded 422 adults from a total of 1186 puparia.

Progression into the month of November revealed the fact that each week was to become a little more adverse to fruit fly development than the preceding one; consequently, by month's end fruit fly development was almost inhibited. The first week's climatological pattern had thermal peaks often in excess of 80° F. and the minimum temperature never fell below 42° F. Relative humidity was very much lower than the preceding weeks, on occasions going no higher than 35% and often dropping to a value between 20 and 30%. The second week in November provided a definite drop in thermal peaks and a consistent pattern of minimum temperatures. The daily thermal peaks seldom rose to 70° F. and for the most part they ranged in the high 60's. The minimum temperatures stayed in the very low 40's with the relative humidity quite high during most of the week. Some slight improvement in temperature was experienced early in the following week, when daily peaks climbed well into the 70's and the minimum temperatures stayed in the high 50's. Maximum temperatures seldom exceeded 60° F. and the minimum temperatures clung in the low 40's during the remainder of November. Of interest was the fact that for three consecutive days when the temperatures ranged between 60° and 70° F., the relative humidity stayed more or less even at about 30%, and then rose

when the temperature values fell 10 degrees (50° to 60° F.) towards the end of the week. The latter part of November provided a more or less stable pattern of temperature with peaks just above 60° F. and nightly minima in the high 40's. Some progeny returns were recovered during November but these, in contrast to those for the previous month, were low. A total of 481 oriental fruit fly adults were recovered from 1936 pupae. From the melon fly, 568 pupae yielded 152 adults; and from the Mediterranean fruit fly, 57 pupae provided but 14 adults. Pre-imaginal developmental time for the oriental fruit fly was from 47 to 52 days; for the melon fly, 44 to 51 days, followed by 46 to 54 days for the Mediterranean fruit fly.

Cabinet No. 6 - Orlando, Florida (June, July, August, September, 1930)

The climatological conditions experienced during the entire month of June were such that uninterrupted fruit fly development could take place. The maximum temperatures were for the most part in excess of 80° F. but very rarely exceeded 90° F. The minimum temperatures were upon an average about 70° F. and relative humidities were fairly high seldom falling lower than 60%, and when this did occur the actual period of duration was very short and of little consequence.

Pre-imaginal development under such ideal climatological conditions was near optimal for all three species of fruit flies. The Mediterranean fruit flies established an F-7 generation; the oriental fruit flies maintained a strong F-3 generation; and the melon flies were able to produce their initial third generation. Since continuous fruit fly reproduction was possible under the near-optimal conditions experienced throughout June and the months that followed and pre-imaginal development was near-optimal throughout that period, the numbers of progeny recovered per month adds nothing of value to this report; consequently a resume of the population build-up, generations produced, and a preliminary interpretation of the biological findings during the complete simulated annual climatic cycle will be dealt with and the individual count of pupae and adult emergence per month will be omitted until the report is presented in final form.

Interest in this study site was particularly great because of the importance attached to the climatological conditions experienced in December 1929 during the Mediterranean fruit fly eradication program then being conducted in Orlando, Florida. It has been suggested by some that the severity of this winter had been an important factor in the eradication of the Medfly in Florida. Thus it seemed logical to determine under simulated climatic cabinet studies how successfully the Mediterranean fruit flies should have been able to withstand the unusual winter conditions which occurred at the time of the successful eradication project.

Commencement of this chronological progression of simulated climate was begun with the last week of September, 1929, at which time the daily thermal peaks were just in excess of 80° F. and the minimum temperatures on occasions went down to 60° F. but more generally around 70° F. Oriental and Mediterranean fruit flies were included in the study (1000 sexually mature adults equal to sex) from the initial day of climate simulation, but the melon fly

because of its unavailability had to be omitted until late in October when stocks were once more plentiful.

The month of October was characterized by a marked drop in temperature, but it was not of sufficient magnitude or intensity to affect adult fly activity or development of the immature stages of the insect. It was during this month that the initial progeny representing the F-1 generation of both oriental and Mediterranean fruit flies were recovered, the elapsed pre-imaginal developmental time was comparable for both species approximately 23 days. Of particular interest is the fact that the oriental fruit flies built up to such enormous proportions that the parent stocks had to be sacrificed in order to provide sufficient cages and space for the progeny. The Mediterranean fruit flies in the meantime had reproduced in sizable strength but only in about one-fourth the capacity of the oriental fruit flies.

Throughout the month of November a more or less uniformly acceptable climate prevailed with emergence of all three species being recorded. Both oriental and Medflies established an F-2 generation and the melon flies contributed their initial F-1 generation. Particular attention was directed on the effects of the oft-described "severe" winter conditions experienced during the following days of December. It began with a decided drop in minimum temperatures. Three times within a week they fell to 40° F. and for two successive days the maximum temperature did not exceed 55° F. This was followed by a warm spell (60° min.; 80° max.) which lasted almost two weeks but was terminated by an abrupt diurnal drop in temperature. The temperature within two days fell 40° F. whereas peaks of 80° F. had been common we now had one day with a maximum of 52° F. and a minimum of 38° F. These conditions were followed by a day in which a maximum temperature of 70° F. was reached followed by steadily decreasing temperatures that finally reached a low of 30° F., then bounced back to a peak of 50° during the day, then fell once more to the previous established minimum at night (30° F.). After these two consecutive nights of such freezing weather, temperatures began to climb during the day and peaks of 55° and 60° were experienced on the following two days with minimum temperatures falling to 40° F. The following days exhibited a steady thermal climb. Daily peaks of 70°, 75°, 65° F. were experienced with minimum temperatures of 48° to 58° followed by another low of 36° F. This terminated the very cold spell and steadily improving conditions followed with the minimum temperatures climbing from 40° F. to 58° F. and the accompanying daily thermal peaks reaching above 70° F. Obviously these severe conditions following on the heels of a near-optimal clime had some adverse effect on all stages of the fruit flies' development. The adults' activity was definitely restricted. No oviposition took place for a period of four days and little emergence from pupae took place for an entire week but no serious mortalities were experienced in the adult stocks of all three species of fruit flies. This period represented the most adverse weather experienced during the entire year of simulation yet the fruit flies exhibited their ability to withstand it and continue to develop. It was obvious that the only measurable effect that this cold period had upon the insects was one of depressed activity and development. Viable eggs were deposited by females of all three species, when the temperatures climbed sufficiently high in the days immediately following the cold spell. The Mediterranean fruit fly very obviously was not annihilated by the cold weather

but reproduction was inhibited for a few days during the period of greatest intensity of cold.

Neither larvae nor pupae suffered any great effects from the cold spell as is illustrated by the adult recoveries from puparia formed after larval migration from the fruits that had been infested just prior to the acute winter conditions. Melon fly recoveries were made on January 6 from fruit that had been infested December 4-5, indicating a pre-imaginal developmental period of about 30 days in spite of the cold days. During the daily peak temperature on the day before Christmas, 8 Medflies were recovered which although quiescent were very much alive. Assuming that this date is accurate for emergence, pre-imaginal development than had taken 38 days since the fruit had been exposed November 16. Consecutive daily emergence began January 11 when 17 Medflies were recovered from a fruit infested Nov. 18-19 showing an elapsed developmental period of 54 days. The oriental fruit flies which were at a very high population level during this period yielded the first adults (after 7 days of no production) on December 27. These had developed from fruits that were infested on November 18 and 19. About 39 days were required for complete pre-imaginal development. It is significant that throughout the study the Medfly and oriental fruit fly have had very comparable developmental cycles. The retardation of their development by the adverse days of December followed similar patterns. Climatological conditions improved to the near-optimal point and stabilized themselves at this level throughout the remainder of the year. A brief account of the most pertinent findings for other portions of the simulated year may be of interest.

The oriental fruit fly demonstrated its ability to produce much higher populations than either of the other two fruit fly species. As an outstanding example, the F-1 generation of the oriental fruit fly had about the same number of individuals as at least 5 generations produced by the Medfly and as many, 7000 offspring as were in the entire progeny in 4 generations of the melon fly produced during the entire year of climate simulation. However, during the coldest or most severe periods of the year both the melon and Mediterranean fruit fly again demonstrated their ability to reproduce and develop with greater facility than the oriental fruit fly, particularly when low temperatures restricted activity. It was further demonstrated that these two species were able to reproduce and perpetuate themselves when their respective population levels had fallen to but a few adults.

The Orlando period (September 1929-August 1930) for the most part presented ideal conditions for fruit fly development. It was the first study site that we have simulated which has provided conditions of temperature and humidity so favorable for their requirements that the fruit flies could maintain themselves in entirety under winter conditions and successfully reproduce throughout the entire year.

Pupae recovered from individual papayas that had been exposed to the oriental fruit flies for a period of 24 hours frequently totaled more than 400 and in several cases exceeded 600. Fly emergence was relatively high but a very significant drop in the percentage of emergence was evidenced for all three species as a result of the critical temperature period experienced in December. Many of the cucumbers infested by the melon fly yielded three

figure pupal recoveries. The record was well in excess of 800. In most fruits the Medfly seldom produced pupae in excess of 200 but on occasions the yield did climb up into the 300 bracket.

Climatological conditions such as were experienced throughout the Orlando simulation year showed that the Mediterranean fruit fly was more adaptable to Orlando conditions and able to build up population strength and produce more generations multiplicity than either the oriental fruit fly or melon fly. The Medfly was able to produce 10 generations during the year which, collectively, amounted to a population of 14,215 fruit flies.

Oriental fruit fly production was particularly heavy in the early generation, but when their numbers fell to low limits this fly was not able to reproduce at a rate comparable to the other two species. Nevertheless, five generations were realized, which together contained 10,693 adult flies.

The melon fly, which it must be remembered was included in this study, almost one month after the introduction of the other two species, built up a population of 7,344 adults which in turn were representative of four generations.

The results of the Orlando cabinet study provides very strong evidence to support the view that the eradication of the Medfly in Florida was due to eradication efforts and that climate per se, provided very little, if any, environmental resistance. These findings relative to the Mediterranean fruit fly are supported by the fact that in Valencia, Spain, where with the average winter monthly average often is no higher than 48.4° F., the fly can successfully maintain itself and by the reported infestation in the vicinity of Paris, France, where winter frosts are common.

Cabinet No. 7 - Weslaco, Texas. (July, August, September, October 1952)

The simulation of this climate was initiated with cams prepared from average temperature and humidity records that had been compiled over a 30-year period. Machines to record the actual climatological records for the Weslaco site were not placed in operation until late in the fall of 1952, at a time when there would have been little opportunity for the flies to become established. The 30-year average cams were run so as to give the flies a chance to become established and to properly condition them for the actual simulation period.

The average temperatures for the last week of July and entire month of August were such (70 to 96° F.) that uninterrupted development of the fruit flies could take place. However, a decline in temperatures was evidenced towards the latter part of August (58 to 80° F.) but these were not of such a magnitude that any perceptible effect could be noted on fruit fly activity.

The first fruits exposed during the simulated average July conditions produced adults in early August. All three species of fruit flies were able to reproduce in near-optimal time. Emergence of the oriental fruit fly was quite high and it outproduced the other species almost 4 to 1 in its initial F-1 generation. A total of 2,212 adults were recovered from the fruits

infested by the oriental fruit fly. Pre-imaginal development ranged from 19 to 22 days. The Mediterranean fruit fly produced progeny amounting to 609 adults. The elapsed time for complete pre-imaginal development of the Medfly averaged about 19 days. The melon fly produced 689 progeny and it was able to complete its development in as short a time as 13 days.

After sufficient time had elapsed for the establishment of the fruit flies in the cabinet, the cabinet was changed over to the simulation of actual Weslaco records, beginning October 20, rather than average conditions.

It was unfortunate that the Mediterranean fruit fly failed to maintain itself during the first few weeks of study in this cabinet but because of a very short longevity coupled with parent stock shortages there was insufficient stock to maintain this species. As a consequence, the investigation had to proceed without further inclusion of this species.

