THE RAVAGES, LIFE HISTORY, WEIGHTS OF STAGES, NATURAL ENEMIES AND METHODS OF CONTROL OF THE MELON FLY (DACUS CUCURBITAE COQ.).

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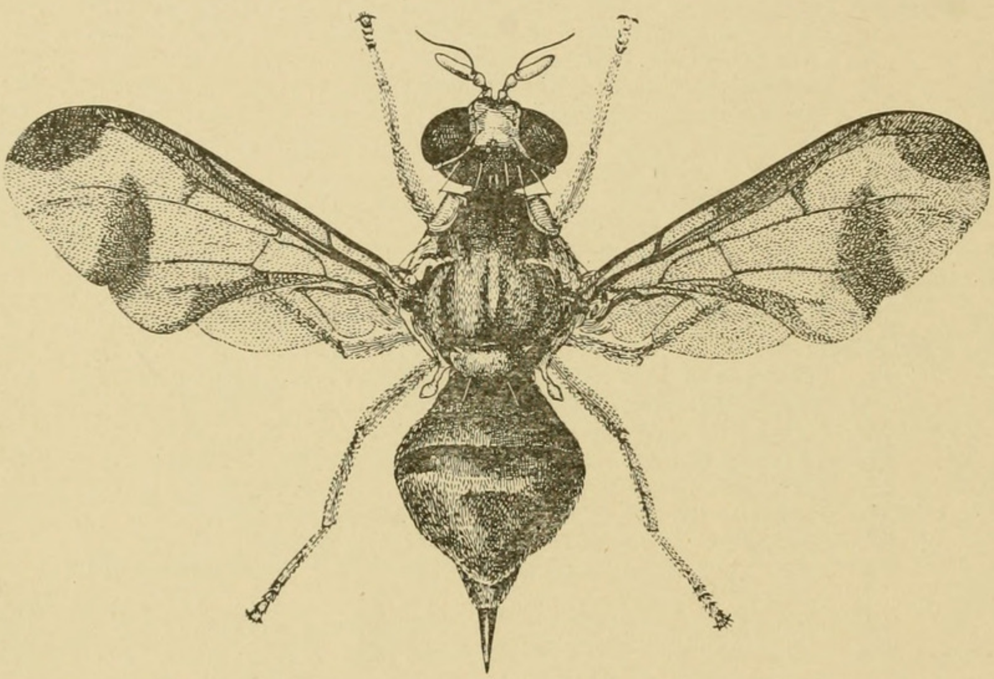
I. Introduction.

The most destructive pest of the Cucurbitaceæ in the Hawaiian Islands is commonly called the Melon Fly (Dacus cucurbitæ Coq.) or the Bitter Gourd Fruit Fly in other parts of the world. Previous to the accidental introduction of this insect into Hawaii, melons were sold at ten cents each, but today the consumer often pays from fifty cents to one dollar for a watermelon. It has been estimated that the loss in the Hawaiian Islands amounts to almost a million dollars annually, in tribute to this fly, or a little over five cents a day for a family

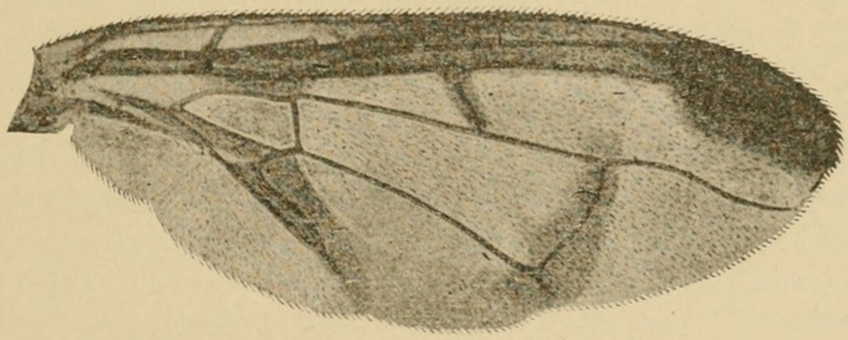


Text Fig. 1. Melon fly, Dacus cucurbitæ Coq. (After Perkins).

of four, on an estimated population of 192,000. When one stops to consider that the Hawaiian Islands are smaller than the state of Rhode Island, that the principal agricultural products are sugar, pineapples, coffee and rice, one realizes what a tremendous amount of injury this fruit fly causes to the limited vegetable crops grown in the islands. This trypetid has been allowed to play havoc unmolested for a period of sixteen years or more, so that today in many localities swarming with the pest, barely do the seeds of some cucurbits germinate, when the seedlings are "stung" by the flies; the larvæ which hatch from the eggs devour the tissue of the stems and cause decay, then the maggots penetrate into the roots and completely destroy the plants.