November conditions at Weslaco provided a month of variable weather commencing with a week of uniform temperature and very high humidities. The temperature consistently ranged between a low of 60° F. to a high of 70° F. with but a single exception. This occurred towards the end of the period when the thermal peak reached 79° F. A rapid drop in temperatures followed during ensuing days with a minimum of 38° F. being registered. Then followed a gradual climb with peaks ascending to values very near the 90° F. mark for a couple of days and then declining once more to between 70 and 80° F. The minimum temperature seldom went as low as 60°F during this latter period. The occurrence of two nights wherein the minimum temperatures fell to 46° F. ruined what would have made a very acceptable pattern of climate the third week when the mercury rose to between 70 and 80° F. both on the opening and closing days which was the forerunner of a much reduced thermal scale for the remaining week of the month. After the daily maximum temperatures declined gradually to 40° F. from then to the end of the month there was practically no more than 5° F. maxima and minima. Obviously these conditions were not amenable to fruit fly development or activity. They were not however, of sufficient magnitude to completely arrest development. During November emergence of progeny stocks of both the melon and oriental fruit flies were recovered, with the latter producing 1,286 adults and the melon fly 341. Pre-imaginal development for the melon flies averaged about 25 days and for the oriental fruit fly about 29-32 days. A recovery of 46 Mediterranean fruit flies representing the F-2 generation from a fruit infested by the first progeny on January 21-22, indicated a total of 42 days for complete pre-imaginal development. The oriental fruit fly also provided the beginning of an F-2 generation by producing 6 adults. These were the progeny returns from a fruit infested January 30-31. The pre-imaginal developmental period was from 35 to 36 days.

Line Project I-a-5-5 INACTIVE DURING THIS QUARTER.

Line Project I-a-5-6. Mass Rearing of Fruit Flies for Experiments. (D. Nimmo and N.E Fliters)

Sufficient quantities of both oriental and melon flies were reared to meet all experimental demands; however, the Mediterranean fruit fly stocks remained at a very low level.

Limited experimentation was undertaken on the culturing methods of the Medfly in order to discover where the weakness occurred. Larval washings were changed from the normal direct faucet stream washing to one of separation by immersing the screen containing the medium in a container of water and applying the force of water from the faucet directly into the water and thereby avoiding the risk of larval damage that could arise from too great a pressure of water being applied directly to the bodies and driving them too forcibly against the metal screen.

Infrared and ultraviolet lights were installed over the breeding cages in an effort to provide conditions of light that would more nearly approach normal daylight. A composition of quartz sand and soil was substituted for the ocean sand generally used as a medium for pupal formation. The carrot media substrate was discontinued and a papaya and banana combination used in its stead. These changes have only resulted in spasmodic improvements and further investigations will of necessity have to be made. It is hoped that with a heavy Medfly infestation in peaches on Maui that the resultant field collections will provide us with an entirely new laboratory breeding stock.

The most disturbing aspect of the Medfly problem is the fact that to all intents and purposes, development up to and into the pupal stage appear normal. The pupae look sound, well-formed, turgid, and of good color but actual emergence is particularly low and in some cases negative. Dissection of the pupae reveals a fully formed fly with no visible signs of disease.

Through the kind cooperation of Dr. Bushnell of the University of Hawaii, a student in bacteriology has been assigned to the problem of isolating and identifying the bacteria present in the dead pupae. Since this same condition has been found to be present in our ecological laboratory on Maui where stocks of Medfly are being reared from field-collected fruits, it would appear that it is not a local condition occasioned by continued laboratory cultures. Considerable significance might be attributable to this condition, if it is a disease and widespread in the field. It could have been one of the factors contributing to the quick decline of the Medfly immediately following the establishment of the oriental fruit fly in Hawaii. At any rate a valuable contribution could be made by determining the cause of this deleterious Medfly condition.

Line Project I-a-5-7 INACTIVE DURING THIS QUARTER.

Line Project I-a-5-8. Biological Studies of Natural Enemies of Fruit Flies. (N.E. Flitters, E. Dresner)

A preliminary test series was undertaken in the bioclimatic cabinets to determine what effect the fluctuating temperature and humidity of certain simulated mainland sites would have upon the development of some of the introduced opiine parasites. Fruits that had been exposed for oviposition to the oriental fruit fly and later to caged parasites of the longicaudatus complex were placed in the various cabinets. It was determined that at an average temperature of approximately 64° F. the following parasites were able to complete their development and emerge: Opius formosanus, O. compensans, New Caledonia and O. Siam. Total elapsed time for complete development (egg to adult) was just in excess of one month.

In another cabinet wherein the spring climatological conditions of Tempe, Arizona, were being simulated during a period when the average temperature was approximately 58° F., emergence of both male and female O. Siam took place in a period ranging from 43 to 49 days. Of particular interest is the fact that both O. compensans and O. formosanus went through diapause, emerging after two months of diapause. Present indications are that in all probability the entire longicaudatus complex may go through a period of diapause which if true, might materially enhance their value if they are introduced into areas with comparatively cool marginal winter conditions.

Techniques for culturing large populations of parasites have been explored in the laboratory. The most successful method found thus far is that of exposing fruit fly-infested papayas to parasites held in fine screened rearing cages with a more or less standard number of no less than 50 ♀♀ and approximately half that number of ♂♂, in each cage. The infested papayas are exposed to the fruit flies for a period of from 3 to 4 days. Then they are removed and isolated in standard holding trays and boxes. Regular weekly sifting of the sand beneath the fruit is practiced and the pupae so recovered are held in small cages until fruit fly emergence is through and parasite emergence begins. The first two days of parasite emergence is predominantly male. The females follow in great abundance after the second day. The techniques and observations outlined are but slight variations of those previously reported by members of the biological control group.

Like other workers who attempted the mass culture of O. conhilus, we have discovered its reticence to reproduce under laboratory conditions comparable to the O. longicaudatus types. This parasite has proven itself to be most difficult to rear possibly due to its special requirements. Apparently it needs almost indirect sunlight and a plentiful circulation of air to induce mating, and the females after successful copulation are reticent about exploring the surface of fruits in order to discover oriental fruit fly ovipunctures unless the fruit itself is bathed in light.

The collection of field stocks has been greatly facilitated by luring the parasites to certain collection points in their favorite habitat by lightly spraying the fruits with a saturated sugar solution, a method such

as that used in collecting Tiphia parasites of the Japanese beetle and then aspirating the individuals that are attracted to the sprayed surface. It has been found that the most efficient collecting receptacle is a small can in which windows are cut, sealed with fine mesh screening, and a cover made for the end of the can which is punctured in the center with a hole sufficiently large to accept a No. 9 cork. The can is then provided with two heavy elastic bands which function as supports for attaching the can to the collector's belt. With this lightweight collecting can, a much simplified and less cumbersome operation can be performed. By adding a disk of moist filter paper to the base of the can the parasites can be held in the container for many hours without any apparent ill effect.

MAUI - (R. Miyabara and T. Yamada)

Line Project I-a-5-2. Hosts of Fruit Flies in Hawaii.

Fruits collected on Maui included 256 lots containing 9239 fruits. These weighed 235,915 grams. A total of 9298 pupae was recovered. The index was 39.4 per 1000 grams of fruit. Emergence was 80 per cent with 49 per cent parasites, 21 per cent dorsalis, and 29 per cent capitata.

Many of the fruits had high infestation of over 100 pupae per 1000 grams of fruit. Kamani (29 lots weighing 24,445 grams) had an index of 103 pupae per 1000 grams of fruit. Parasitization was 80 per cent. Loquat collected at Kula (2850') had an index of 108, while those collected at 3000' had an index of 328 per 1000 grams of fruit. C. capitata was much the dominant species in collections from both of these areas. Guava collections at Iao Valley included 51 lots of ripe ground fruits weighing 54,376 grams with an infestation index of 2.7 per 1000 grams of fruits; 13 lots of tree ripe guava weighing 12,466 grams with an index of 22.2; 5 lots of half-ripe guava weighing 4182 with an index of 39.9; and 2 lots of green, mature guava with an infestation index of 25.3 per 1000 grams of fruit. These results indicated that half-ripe and green guava may yield more puparia than tree-ripe or ripe, ground fruits. Kaupo tree-ripe guavas had the highest infestation with 71.1 per 1000 grams of fruits. Fourteen lots of chebula collected at Haiku nursery and weighing 9551 grams had an infestation of 122 per 1000 grams. The index in coffee collected at Kaupo was 162 per 1000 grams of fruits, with dorsalis predominating. Cotton collected in Kihei was infested only by Medflies. The infestation index was as high as 45 pupae per 1000 grams of bolls. Solanum sodomeum collections on Maui weighing 11,694 grams provided negative results. The results of induced oviposition tests with Sodom apple were also negative. Many eggs were observed in the punctured fruits but the eggs of all three fruit flies failed to produce any pupae. Cactus collections weighing 6485 grams of red and 8487 grams of white cactus had very low infestation indices. Fruit collections are tabulated on pages 25 to 33.

FRUIT COLLECTED ON MAUI FROM NOV. 10 TO FEB. 16, 1953

date	Lot	Locality	Elev. ft.	Stage	Wt.	No. fruit	Pupae	Dor.	Med.	Lon.	Van.	Cop.	% para.	Index
						KAMANI								
11/10	5703	Iao V.	420	ripe	960	50	168	32	0	1	0	119	79	175
11/10	5708	" "	600	"	460	25	0	0	0	0	0	0	0	0
11/17	5733	" "	420	half r.	907	50	206	37	0	0	0	110	75	227
11/17	5739	" "	600	"	629	35	0	0	0	0	0	0	0	0
11/24	5742	" "	420	ripe	792	40	107	3	2	0	0	64	93	135
11/24	5743	" "	420	"	707	40	102	4	0	1	0	81	95	144
12/1	5750	" "	420	"	721	40	80	3	1	0	0	53	93	111
12/8	5757	" "	420	"	758	40	55	15	0	1	0	33	69	73
12/8	5762	" "	600	"	1077	50	1	0	0	0	0	0	0	1
12/8	5763	" "	600	"	877	40	2	1	0	0	0	0	0	2
12/15	5766	" "	420	"	799	40	24	0	0	0	0	22	100	30
12/22	5788	" "	420	"	686	40	4	0	0	0	0	4	100	6
12/29	5794	" "	420	"	650	20	15	1	0	0	0	13	93	23
1/13	5812	" "	420	"	384	21	19	4	0	0	0	8	67	49
1/5	5804	" "	420	"	495	25	30	3	0	0	0	21	88	61
Total	15	Iao V.			10902	556	813	103	3	3	0	525	83	75
11/12	5711	Kaupo	250	ripe	1330	60	228	23	0	1	0	156	87	171
11/12	5712	"	250	"	978	40	130	7	0	0	0	38	84	133
12/17	5779	"	250	"	368	16	18	3	0	0	0	15	83	49
Total	3	Kaupo			2676	116	376	33	0	1	0	209	86	141
11/12	5714	Makaalae	100	ripe	1067	30	24	2	0	0	0	7	78	22
1/21	5860	"	100	"	354	12	154	11	0	0	8	99	91	435
Total	2	Makaalae			1421	42	178	13	0	0	8	106	90	125
11/13	5723	Olowalu	10	ripe	552	30	24	21	0	1	0	1	9	43
11/13	5724	"	10	"	1250	50	254	113	1	0	0	79	41	203
11/21	5741	"	10	"	453	42	5	3	0	0	0	0	0	11
Total	3	Olowalu			2255	122	283	137	1	1	0	80	37	125
12/17	5773	Hana	10	ripe	1602	40	100	3	0	0	0	74	96	62
12/17	5774	"	10	"	1408	40	109	14	0	0	0	73	84	77
1/21	5858	"	10	"	970	40	143	17	0	1	0	104	86	147
1/21	5859	"	10	"	806	30	60	13	0	2	0	32	72	74
1/21	5873	"	10	"	1259	30	244	16	0	1	0	178	92	194
1/21	5874	"	10	"	1146	30	205	21	0	1	0	147	88	179
Total	6	Hana			7291	210	861	84	0	5	0	608	88	130
TOTAL 29 LOTS		GROUND KAMANI			24445	1046	2511	370	4	10	8	1528	80	103

Date	Lot	Locality	Elev. ft.	Stage	Wt.	No. fruit	Pupae	Dor.	Med.	Lon.	Van.	Cop.	% par.	Index
						LOQUAT								
1/5	5803	Kula	2850	T. ripe	410	19	84	0	58	0	0	6	9	205
1/19	5833	"	3000	" "	560	40	90	0	78	0	0	0	0	161
1/23	5875	"	3000	" "	980	50	50	7	39	0	0	2	4	51
1/23	5876	"	2850	" "	474	50	59	0	41	0	2	16	31	124
1/23	5877	"	2850	" "	420	50	111	1	69	0	0	20	22	264
1/26	5881	"	2850	" "	453	50	44	0	33	0	0	6	15	97
1/26	5882	"	3000	" "	703	50	300	10	243	0	0	8	3	427
1/26	5883	"	3000	" "	704	50	135	11	113	0	0	0	0	192
2/2	5904	"	2850	" "	511	50	33	2	27	0	0	2	6	65
2/2	5905	"	3000	" "	679	50	162	18	105	0	0	7	5	239
2/2	5906	"	3000	" "	587	50	278	9	214	0	0	0	0	474
2/10	5938	"	3000	" "	677	50	316	17	269	0	0	0	0	467
2/10	5939	"	3000	" "	636	50	360	9	300	0	0	10	3	566
2/10	5940	"	2850	" "	467	50	144	8	64	0	0	58	45	308
2/16	5966	"	3000	" "	562	50	205	14	168	0	0	0	0	365
2/16	5967	"	3000	" "	552	50	285	24	172	0	0	0	0	516
Total	6	Lots	2850'		2735	269	475	11	293	0	2	106	27	174
"	10	"	3000'		6040	490	2251	119	1701	0	0	27	1	328
1/21	5854	Paia	750	T. ripe	410	28	51	12	10	0	0	19	46	124
1/29	5901	Kanaio	2000	T. ripe	248	50	22	0	15	0	0	0	0	89
1/29	5902	"	2000	" "	212	50	9	0	9	0	0	0	0	42
Total	2	Lots			460	100	31	0	24	0	0	0	0	67
						MANGO								
11/13	5725	Makaoioi	150	Gd.ripe	2268	15	1	1	0	0	0	0	0	1
1/21	5857	Kaupo	350	Gd.ripe	1245	12	31	3	0	0	0	26	90	25
2/5	5925	"	350	" "	1927	19	18	13	0	0	0	3	19	9
Total	2	Lots	Kaupo		3172	31	49	16	0	0	0	29	64	15
1/21	5855	Kipahulu	200	Gd.ripe	1970	20	16	9	0	0	0	5	36	8
1/21	5856	"	200	" "	1700	15	14	10	0	0	0	3	23	8
2/5	5926	"	200	" "	1446	15	37	32	0	0	0	3	8	26
2/5	5927	"	200	" "	1602	13	20	17	0	0	0	0	0	12
Total	4	Lots	Kipahulu		6718	63	87	68	0	0	0	11	14	13
TOTAL	7	LOTS			12158	109	137	85	0	0	0	40	32	11
						DIOSPYROS DISCOLOR								
11/13	5728	Honokahua	50	Gd.ripe	1430	15	6	1	0	0	0	0	0	4
12/18	5785	"	50	" "	1658	15	0	0	0	0	0	0	0	0

Date	Lot	Locality	Elev. ft.	Stage	Wt.	No. fruit	Pupae	Dor.	Med.	Lon.	Van.	Con.	% para.	Index
						GUAVA								
11/10	5705	Iao V.	450	Gd.ripe	1502	20	4	0	0	0	0	4	100	3
11/10	5706	" "	500	" "	1287	20	3	0	0	0	0	1	100	2
"	5707	" "	600	" "	1080	20	4	2	0	0	0	2	50	4
"	5709	" "	700	" "	1347	20	0	0	0	0	0	0	0	0
11/17	5734	" "	450	" "	1065	20	5	1	0	0	0	3	75	5
"	5736	" "	500	" "	1309	20	0	0	0	0	0	0	0	0
"	5738	" "	600	" "	970	20	0	0	0	0	0	0	0	0
"	5740	" "	700	" "	1280	20	0	0	0	0	0	0	0	0
11/24	5744	" "	450	" "	1091	20	0	0	0	0	0	0	0	0
"	5745	" "	500	" "	1403	20	2	1	0	0	0	1	50	1
"	5746	" "	600	" "	1403	20	0	0	0	0	0	0	0	0
"	5747	" "	700	" "	949	20	0	0	0	0	0	0	0	0
12/1	5751	" "	500	" "	1417	20	0	0	0	0	0	0	0	0
"	5752	" "	600	" "	1245	20	0	0	0	0	0	0	0	0
"	5753	" "	700	" "	849	20	0	0	0	0	0	0	0	0
12/8	5758	" "	450	" "	1302	20	5	0	0	0	0	5	100	4
"	5759	" "	450	" "	1140	20	0	0	0	0	0	0	0	0
"	5760	" "	500	" "	1202	20	5	5	0	0	0	0	0	4
"	5761	" "	550	" "	1346	20	1	0	0	0	0	0	0	1
"	5764	" "	700	" "	992	20	10	0	0	0	0	5	100	10
12/15	5767	" "	450	" "	1422	20	10	3	0	0	0	6	67	7
"	5768	" "	550	" "	1205	20	1	0	0	0	0	1	100	1
"	5769	" "	600	" "	1077	20	0	0	0	0	0	0	0	0
"	5770	" "	700	" "	940	20	0	0	0	0	0	0	0	0
12/22	5789	" "	450	" "	1140	20	7	0	0	0	0	7	100	6
"	5790	" "	500	" "	1044	20	5	0	0	0	0	4	100	5
"	5791	" "	600	" "	1000	20	11	7	1	0	0	1	13	11
"	5792	" "	700	" "	1084	20	0	0	0	0	0	0	0	0
12/29	5795	" "	450	" "	1048	20	2	0	0	0	0	2	100	2
"	5796	" "	500	" "	1052	20	0	0	0	0	0	0	0	0
"	5797	" "	600	" "	1094	20	7	0	0	0	0	5	100	6
"	5798	" "	700	" "	960	20	0	0	0	0	0	0	0	0
1/5	5805	" "	450	" "	990	20	6	0	2	0	0	3	60	6
"	5806	" "	600	" "	829	15	0	0	0	0	0	0	0	0
"	5807	" "	700	" "	964	20	0	0	0	0	0	0	0	0
1/13	5813	" "	450	" "	877	17	2	1	0	0	0	1	50	2
"	5815	" "	500	" "	328	4	6	1	0	0	0	5	83	18
"	5817	" "	700	" "	544	14	0	0	0	0	0	0	0	0
1/19	5835	" "	450	" "	880	17	0	0	0	0	0	0	0	0
"	5837	" "	500	" "	1062	20	0	0	0	0	0	0	0	0
"	5839	" "	600	" "	921	11	3	2	0	0	0	1	33	3
"	5840	" "	700	" "	1389	30	3	1	0	0	0	1	50	2
1/27	5891	" "	500	" "	1175	26	5	0	0	0	0	4	100	4
"	5892	" "	700	" "	887	27	0	0	0	0	0	0	0	0
2/3	5920	" "	450	" "	1065	20	7	0	0	0	0	7	100	7
"	5923	" "	500	" "	842	20	3	0	1	0	0	1	50	4
"	5924	" "	700	" "	964	20	0	0	0	0	0	0	0	0
2/11	5947	" "	420	" "	1316	20	17	0	1	0	0	11	92	13
"	5951	" "	500	" "	788	20	15	4	0	0	0	7	64	19
"	5956	" "	600	" "	762	14	0	0	0	0	0	0	0	0
"	5957	" "	700	" "	548	13	1	0	0	0	0	0	0	2
Total	51	Lots Iao V.			54376	988	150	28	5	0	0	88	73	2.7

Date	Lot	Locality	Elev. ft.	Stage	Wt.	No. Fruit	Pupae	Dor.	Med.	Lon.	Van.	Oop.	% para.	Index
						GUAVA (cont'd)								
1/13	5814	Iao V.	450	T.ripe	311	5	0	0	0	0	0	0	0	0
"	5816	" "	500	" "	542	9	4	2	0	0	0	2	50	7
"	5818	" "	700	" "	921	20	9	0	2	0	0	5	71	10
1/19	5836	" "	500	" "	1025	14	19	2	2	0	0	13	76	19
"	5838	" "	600	" "	764	11	14	2	0	0	0	11	85	18
1/27	5888	" "	450	" "	1396	14	44	17	0	0	0	32	65	32
"	5890	" "	500	" "	747	21	34	20	2	0	0	16	42	46
2/3	5919	" "	450	" "	1068	20	9	3	0	0	0	6	67	8
"	5922	" "	500	" "	1247	20	25	4	2	0	0	14	70	20
2/11	5948	" "	420	" "	1069	20	6	0	1	0	0	4	80	6
"	5952	" "	500	" "	764	20	29	2	0	0	0	24	92	38
"	5955	" "	600	" "	1410	20	66	6	1	0	0	40	85	47
"	5958	" "	700	" "	1202	20	18	2	0	0	0	13	87	15
Total	13	Lots Iao V.		T.ripe	12466	234	277	60	10	0	0	180	72	22.2
1/27	5889	Iao V.	500	½ ripe	828	26	74	8	0	0	0	61	88	89
2/3	5918	" "	450	" "	921	20	12	0	1	0	0	11	92	13
"	5921	" "	500	" "	935	20	25	4	1	0	0	18	78	27
2/11	5949	" "	420	" "	752	20	14	1	0	0	0	10	91	19
"	5953	" "	500	" "	746	20	42	3	0	0	0	35	92	56
Total	5	Lots Iao V.		half-ripe	4182	106	367	16	2	0	0	135	88	39.9
2/11	5950	Iao V.	420	mature green	1053	20	29	5	7	0	0	16	57	28
"	5954	" "	500	"	719	20	16	1	9	0	0	6	38	22
Total	2	Lots Iao V.		mature green	1772	40	45	6	16	0	0	22	50	25.3
11/12	5715	Makaalae	100	Gd.ripe	1174	20	7	1	0	0	0	5	83	6
12/17	5781	"	100	" "	518	11	0	0	0	0	0	0	0	0
11/12	5716	Nahiku	100	Gd.ripe	1686	20	6	1	0	0	0	3	75	4
12/17	5772	"	100	" "	2509	20	0	0	0	0	0	0	0	0
1/21	5845	"	200	" "	1062	10	1	0	0	1	0	0	100	1
"	5847	"	300	" "	978	10	1	0	0	0	0	1	100	1
"	5848	"	200	" "	1146	11	2	0	0	0	0	2	100	2
"	5846	"	300	T. "	1119	11	4	0	0	0	0	4	100	4
Total	6	Lots Nahiku			8500	82	14	1	0	1	0	10	83	1.6
11/13	5721	Waihee	150	Gd.ripe	1146	15	4	0	0	0	0	2	100	3
12/18	5786	"	150	" "	1707	20	0	0	0	0	0	0	0	0
1/22	5872	"	150	T. "	2350	22	16	4	0	0	0	8	67	7
Total	3	Lots Waihee			5203	57	20	4	0	0	0	10	71	3.6
11/13	5726	Honokahua	50	Gd.ripe	1294	17	0	0	0	0	0	0	0	0