II. Native Home.

Some difference of opinion exists as to the native home of the melon fly. Muir (5, p. 17) "found that India was its original home" and later on, Froggatt's (5, p. 17) investigations showed that the melon fly was widely distributed over India and also Ceylon. Perkins (10, p. 36) believes "its true home is no doubt in China or Japan." In a map showing the fruit fly regions with steamship connections to California, Compere (2, p. 728) records the danger of introducing the pest into that state from the following sea ports: Hawaiian Islands, Timor, Manila, Nagasaki, Hongkong, India and Singapore. Compere claims that this pest is rarely found in the Philippine Islands and he informed the writers that the melon fly was originally native of these islands. It was imported from one of the above mentioned countries into the Hawaiian Islands about the year 1897.



Text Fig. 2. Wing of melon fly. (After Froggatt).

III. Description of Melon Fly.

The melon fly is wasp-like in its general shape and behavior and resembles a hornet (Polistes) somewhat in color but is less than half as large. The head is yellow in color; the thorax is reddish yellow marked with a number of light yellow areas and the abdomen is yellow on the first two segments and reddish-yellow on the others. At the base of the second, abdominal segment is a transverse black line, which unites with a black, dorsal, median line on the next three segments. A lateral, brown spot is usually present on the fourth and fifth segments. The transparent wings are marked with brown bands. A brown band extends along the front margin of each wing and ends in a large spot at the apex; another brown band extends along a fold of the wing near the body; between the distal ends of these bands is a transverse marking (Text fig. 2). The legs are light yellow in color.

Compere (2, p. 710) recognized the melon fly as a new species in Hawaii and sent specimens to Coquillet (3, pp. 129-130) whose original description follows:

"*Dacus cucurbitæ.*—Head light yellow; the occiput, except the sides and upper margin, reddish-yellow, an ocellar black dot, front marked with a brown spot in front of its centre, and with three pairs of orbital brown dots, a black spot on each side of the face near the middle, and a brown spot on the middle of each cheek; antennæ, palpi, and proboscis yellow, the latter mottled with brown; thorax, reddish-yellow, the humeri, a median vitta on the posterior half of the mesonotum, another on each side, above the insertion of the wings, uniting with an irregular band which extends upon the pleura to the upper part of the sternopleura, also a large spot on each side of the metanotum, encroaching upon the hypopleura, light yellow; scutellum, except its extreme base, light yellow, bearing two bristles; abdomen light yellow on first two segments, reddish-yellow on the others, the extreme base, a fascia at the bases of the second and third segments, usually a lateral spot on the fourth and fifth, also a dorsal vitta on the last three segments, blackish or brownish; first segment of the ovipositor of the female slightly longer than the fifth segment of the abdomen. Wings hyaline, the apex of the subcostal cell, from a short distance in front of the apex of the auxiliary vein, the marginal and submarginal cells, the median third of the first basal cell, and a large spot in upper outer corner of the first posterior cell, brown, this colour encroaching on the third posterior cell and bordering the sixth vein almost to its apex; posterior cross vein bordered with brown, this colour extending to the hind margin of the wing; upper end of the small cross vein is also bordered with brown. Halteres light yellow. Legs light yellow, the broad apices of the femora and the last four joints of the tarsi reddish-yellow; hind tibiæ reddish-yellow or dark brown. Length, 6 to 8 mm. Type No. 4,207 in the United States National Museum."

IV. Field Observations in a Pumpkin Patch.

Casual observations on the injuries caused by the melon fly have been put on record but no intensive study of its destructive work has as yet been published. In our work careful examinations were made of different parts of pumpkin plants to ascertain the following points: (1), where the pest deposits

its eggs under natural conditions; (2), the external indication of egg deposition and (3), the injury caused by the larvæ. Observations were also noted on other host plants injured by this fruit fly, but these were not so extensive as those made on pumpkin plants.