Date	Lot	Locality	Elev. ft.	Stage	Wt.	No. fruit	Pupae	Dor.	Med.	Lon.	Van.	Oop.	% para.	Index
					GUAVA (cont'd)									
11/12	5717	Kailua	500	T.ripe	1440	20	5	0	0	0	0	4	100	3
1/21	5852	"	500	" "	813	8	0	0	0	0	0	0	0	0
11/12	5718	"	500	gd.ripe	1878	20	1	1	0	0	0	0	0	1
12/17	5771	"	500	" "	1686	20	0	0	0	0	0	0	0	0
1/21	5853	"	500	" "	1407	20	1	1	0	0	0	0	0	1
Total	5	Lots	Kailua	Gd. ripe	7224	88	7	2	0	0	0	4	67	.96
11/12	5719	Olinda	2100	gd.ripe	921	15	0	0	0	0	0	0	0	0
"	5720	"	2100	" "	1112	15	0	0	0	0	0	0	0	0
12/17	5782	"	2100	" "	949	20	0	0	0	0	0	0	0	0
1/21	5849	"	2100	" "	1330	30	0	0	0	0	0	0	0	0
2/2	5907	"	2100	" "	826	16	2	0	0	0	0	2	100	2
"	5910	"	2100	" "	928	20	14	2	0	0	0	12	86	15
Total	6	Lots	Olinda	Gd. ripe	6066	116	16	2	0	0	0	14	88	2.6
2/10	5942	Olinda	1900	T.ripe	1510	24	44	5	1	0	0	28	82	29
2/2	5909	"	1900	" "	978	14	51	9	5	0	0	25	64	52
Total	2	Lots	Olinda	T. ripe	2488	38	95	14	6	0	0	53	73	38.1
2/2	5908	Olinda	2100	½ ripe	560	11	8	0	0	0	0	7	100	14
2/10	5941	"	1900	" "	1086	23	34	3	13	0	0	13	45	31
Total	2	Lots	Olinda	Half-ripe	1646	34	42	3	13	0	0	20	56	25.3
11/17	5729	Haiku	600	gd.ripe	856	20	27	5	0	0	0	8	62	32
"	5731	"	600	" "	1188	20	32	1	0	0	0	16	94	27
1/5	5801	"	550	" "	978	20	3	2	0	0	0	0	0	3
1/13	5810	"	550	" "	984	20	6	1	0	0	0	5	83	6
1/19	5831	"	550	" "	1287	20	1	0	0	0	0	0	0	1
1/27	5887	"	550	" "	749	20	9	2	0	0	0	0	0	12
2/3	5917	"	550	" "	764	20	10	0	0	0	0	9	100	13
Total	7	Lots	Haiku	Gd. ripe	6806	140	88	11	0	0	0	38	76	12.9
1/19	5811	Haiku	550	T.ripe	892	20	12	0	0	0	0	10	100	13
"	5832	"	550	" "	1016	20	19	3	0	0	0	15	83	19
1/27	5886	"	550	" "	841	20	17	2	0	0	0	13	87	20
2/3	5914	"	550	" "	584	11	66	8	0	0	1	53	87	113
"	5916	"	550	" "	813	20	4	1	0	0	0	3	75	5
2/10	5946	"	550	" "	550	13	28	19	0	0	0	5	21	51
Total	6	Lots	Haiku	Tree-Ripe	4696	104	146	33	0	0	1	99	75	31
1/27	5885	Haiku	550	¼ ripe	735	20	3	0	0	0	0	2	100	4
2/3	5915	"	550	" "	617	20	48	7	0	0	0	37	84	78
Total	2	Lots	Haiku	Half-ripe	1352	40	51	7	0	0	0	39	85	37.7

Date	Lot	Locality	Elev. ft.	Stage	Wt.	No. Fruit	Pupae	Dor.	Med.	Lon.	Van.	Cop.	% para.	Index
						GUAVA (cont'd)								
12/17	5775	Kaupo	250	gd.ripe	921	20	3	1	0	0	1	1	67	3
"	5776	"	250	" "	1150	20	5	0	0	0	0	4	100	4
"	5777	"	250	" "	1330	20	47	9	0	0	0	28	76	35
"	5780	"	350	" "	360	6	2	1	0	0	0	1	50	6
1/21	5851	"	"	" "	746	15	228	37	0	0	1	142	79	306
Total	5	Lots	Kaupo	Ground Ripe	4507	61	285	48	0	0	2	176	79	63.2
12/17	5778	Kaupo	250	T. ripe	1259	20	54	11	0	0	0	31	74	43
1/21	5850	"	200	" "	892	10	99	37	0	0	0	50	57	111
Total	2	Lots	Kaupo	Tree-ripe	2151	30	153	48	0	0	0	81	69	71.1
1/21	5841	Kipahulu	200	gd.ripe	921	15	43	22	0	1	0	15	42	47
1/21	5842	Kipahulu	200	T. ripe	949	20	37	11	0	0	0	9	45	39
"	5843	"	200	" "	1062	20	44	24	0	0	0	15	38	42
"	5844	"	200	" "	992	20	89	47	0	0	0	38	45	90
Total	3	Lots	Kipahulu	Tree-ripe	3003	60	170	82	0	0	0	62	43	56.6
2/2	5911	Kokomo	1400	½ ripe	686	13	4	0	2	0	0	0	0	6
2/10	5944	"	1500	½ "	440	10	65	8	10	0	0	28	61	141
Total	2	Lots	Kokomo	Half-ripe	1126	23	69	8	12	0	0	28	59	51.2
2/2	5912	Kokomo	1400	T ripe	971	11	15	2	0	0	0	12	86	15
2/10	5943	"	1500	" "	1050	20	91	29	0	0	0	52	64	87
Total	2	Lots	Kokomo	Tree-ripe	2021	31	106	31	0	0	0	64	67	52.3
						APPLE								
1/5	5802	Kula	2850	T.ripe	830	8	25	0	18	0	0	4	18	30

Date	Lot	Locality	Elev. ft.	Stage	Wt.	No. fruit	Fumae	Dor.	Med.	Lon.	Van.	Cop.	% para.	Index
						T. CHEBULA								
11/17	5730	Haiku	500	Gd.ripe	305	43	92	17	0	20	0	9	63	302
12/1	5754	"	500	" "	141	20	14	0	0	8	1	2	100	99
12/8	5755	"	500	" "	184	34	3	0	0	0	0	0	0	16
12/22	5787	"	500	" "	178	30	0	0	0	0	0	0	0	0
12/29	5793	"	500	" "	525	80	8	7	0	0	0	0	0	15
1/5	5799	"	500	" "	601	100	34	23	0	0	0	11	32	57
1/5	5800	"	500	" "	1714	260	62	20	0	0	0	33	62	36
1/13	5808	"	500	" "	2026	300	256	138	2	1	1	95	41	126
1/13	5809	"	500	" "	1105	160	104	36	10	2	0	51	54	94
1/19	5830	"	500	" "	573	80	56	8	7	0	0	8	47	98
1/27	5884	"	500	" "	587	80	55	15	6	0	0	24	53	94
2/3	5913	"	500	" "	735	100	258	114	3	4	2	105	49	351
2/11	5960	"	500	" "	650	100	247	28	0	1	9	45	64	380
2/16	5968	"	500	" "	227	30	69	15	1	0	2	41	73	304
Total	14	Lots	Haiku		9551	1417	1166	421	23	36	15	424	52	122
						STAR FRUIT								
12/1	5749	Iao V.	290	T. ripe	964	14	19	2	0	0	0	15	88	20
11/7	5732	" "	290	" "	834	20	22	5	0	5	0	8	72	26
11/24	5748	" "	290	" "	664	12	6	0	0	0	0	5	100	9
12/8	5756	" "	290	" "	402	7	1	0	0	0	0	1	100	2
12/15	5765	" "	290	" "	892	10	3	1	0	0	0	2	67	3
Total	5	Lots	Iao V.		3756	63	51	8	0	5	0	31	82	14
						S. ALBUM								
12/18	5783	Makaoloi	50	T. ripe	215	211	42	3	0	1	1	22	89	195
1/22	5896	"	50	" "	85	100	0	0	0	0	0	0	0	0
1/22	5870	"	50	" "	85	100	15	2	1	0	0	9	75	176
Total	3	Lots	Makaoloi		385	411	57	5	1	1	1	31	85	139
						ORANGE								
1/21	5864	Kaupo	350	T. ripe	1675	9	26	13	0	0	0	9	41	16
						S. DULCIS								
1/22	5867	Honokahua	50	T. ripe	745	21	0	0	0	0	0	0	0	0
						BESTILI.								
1/22	5871	Waikapu	200	Gd.ripe	396	23	1	0	0	0	0	0	0	3
						PAPAYA								
11/12	5710	Kaupo	350	T. ripe	1745	3	162	14	0	0	0	28	67	93
						E. CUMINI								
11/12	5713	Kaupo	350	T. ripe	163	40	2	0	0	0	0	0	0	12
						L. GUAVA								
11/13	5722	Waihee	150	Gd.ripe	608	65	0	0	0	0	0	0	0	0
11/17	5737	Iao V.	450	" "	566	50	0	0	0	0	0	0	0	0

Date	Lot	Locality	Elev. ft.	Stage	Wt.	No. fruit	Pupae	Dor.	Med.	Long.	Van.	Cop.	% para.	Index
						COFFEE								
11/10	5704	Iao V.	450	T. ripe	141	80	2	0	0	0	0	1	100	14
11/17	5735	" "	450	" "	156	90	0	0	0	0	0	0	0	0
Total	2	Lots Iao V.			297	170	2	0	0	0	0	1	100	7
1/21	5865	Kaupo	300	T. ripe	198	150	24	7	3	0	0	11	52	121
1/21	5866	"	300	" "	184	150	49	20	0	0	0	19	49	266
2/5	5928	"	100	" "	368	200	50	12	0	0	0	28	70	136
2/5	5929	"	100	" "	241	120	39	7	0	0	0	20	74	162
2/5	5930	"	300	" "	255	150	23	5	1	0	0	14	70	90
2/5	5931	"	300	" "	241	150	39	10	0	0	0	20	67	162
2/5	5932	"	300	" "	212	150	20	6	1	0	0	10	59	94
2/5	5933	"	300	" "	241	150	71	11	1	4	0	47	81	295
Total	8	Lots Kaupo			1940	1220	315	78	6	4	0	169	67	162
						SANTOL								
11/13	5727	Honokahua	50	Gd. ripe	2416	18	66	8	0	0	0	22	73	27
12/18	5784	"	50	" "	679	7	5	3	0	0	0	2	40	7
Total	2	Lots Santol			3095	25	71	11	0	0	0	24	69	23
						M. ORANGE								
2/10	5959	Wailuku	200	T. ripe	89	150	25	23	1	0	0	0	0	281
						COTTON								
1/22	5868	Honokahua	50	T. ripe	212	15	0	0	0	0	0	0	0	0
1/29	5893	Wailuku	200	" "	196	18	0	0	0	0	0	0	0	0
1/29	5894	Kahului	50	" "	276	20	0	0	0	0	0	0	0	0
1/29	5895	Kihei	50	T. ripe	325	24	3	0	3	0	0	0	0	9
2/12	5961	"	50	" "	290	22	2	0	2	0	0	0	0	7
2/12	5962	"	50	" "	297	22	0	0	0	0	0	0	0	0
2/12	5963	"	50	" "	268	22	3	0	3	0	0	0	0	11
2/12	5964	"	50	" "	269	21	12	0	11	0	0	0	0	45
2/12	5965	"	50	" "	297	23	0	0	0	0	0	0	0	0
Total	6	Lots Kihei			1746	134	20	0	19	0	0	0	0	11
						S. SODOMEUM								
1/21	5861	Kaupo	350	T. ripe	873	70	0	0	0	0	0	0	0	0
1/21	5862	Nuu	50	" "	764	65	0	0	0	0	0	0	0	0
1/21	5863	Kahikinui		" "	900	65	0	0	0	0	0	0	0	0
1/23	5878	Kula	2850	" "	740	50	0	0	0	0	0	0	0	0
1/26	5879	"	2850	" "	709	50	0	0	0	0	0	0	0	0
1/26	5880	"	2850	" "	634	50	0	0	0	0	0	0	0	0