1. *Oviposition in stems of pumpkin vines.*—The melon fly often deposits its eggs in the stems of cucurbit seedlings. In pumpkin vines the eggs are often laid within the tender stems near the growing ends (plate XXVII, fig. 3), but the pest is not able to puncture the older and tougher stems with its needle-like ovipositor. A gummy substance exudes from the wound and hardens in the form of a small, resinous lump on the stems (plate XXVII, figs. 1 and 2).

2. *Oviposition in petioles of leaves.*—Occasionally the melon fly deposits its eggs within the petioles of the leaves. The external indication of oviposition, as in the case of the stems, is shown by the resinous material which accumulates at the region where the petiole was punctured by the ovipositor.

3. *Oviposition in pumpkin flowers.*—Eggs were found on the outer and inner surfaces of the corolla and its lobes (plate XXVII, figs. 4 and 7). When the melon fly oviposits on the inner surface of a corolla, it punctures the closed flower, glueing the eggs either at one end in a mass or scattering them loosely on the inner surface of the corolla and its lobes. At that region where the flower has been punctured it becomes discolored (plate XXIX, figs. 20 and 21).

Dacus often oviposits within a receptacle formed by its ovipositor in the anthers or column of the stamens of the staminate pumpkin flowers. More often, however, eggs are deposited in the tissue of the cup-shaped disc formed by the union of the calyx and corolla, or the eggs are simply dropped loosely into this cup-shaped disc. Occasionally, the eggs may also be found within the peduncle of the staminate flowers.

The pest also deposits its eggs in the stigmas and styles of the pistillate flowers. The trypetid does not enter the male or female pumpkin flowers to lay its eggs, but punctures the corolla from the outside with its ovipositor. Wherever the ovary of the pistillate flower has been "stung" by the female fly, a resinous material covers the wound (plate XXIX, fig. 18). Within the ovary, the ovipositor forms a small receptacle in which the eggs are laid (plate XXVII, figs. 5 and 8). Eggs are often deposited in the constriction between the perianth and ovary, as is shown by the resinous substance found frequently in this region (plate XXIX, fig. 19).

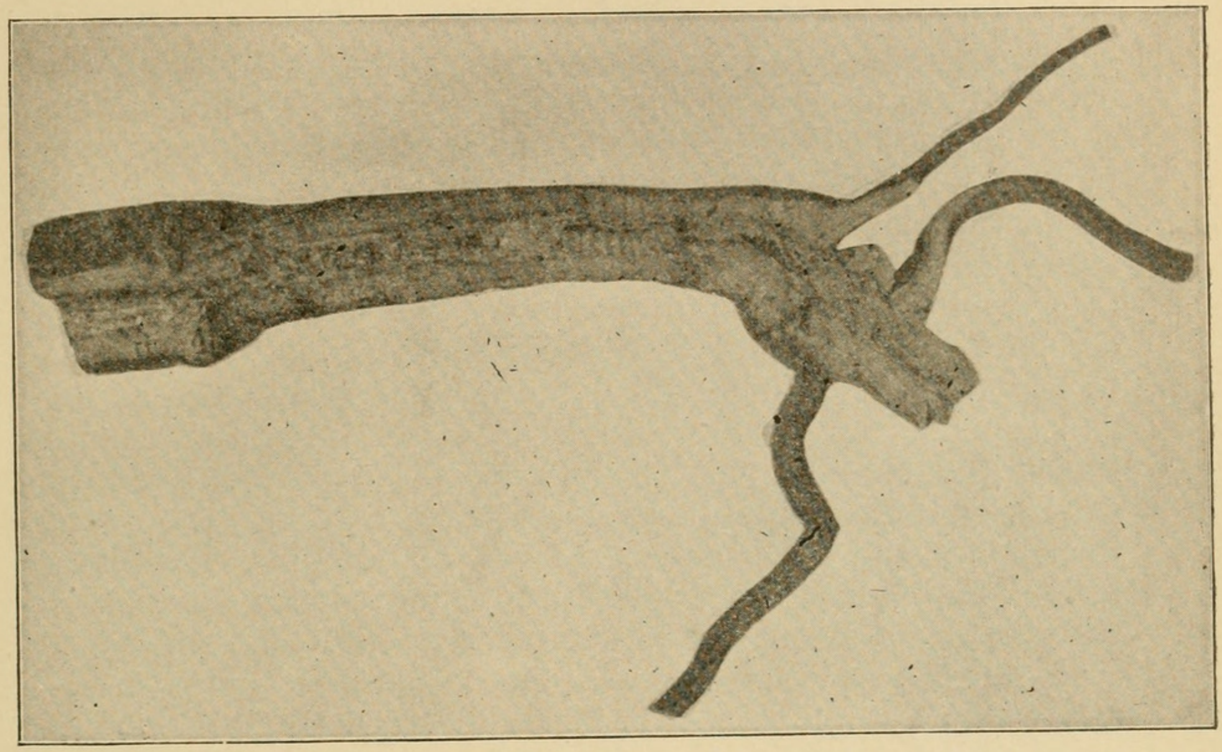
Green staminate and pistillate buds are often "stung" by the fly, the eggs being laid in the various parts of the unopened flowers (plate XXVII, fig. 6), as has just been described for the mature flowers.