Date	Lot	Locality	Elev. ft.	Stage	Wt.	No. fruit	Pupae	Dor.	Med.	Lon.	Van.	Oop.	% para.	Index
						S. SODOMEUM (cont'd)								
1/29	5896	Kanaio	2000	T.ripe	643	50	0	0	0	0	0	0	0	0
1/29	5897	"	2000	" "	824	50	0	0	0	0	0	0	0	0
1/29	5898	"	2000	" "	636	50	0	0	0	0	0	0	0	0
1/29	5899	"	2000	" "	700	50	0	0	0	0	0	0	0	0
1/29	5900	"	2000	" "	707	50	0	0	0	0	0	0	0	0
2/2	5903	Kula	2850	" "	792	60	0	0	0	0	0	0	0	0
2/5	5934	Kahikinui	1100	" "	552	50	0	0	0	0	0	0	0	0
2/5	5935	"	1100	" "	721	50	0	0	0	0	0	0	0	0
2/10	5936	Kula	2850	" "	752	50	0	0	0	0	0	0	0	0
2/10	5937	"	2850	" "	747	50	0	0	0	0	0	0	0	0
Total	16	Lots			11,694	860	0	0	0	0	0	0	0	0
						RED CACTUS								
12/10	5819	Pulehu	2300	T.ripe	2069	10	0	0	0	0	0	0	0	0
12/10	5821	"	2000	" "	1081	10	0	0	0	0	0	0	0	0
12/10	5824	"	1600	" "	1139	10	3	3	0	0	0	0	0	3
12/10	5826	"	1300	" "	1119	10	0	0	0	0	0	0	0	0
12/10	5828	"	800	" "	1077	10	0	0	0	0	0	0	0	0
Total	5	Lots			6485	50	3	3	0	0	0	0	0	.46
						WHITE CACTUS								
12/10	5820	Pulehu	2300	T.ripe	1700	10	23	0	19	0	0	0	0	14
12/10	5822	"	2000	" "	1302	10	1	0	0	0	0	0	0	1
12/10	5823	"	1600	" "	1347	10	0	0	0	0	0	0	0	0
12/10	5825	"	1300	" "	1112	10	0	0	0	0	0	0	0	0
12/10	5827	"	1000	" "	1347	10	0	0	0	0	0	0	0	0
12/10	5829	"	800	" "	1679	10	5	2	0	0	0	0	0	3
Total	6	Lots			8487	60	29	2	19	0	0	0	0	3

SUMMARY

256 Total collections
9,239 Total fruits
235,915 Total weight in grams
9,298 Total pupae
39.4 Index pupae per 1000 grams
80% - 7458 Emergence
21% - 1603 D. dorsalis
29% - 2182 C. capitata
58 O. longicaudatus
29 O. vandenboschi
3586 O. oophilus
49% Parasites

Line Project I-a-5-3. Effect of Climate and Other Factors on the Development of Fruit Flies in Hawaii Under Field Conditions.

Meteorological Data.--Monthly minimum mean temperatures of from 39 to 41 degrees and monthly maximum means of from 59 to 62 degrees were recorded at the Haleakala 7030' station for this quarter. The absolute maximum was 72 degrees; the absolute minimum, 33 degrees. The Haleakala 5500' station was slightly warmer with a minimum mean of 45 degrees and maximum mean of 58 to 60 degrees. The absolute maximum was 70 degrees with absolute minimum of 41 degrees for this station. Rainfall for the three stations were nearly the same. Meteorological data for Maui stations are summarized on page 35.

Pupal Studies.--Weekly experiments carried out at Haleakala 7030' station were all negative during this quarter. The Haleakala 5500' station had four experiments with emergences from 58 to 78 days. The fly emerging after 78 days was malformed but the one emerging after 75 days was normal. All experiments carried out at Kula 3750' gave good results. Fly emergence ranged from 35 to 43 days. All pupal experiments are tabulated on page 36.

Population Trends - Methyl Eugenol Traps.--The catch at Kaupo (2028 per trap day) declined to the lowest there since trapping was started in June, 1952, but the flies were still almost twice as abundant there as they were at any other trapping site. Kihei, with relatively few hosts in fruit, showed the opposite trend. The highest catch at Kihei was recorded this quarter (710 flies per trap day). The lowest index for all ten traps since installation was recorded in June, 1952, when the traps were installed (708 flies per trap day). In January, 1953, the index was up to 1208 flies per trap day; in February, 1046 flies per trap day; and in March, 952 flies per trap day. The March index was the second lowest since installation of the traps. Methyl eugenol trap data and graphs are on pages 37 to 40.

Population Trends - Citronella Traps.--The high population densities noted in August, 1952, continued through March, 1953, in all citronella trapping areas. Population densities at Kula 3000' area was the highest since March, 1950. More flies were taken in the citronella traps during the quarter than during comparable periods in 1950, 1951, and 1952. (See pages 41 and 42.)

METEOROLOGICAL DATA FOR MAUI STATIONS

Stations	January	February	March	Temperature
HALEAKALA	72	70	69	Absolute Max.
	62	59	59	Max. Mean
7030'	41	41	39	Min. Mean
	34	35	33	Absolute Min.
	.47	2.52	7.12	Ppt.
HALEAKALA	68	70	64	Absolute Max.
	60	59	58	Max. Mean
5500'	45	45	45	Min. Mean
	41	42	41	Absolute Min.
	.47	1.75	6.49	Ppt.
KULA	72	69	72	Absolute Max.
	67	68	66	Max. Mean
3750'	51	51	51	Min. Mean
	45	49	46	Absolute Min.
	.33	1.62	6.56	Ppt.
NASKA	89	87	90	Absolute Max.
	84	83	84	Max. Mean
50'	64	64	66	Min. Mean
	57	59	60	Absolute Min.
HAIKU 500'	.59	2.54	2.92	Ppt.
IAO VALLEY 420'	2.01	3.76	2.97	Ppt.
WAILUKU 200'	.63	1.43	1.77	Ppt.

The results obtained from the pupal experiments were as follows:

Dacus dorsalis

Expt.	No. pupae	Date pupated	Date emerged	Duration	Fly emerged
		HALEAKALA 7030'			
2998	210	11- 8-52	negative	---	---
3004	30	11-14-52	"	---	---
3012	70	11-18-52	"	---	---
3018	100	11-19-52	"	---	---
3030	40	12- 4-52	"	---	---
3036	15	12-19-52	"	---	---
3042	25	12-23-52	"	---	---
3048	25	1- 3-53	"	---	---
3056	75	1-10-53	"	---	---
3062	30	1-13-53	"	---	---
3068	25	1-16-53	"	---	---
3074	125	1-22-53	"	---	---
		HALEAKALA 5500'			
3000	170	11- 8-52	1- 5-53	58 days	15
3006	30	11-14-52	1-30-53	78 "	1 malformed
3014	70	11-18-52	1-18-53	61 "	7
3020	100	11-19-52	negative	---	---
3032	40	12- 4-52	2-17-53	75 days	1
3038	15	12-19-52	negative	---	---
3044	25	12-23-52	"	---	---
3050	25	1- 3-53	"	---	---
3058	75	1-10-53	"	---	---
3064	30	1-13-53	"	---	---
3070	25	1-16-53	"	---	---
3076	125	1-22-53	"	---	---
		KULA 3750'			
3034	40	12- 4-52	1- 8-53	35 days	16
3040	15	12-19-52	1-28-53	40 "	6
3046	25	12-24-52	2- 1-53	39 "	9
3052	25	1- 3-53	2- 9-53	37 "	23
3060	75	1-10-53	2-15-53	36 "	42
3072	25	1-16-53	2-27-53	43 "	1
3078	100	1-22-53	3- 1-53	38 "	46
3086	60	2- 7-53	3-17-53	38 "	17
3092	50	2-11-53	3-19-53	36 "	13
3100	50	2-17-53	3-27-53	38 "	14

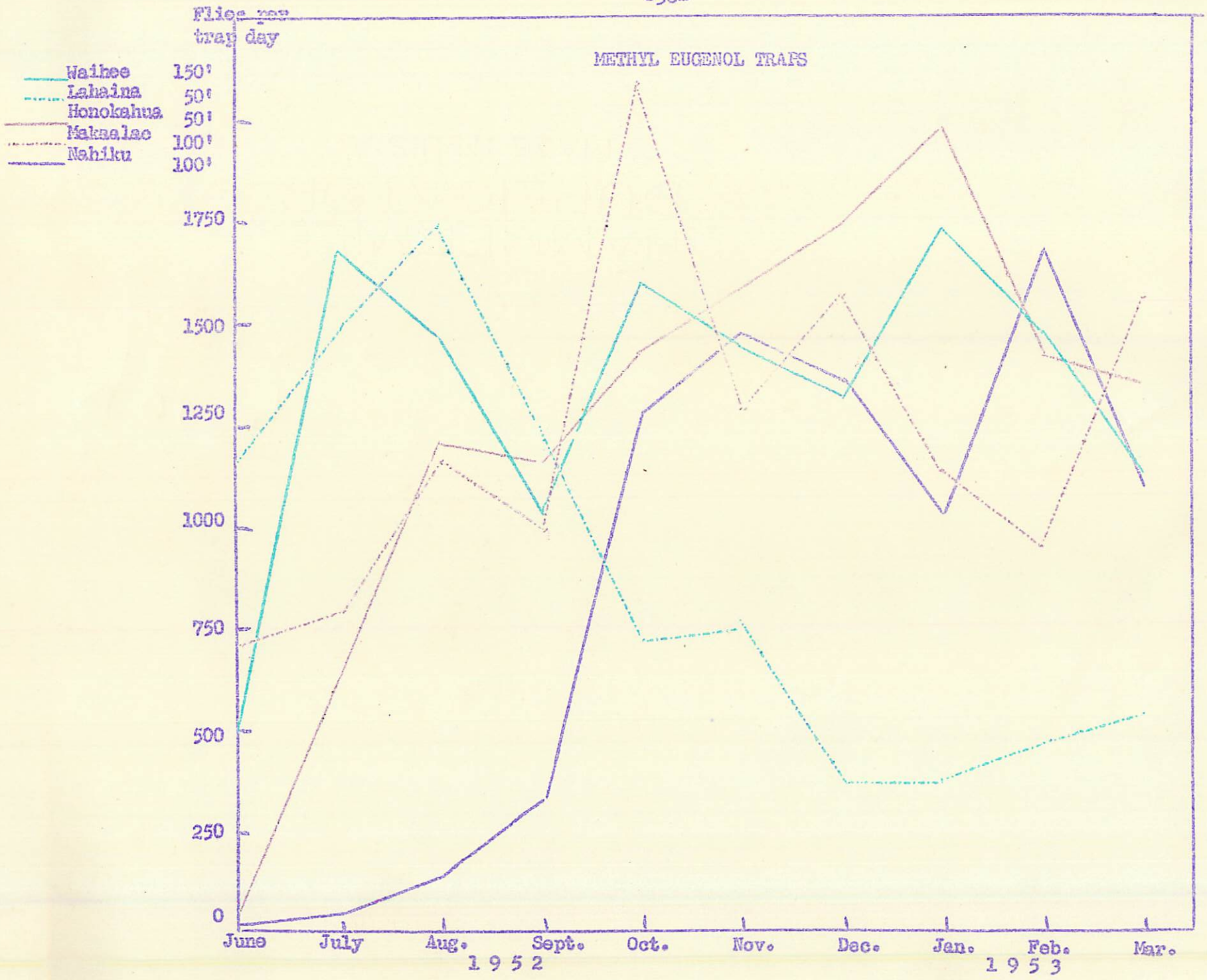
POPULATION TRENDS MAUI

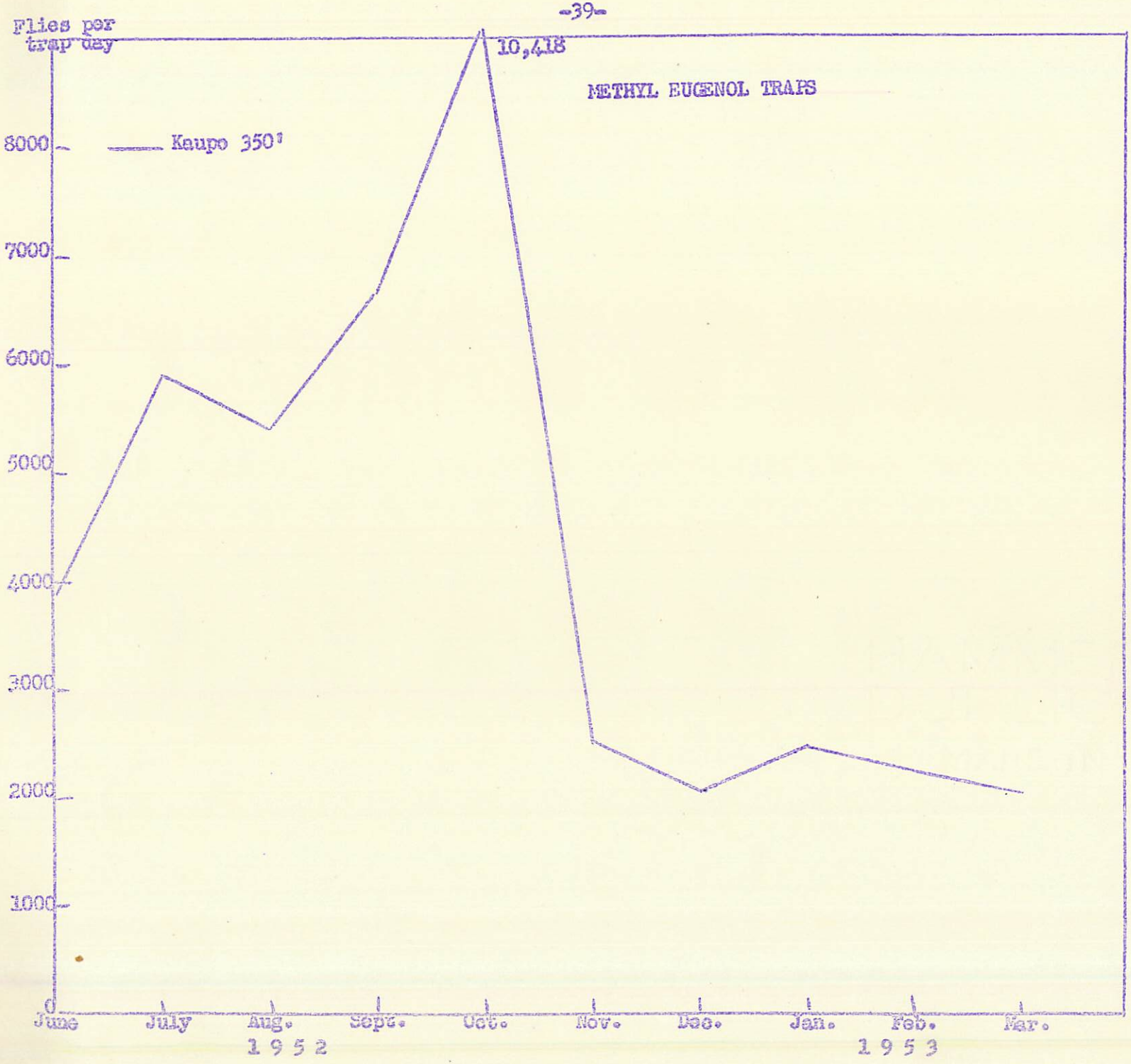
Methyl eugenol lure
Flies per trap day

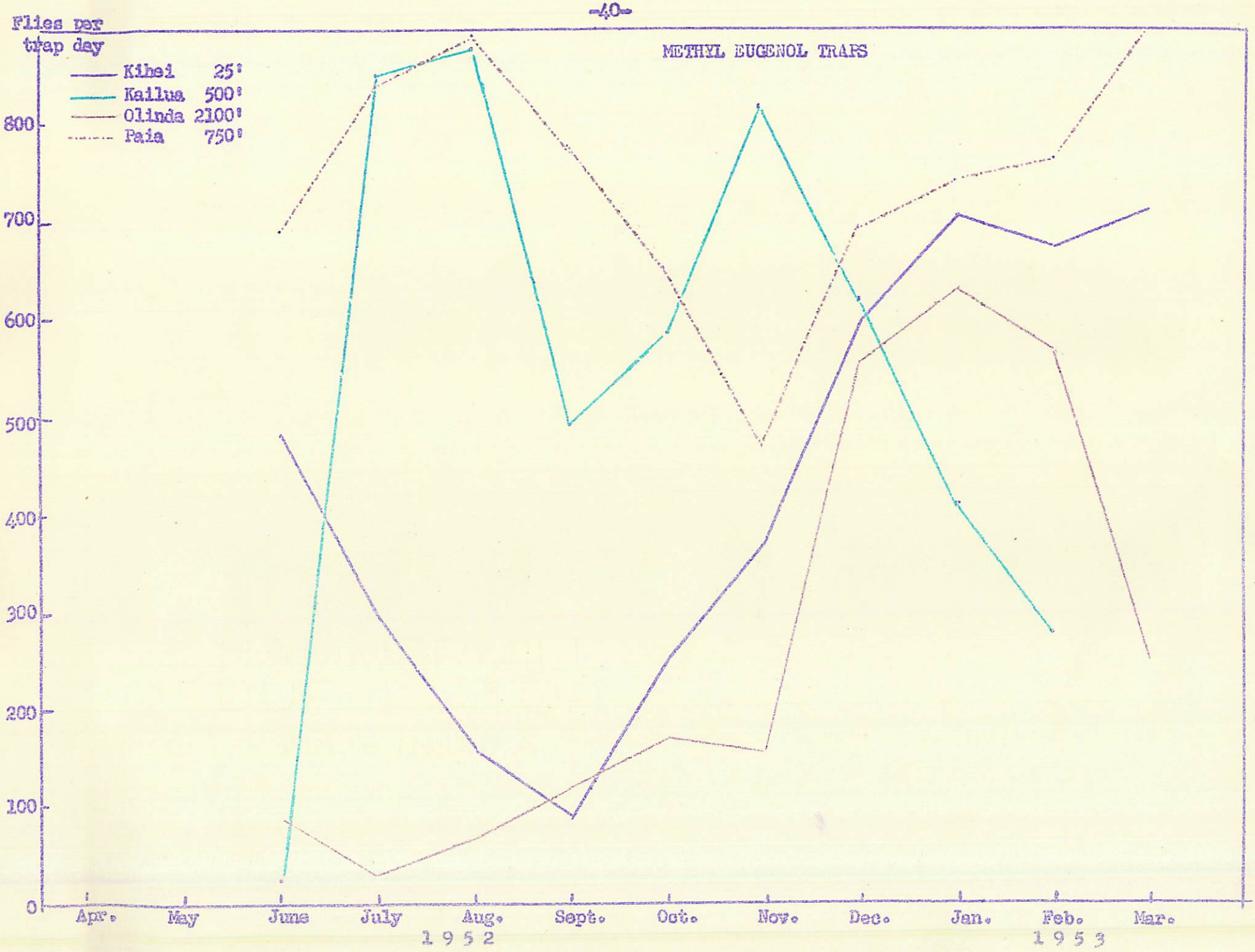
1952	Waihee 150'	Lahaina 50'	Honokahua 50'	Kihei 25'	Kaupo 350'	Makaelae 100'	Nahiku 100'	Kailua 500'	Olinda 2100'	Paia 750'
June	511	1147	56	481	3844	710	15	26	91	690
July	1669	1492	629	299	5823	787	35	853	32	845
Aug.	1393	1746	1193	158	5439	1152	127	879	70	894
Sept.	1030	1222	1155	91	6602	998	312	492	120	789
Oct.	1583	695	1430	254	10418	2071	1268	587	172	652
Nov.	1425	728	1577	374	2516	1283	1455	821	161	472
Dec.	1316	351	1740	599	2061	1559	1349	617	556	695
1953										
Jan.	1728	364	1941	702	3483	1139	1012	314	629	746
Feb.	1415	479	1426	672	2225	940	1678	278	567	765
Mar.	1115	532	1332	710	2028	614	1089	—	253	905

Monthly Total Ten Traps

1952	Total Flies	Trap days	Index
June	95,562	135	708
July	431,628	347	1244
Aug.	182,701	140	1305
Sept.	435,572	340	1281
Oct.	554,798	290	1913
Nov.	302,744	280	1081
Dec.	379,536	350	1084
1953			
Jan.	434,098	360	1208
Feb.	304,350	291	1046
Mar.	238,848	251	952


Flies per trap day
METHYL EUGENOL TRAPS
Waihee 150'
Lahaina 50'
Honokahua 50'
Makaalae 100'
Nahiku 100'
1750
1500
1250
1000
750
500
250
0
June
July
Aug.
Sept.
Oct.
Nov.
Dec.
Jan.
Feb.
Mar.
1952
1953

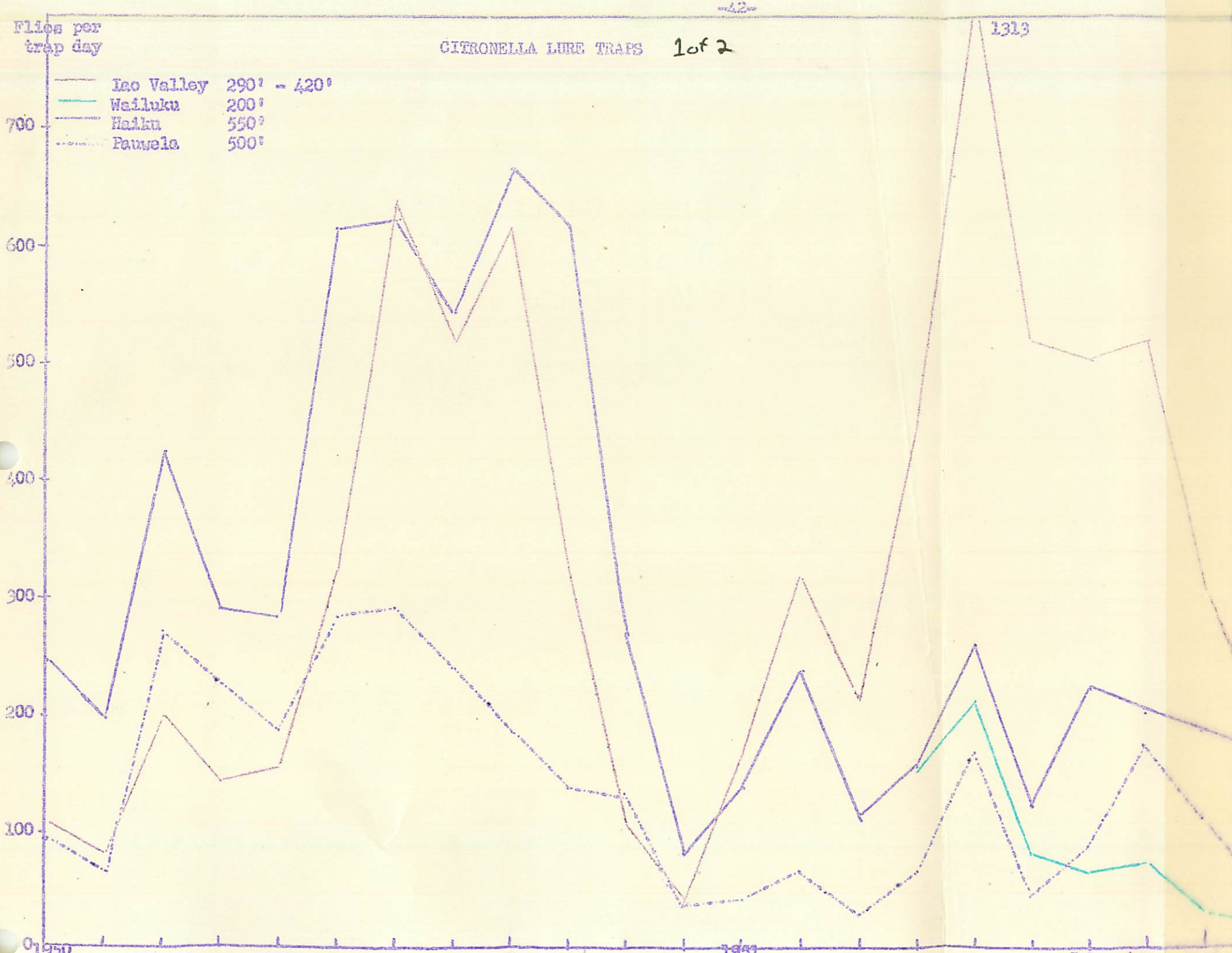

Flies per trap day
10,418
METHYL EUGENOL TRAPS
Kaupo 350'
8000
7000
6000
5000
4000
3000
2000
1000
0
June
July
Aug.
Sept.
Oct.
Nov.
Dec.
Jan.
Feb.
Mar.
1952
1953


Flies per trap day
METHYL EUGENOL TRAPS
Kibei 25'
Kailua 500'
Olinda 2100'
Paia 750'
800
700
600
500
400
300
200
100
0
Apr.
May
June
July
Aug.
Sept.
Oct.
Nov.
Dec.
Jan.
Feb.
Mar.
1952
1953

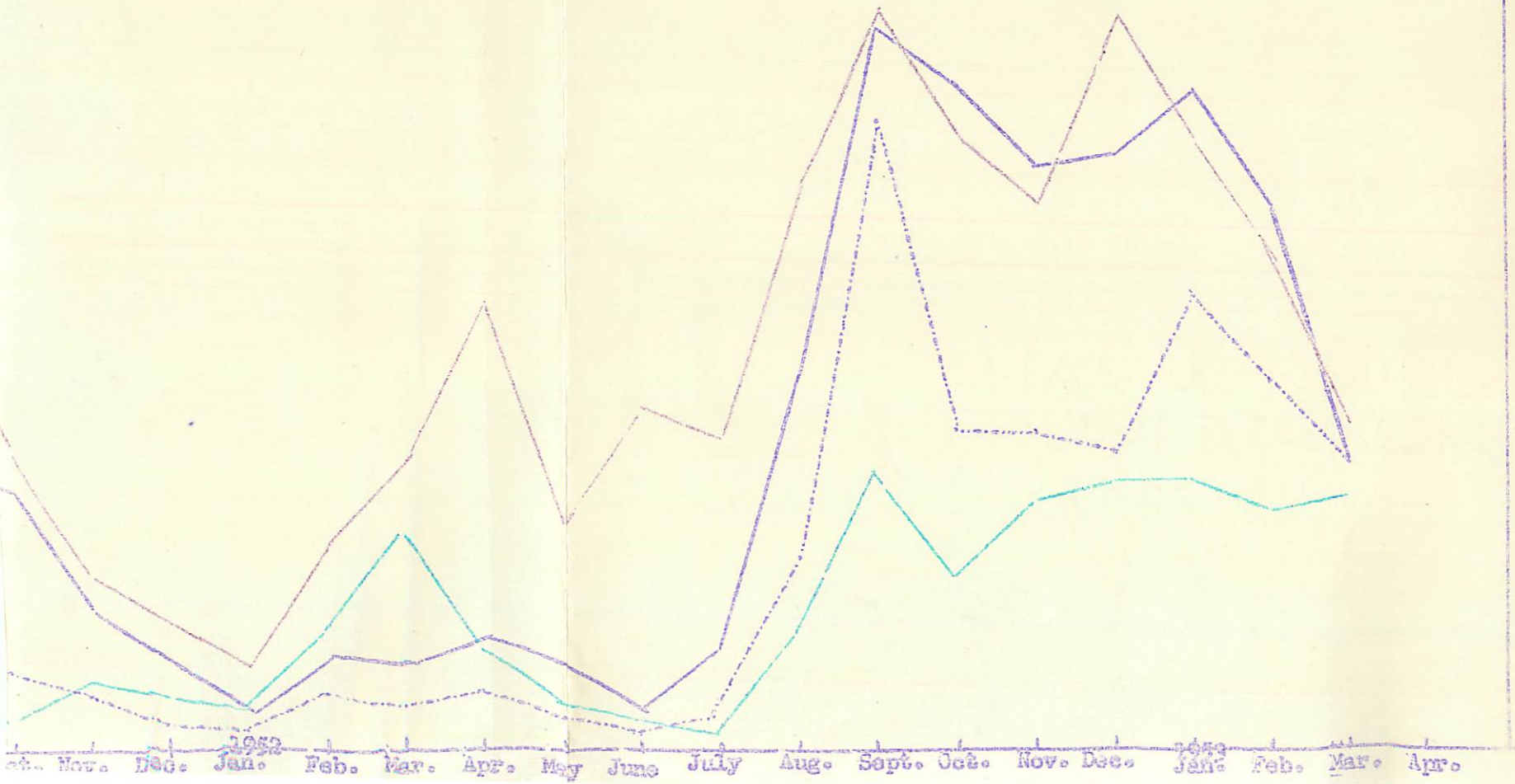
POPULATION TRENDS MAUI

Citronella Lure
Flies per trap day

Year		Wailuku 200'	Iao Valley 290 - 420'	Pauwela 500'	Haiku 550'	Kula 3000'
1950	Jan.		109	94	245	2.1
	Feb.		81	68	199	3.7
	Mar.		202	271	423	11.9
	Apr.		144	232	290	5.8
	May		157	188	284	2.5
	June		323	285	614	3.1
	July		637	291	623	4.4
	Aug.		520	242	541	2.9
	Sept.		616	188	666	3.9
	Oct.		326	141	617	3.1
	Nov.		109	132	270	2.9
	Dec.		45	39	81	.33
1951	Jan.		167	44	140	.23
	Feb.		320	67	240	1.1
	Mar.		222	30	116	1.1
	Apr.	153	451	67	159	.41
	May	213	1313	170	261	.36
	June	87	521	49	123	.20
	July	67	506	89	224	.43
	August	75	524	175	202	.36
	Sept.	30	312	112	188	.28
	Oct.	19	191	50	168	.14
	Nov.	46	113	36	93	.11
	Dec.	35	84	18	61	.18
1952	Jan.	27	56	12	26	.53
	Feb.	75	132	38	63	.97
	Mar.	139	182	28	58	.71
	Apr.	65	284	39	72	.71
	May	33	144	22	56	.92
	June	21	217	12	26	1.3
	July	11	199	25	68	1.3
	August	76	356	121	239	1.5
	Sept.	175	466	396	454	1.5
	Oct.	111	387	202	417	.88
	Nov.	158	344	200	368	.71
	Dec.	170	462	187	375	2.22
1953	Jan.	172	382	285	415	4.34
	Feb.	153	308	233	343	8.83
	Mar.	162	205	158	184	3.77


Flies per trap day
CITRONELLA LURE TRAPS 1 of 2
Iao Valley 290' - 420'
Wailuku 200'
Haiku 550'
Pauwela 500'
1313
700
600
500
400
300
200
100
0
1950
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
1951
Jan. Feb. Mar. Apr. May June July Aug. Sept.

citronella lure traps 2 of 2



HAWAII - (S. Nakagawa and G. Farias)

Line Project I-a-5-2. Hosts of Fruit Flies in Hawaii.

During the period of December, 1952, to February, 1953, a total of 340 lots of fruit weighing 318,537 grams (711 pounds) was collected on Hawaii. There was a total of 10,481 fruits. From the total fruit collections 14,580 puparia were recovered with a resulting emergence of 83 per cent of adult fruit flies and parasites. The overall infestation index was 46 larvae per 1000 grams of fruit or 21 larvae per pound. This infestation index is slightly higher than that of the previous quarter.

It was reported in the last quarter that the apples collected from Waikii in October, 1952, were heavily infested by the Mediterranean fruit fly. The December collections resulted in even heavier infestations with 83 larvae per pound of fruit or nearly four times as many as in the October collections. No parasites were recovered from any of the apple collections.

Jerusalem cherries collected from Waikii (4700') in December also were heavily infested by the Mediterranean fruit fly. Two lots of fruit consisting of 200 cherries yielded 368 puparia which gave an infestation index of 923 larvae per pound. A month later, the infestations rose to 1247 larvae per pound of fruit. From a total of 2115 puparia, thirty-five Opius tryoni emerged.

Only two collections of Jerusalem cherries were made along the Mauna Loa Truck Trail (4000-5100') due to the fruit being out of season. The fruit collections made in February produced only three Medfly pupae out of 175 cherries.

The coffee collections from the Kona areas resulted in the recovery of 15 puparia from 2000 berries weighing approximately 8 pounds. One dorsalis, 2 capitata, 1 Opius vandenboschi, and 9 Opius oophilus emerged. Recent collections of the coffee berries appear to be much more heavily infested and this may be the result of fewer berries and other hosts at this time of the year.

The 200 coffee berries from Waiohinu (900') did not yield a single fruit fly puparia.

One hundred and fifty coffee berries picked from a tree by the driveway of a Hilo restaurant (Moto's Inn) yielded 60 puparia from which emerged 57 dorsalis and 2 oophilus. The berries were picked from two trees which had been planted for ornamental purposes. It is interesting to find a rather high infestation in these coffee berries since one might assume that the constant human and vehicle movements would distract the flies and interfere with their normal activities.

Infestations in Navel oranges, Hawaiian oranges, and tangerines continued to be low. Recoveries were 31 pupae from 310 tangerines, 8 from 170 Hawaiian oranges, and 4 from 72 Navel oranges. From the combined total of 43 puparia, 32 dorsalis and 3 oophilus emerged. The late season crop of citrus appears to be much more heavily infested.

Close to 45 per cent of our fruit collections consisted of guavas which were fruiting abundantly throughout the island. A total of 2912 guavas yielded 8130 fruit fly puparia. The infestation index of 22 larvae per pound of fruit increased twice as much as the last report. The highest guava infestation indices were recorded in collections made along the Puna coast (kalapana and Kupaahu) while the lowest infestation indices were from collections made in the Kona area. Sixty per cent of the oriental fruit fly pupae were parasitized, with Opius oophilus the dominant species.

Loquat collections from Kona had a very low fruit fly infestation with only 1 dorsalis pupa being recovered from 90 fruits. The Hilo collections consisting of 120 fruits yielded 79 puparia with equal emergence of parasites and fruit flies.

Summation of the Fruit Collections and Fly Emergence on Hawaii

Total collections	:	340 lots
Total fruit	:	10,481
Total weight	:	318,537 gm. (711 lb.)
Total pupae	:	14,580
Index	:	46 larvae per 1000 gm.
		21 larvae per pound
Total emergence	:	83 per cent

Emergence

D. dorsalis	:	3240 or 26.7 per cent
C. capitata	:	3497 or 28.8 per cent
D. cucurbitae	:	222 or 1.8 per cent
O. vandenboschi	:	338 or 2.8 per cent
O. oophilus	:	4806 or 39.6 per cent
O. tryoni	:	36 or .3 per cent

Individual Fruit Sampling.--Individual screenings of the various hosts, which have been completed are shown in table 1.

The fruits were collected at random from the trees and held in separate containers. Each sampling consisted of 40 fruits. The size and weight of the fruit apparently had little effect on the degree of infestation. Except for the mangoes, all favorable hosts of the oriental fruit fly had comparatively high percentages of infestation. Mountain apple, false kamani, guavas, loquat, and rose apple all had greater than 50 per cent infestations. One guava collection from Kupaahu was infested 100 per cent. Two minor hosts had no infestations. Jerusalem cherry, predominately a Medfly host, was highly infested but the puparia had the lowest rate of parasitization. The greatest number of puparia recovered from a single fruit was 48 from mango, 45 from false kamani, and 44 from guava.

Table 1. — INDIVIDUAL FRUIT SAMPLING

LOCALITY	FRUIT	No. Fruit	Weight-Grams	Am't Inf.	% Inf.	Most pupae per fruit	Total pupae	Per cent			Index*
								Dor.	Med.	Par.	
Kupaahu	Guava	40	27 - 116	26	65	41	159	15	—	85	59
Kupaahu	Guava	40	35 - 124	40	100	44	815	27	—	73	283
Hilo	Rose apple	40	10 - 40	27	67.5	35	494	51	—	49	546
Hilo	Mt. apple	40	29 - 109	35	87.5	31	335	59	—	41	119
Hilo	Star apple	40	62 - 182	4	10	3	6	50	—	50	1
Kupaahu	Mango	40	40 - 185	10	25	48	118	88	—	12	27
M.L.T.T.	Jer. cherry	40	1.6 - 2.2	36	90	5	71	—	96	4	986
Hilo	False kamani	40	13 - 39	32	80	45	454	73	—	27	438
M.L.T.T.	Jer. cherry	40	0.6 - 2.1	35	87.5	8	129	—	100	—	2804
Hilo	A. carambola	40	27 - 138	0	—	—	—	—	—	—	—
Pahoa	Haw'n orange	40	76 - 200	0	—	—	—	—	—	—	—
Hilo	Guava	40	19 - 115	30	75	31	247	43	—	57	115
Hilo	Loquat	40	4 - 19	23	57.5	5	53	34	—	66	127

* Puparia per 1000 grams of fruit weight.

Line Project I-a-5-3. Effect of Climate and Other Factors on the Development of Fruit Flies in Hawaii Under Field Conditions.

Meteorological Data.--Heaviest rainfall among the four citronella trapping localities occurred in Hilo with a total of 39.98 inches for the first three months of 1953. However, the total rainfall at each locality was less than that of 1951 and 1952 for the same comparable months. The highest maximum temperature of 85° F. was recorded at Kupaahu (100'), and the lowest minimum temperature of 29° F. was recorded at Mauna Loa Truck Trail (6700'). The drought which developed in the fall months and continued to January resulted in optimum mean maximum temperature conditions for fly activity. The mean maximum for January increased slightly from that of December at the majority of the trapping areas which probably was responsible for the increased fly catches. (See table 2.)

Pupal Studies.--The cool conditions of the winter months extended the pupal duration at all the ecological stations on Hawaii. The pupal stage required 51 days for its completion at an elevation of 5900', 47 days at 5100', 42 days at 4250', 39 days at 4000', and 16 days at Hilo Insectary (75'). There has been no emergence at 6700'.

Population Trends - Citronella Traps.--Fly catches, which were reported unusually abundant during the last quarter, were even more abundant this quarter although there was a decline in March. Kupaahu and the two trapping districts in Hilo recorded their highest fly indices since trapping was initiated at each respective locality. Kona and Mauna Loa Truck Trail also had increases in fly populations. There were a number of reasons which may have been associated with the tremendous fly increases, but an important factor apparently was the favorable weather conditions which prevailed during the fall months. The dry weather provided excellent conditions for egg hatch, pupation and emergence, and maximum longevity of the adult fruit flies. Good host availability (mangoes and guavas) at the lower elevations was an equally important cause of the buildup of the oriental fruit fly. The flies were very active during the quarter as evidenced by the mass fly movement to the higher and cooler areas along the Mauna Loa Truck Trail and the Kona coast. The results of the citronella traps are shown in table 3.

Population Trends - Methyl Eugenol Traps.--The catch in the 30-day methyl eugenol traps reached its highest peak in the month of February with an average index of 650 flies per trap day. Kalapana continued to lead all the ecological areas and appears to have the highest fly density. The greatest catch at Kalapana occurred in March when the fly index rose to 3996 flies per trap day. Kalapana and Waiohinu maintained steady high fly populations during the past three months to offset the general decreases at the other trapping areas. A table and a map are included to show the population densities throughout the island. (Table 4 and Fig. 1.)

Table 2

METEOROLOGICAL DATA FOR HAWAII STATIONS

Jan. - Mar. - 1953

STATION	JANUARY	FEBRUARY	MARCH	TEMPERATURE
HILO INSECTARY	84	80	80	Absolute Max.
	78.8	75.9	74.9	Max. Mean
75'	63.6	63.4	64.0	Min. Mean
	60	59	60	Absolute Min.
	.34	13.50	26.14	Ppt.
KUPAAHU	85	83	80	Absolute Max.
	81.5	78.7	77.3	Max. Mean
100'	63.7	64.1	64.7	Min. Mean
	59	60	61	Absolute Min.
	1.04	12.10	20.09	Ppt.
KONA	82	82	82	Absolute Max.
	78.4	78.5	78.5	Max. Mean
1700'	56.7	58.7	58.9	Min. Mean
	52	55	56	Absolute Min.
	.37	8.24	5.6	Ppt.
MAUNA LOA TRUCK TRAIL	79	79	76	Absolute Max.
	73.5	70.6	68.5	Max. Mean
4000'	47.1	48.7	49.4	Min. Mean
	44	45	45	Absolute Min.
	1.12	7.16	9.42	Ppt.
MAUNA LOA TRUCK TRAIL	74	72	70	Absolute Max.
	70.2	67.5	65.8	Max. Mean
4250'	46.2	48.2	48.8	Min. Mean
	42	44	44	Absolute Min.
				Ppt.
MAUNA LOA TRUCK TRAIL	70	74	65	Absolute Max.
	64.2	63.4	61.1	Max. Mean
5100'	38.8	41.3	42.5	Min. Mean
	32	36	35	Absolute Min.
MAUNA LOA TRUCK TRAIL	71	74	67	Absolute Max.
	65.2	61.8	60.7	Max. Mean
5900'	34.3	41.2	38.4	Min. Mean
	32	34	30	Absolute Min.
MAUNA LOA TRUCK TRAIL	69	73	66	Absolute Max.
	61.7	59.4	58.8	Max. Mean
6700'	35.6	38.4	37.3	Min. Mean
	31	32	29	Absolute Min.

Table 3
POPULATION TRENDS ON HAWAII

Flies Per Trap Day

Citronella Traps

MONTH	KUPAAHU 100'			HILO 100'			KONA 1700'			HILO (Costa's) 75'				MAUNA LOA TRUCK TRAIL (4000-5100')			
	1951	1952	1953	1951	1952	1953	1951	1952	1953	1950	1951	1952	1953	1950	1951	1952	1953
January	149	121	822	53	20	121	109	14	34	---	16	8	40	133	13	5	260
February	452	451	793	142	45	152	178	13	62	---	39	18	50	269	84	25	245
March	406	309	752	89	19	83	104	6	39	24	38	11	42	203	13	2	59
April	388	379	---	40	13	---	29	1	---	20	17	11	---	150	3	2	---
May	368	356	---	42	8	---	12	1	---	8	21	6	---	64	4	1	---
June	309	276	---	28	9	---	10	1	---	5	8	6	---	24	33	2	---
July	359	352	---	20	11	---	10	2	---	2	6	3	---	115	18	13	---
August	203	218	---	20	4	---	5	4	---	1	10	1	---	74	10	4	---
September	382	497	---	28	10	---	4	3	---	7	13	4	---	49	7	2	---
October	696	541	---	66	7	---	3	3	---	11	29	4	---	21	16	8	---
November	325	438	---	48	26	---	5	2	---	14	19	15	---	8	9	18	---
December	123	537	---	27	74	---	11	7	---	10	9	33	---	7	10	90	---
AVERAGE INDEX	347	365	---	50	21	---	40	5	---	10	19	10	---	93	18	14	---

Table 4

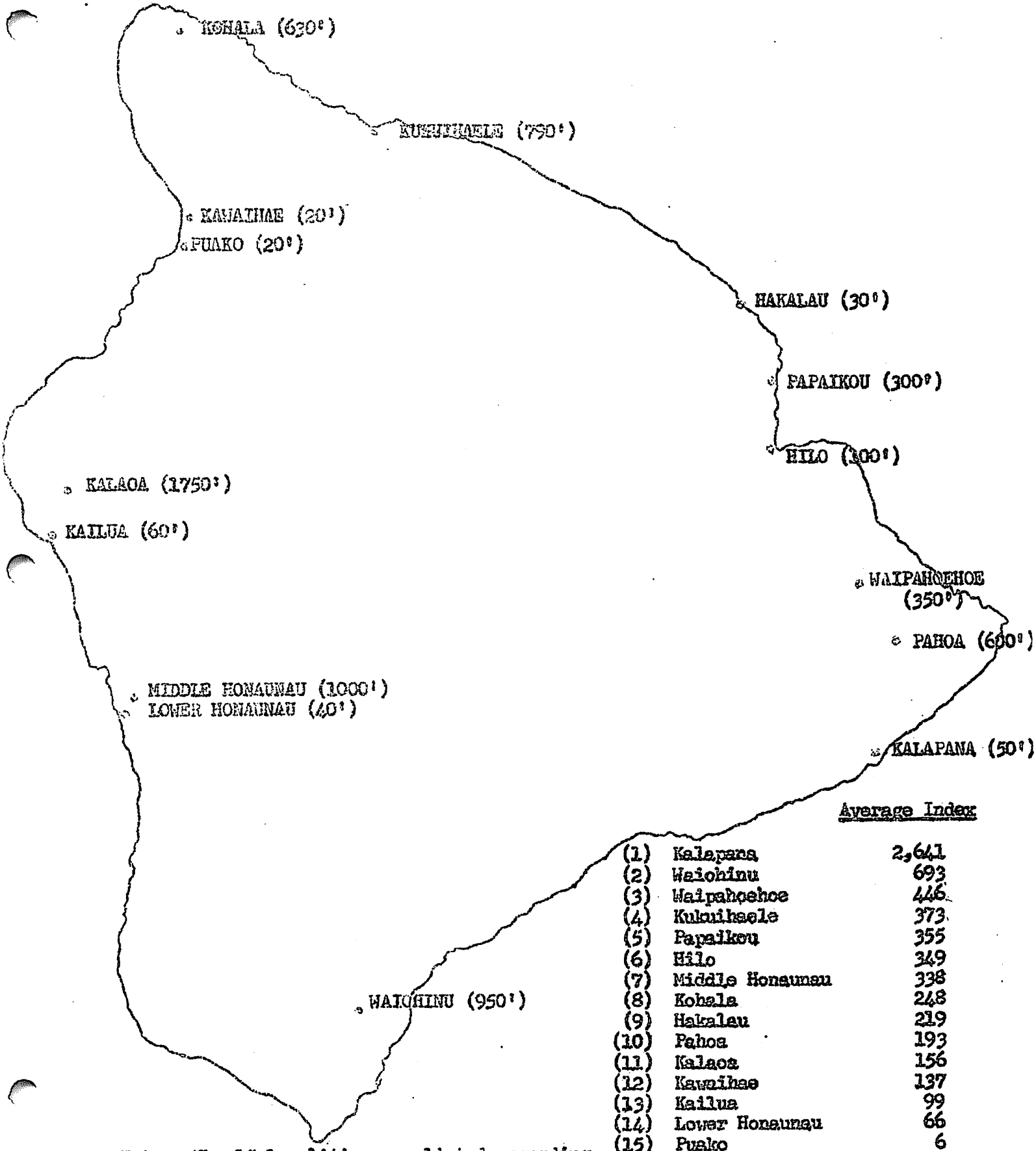
POPULATION TRENDS IN HAWAII
Methyl Eugenol Traps
Flies Per Trap Day

STATION	ELEV.	JUNE'52	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.'53	FEB.	MAR.	AV. INDEX
Hilo	100'	540	511	110	83	232	222	263	600	739	220	349
Hakalau	30'	21	37	39	61	233	306	265	587	255	161	219
Kukuihaele	790'	89	39	16	19	56	87	126	1,547	765	431	373
Puako	20'	16	8	9	1	3	**	---	---	---	---	6
Kalaoa	1750'	3	8	109	88	60	66	2	282	543	270	156
Kailua	60'	56	36	48	44	174	132	106	100	90	168	99
Honaunau	40'	334	110	30	20	2	Trap screen stolen	14	61	49	100	66
Waiohinu	950'	96	224	252	302	578	553	525	846	1,307	1,673	693
Pahoa	600'	68	160	410	54	324	349	107	121	102	122	193
Kalapana	50'	2,189	1,323	848	1,766	3,698	2,865	2,043	3,061	3,922	3,996	2,641
Kohala	630'	---	---	---	---	---	* 206	341	260	196	212	248
Papaikou	300'	---	---	---	---	---	* 254	340	525	382	179	355
Waipahoehoe	950'	---	---	---	---	---	*2,127	688	248	177	86	446
Kawaihae	20'	---	---	---	---	---	76	124	147	181	159	137
Middle Honaunau	1000'	---	---	---	---	---	---	448	363	437	127	338
Av. Index		305	252	219	238	544	546	384	617	650	560	465

** Puako trap transferred to Kawaihae on October 14, 1952.
* Four additional traps installed November, 1952.

Fig. 1.— POPULATION DENSITIES ON THE ISLAND OF HAWAII

20-DAY METHYL EUGENOL TRAPS



		Average Index
(1)	Kalapana	2,641
(2)	Waiohinu	693
(3)	Waipahoehoe	446
(4)	Kukuihaele	373
(5)	Papaikou	355
(6)	Hilo	349
(7)	Middle Honaunau	338
(8)	Kohala	248
(9)	Hakalau	219
(10)	Pahoa	193
(11)	Kalaoa	156
(12)	Kawaihae	137
(13)	Kailua	99
(14)	Lower Honaunau	66
(15)	Puako	6

Note: The 15 localities are listed according to the highest average index (flies per trap-day) for a period of 10 months' trapping operations.