4. *Oviposition in pumpkins*—The trypetid deposits its eggs in small, green pumpkins, but the larger, uninjured pumpkins are immune from the attacks of the pest, because the fly is unable to pierce a hard rind with its ovipositor. If, however, the rind of a large pumpkin has been injured, the fruit fly will lay its eggs within the wound. The insect will oviposit in an exceedingly small hole extending through the resinous substance of a healed wound, such as is often due to a previous infestation by the pest (plate XXVIII, fig. 10). On a pumpkin in the field, eighteen melon flies were counted with their ovipositor inserted within a crack extending through the resinous exudation of such a wound and new arrivals were coming continuously to oviposit in the same place. At the end of that day the resinous material was removed, and hundreds and hundreds of eggs were found closely packed in the pulp beneath the crack.

After the melon fly "stings" the unripe pumpkin and squash, the tissue surrounding the receptacle in which the eggs are laid is killed, probably by a secretion which the fly pours over the eggs. In the further development of these cucurbits a depression results (plate XXVIII, figs. 9, 11 and 12) wherever oviposition has occurred. Small pumpkins which have been "stung" repeatedly, may assume all sorts of abnormal shapes in their further growth (plate XXVIII, fig. 12).

5. *Injury to stems.*—The recently hatched larvæ devour the tissue of the tender stems of young cucurbits and cause decay, then they penetrate the roots and destroy the plants entirely. Several acres of watermelons under observation were replanted a number of times and, without exception, every plant was destroyed in this way. The maggots often destroy the terminal shoots of old pumpkin vines by penetrating from one internode to another and feeding on the tissue of the tender stems. A yellowish substance, probably the excrement of the pest, stains the undevoured fibrous tissue of the stems. No maggots were found in the old stems or roots.

The old stems of the pumpkin vines are often infested with the larva of a Cerambycid (Apomecyna pertigera) which is able to penetrate through the hard nodes. More often, however, this beetle larva was found in the roots of the pumkin plant (Text fig. 3.)



Text Fig. 3. Root of a pumpkin vine split open lengthwise showing the larva of a Cerambycid (Apomecyna pertigera) which feeds on the tissue of the roots and occasionally of the stems.

6. *Injury to petioles.*—Melon fly larvæ, which had recently hatched, were found within the petioles of leaves, but nearly, full-grown maggots were never observed within this part of the plant. In order to ascertain whether the pest could complete its larval period within a petiole, ten maggots of different sizes were placed within a half dozen leaf-stalks. All of the larvæ obtained sufficient nourishment from the wall of the petioles to complete their development. While most of the maggots bored out of the petioles to pupate, others pupated within the leaf-stalks close to the node of the stem.

7. *Injury to flowers.*—The larvæ that hatch from the eggs deposited in the anthers, first feed upon and destroy these structures (plate XXIX, fig. 28); then they may eat out the

column of the stamens (plate XXIX, fig. 29); next the pests may work their way down into, and entirely destroy the cup-shaped disc beneath the column and finally they may penetrate into the long peduncle. The flower often drops from its stalk (plate XXIX fig. 30) on account of a decay which follows an infestation. The wall of the peducle is now eaten until only a thin, papery envelope remains, which encloses a yellowish substance similar to that observed in the infested stems. No evidence was found that the larvæ pass through the node which shuts off the hollow peduncle from the stem, but at this node puparia were occasionally found.

In the pistillate flowers the larvæ devour the stigmas and styles, leaving a decayed mass to which the corolla clings. The maggots then descend into the ovary and often the withered corolla becomes detached (plate XXIX, fig. 25) and drops to the ground, leaving a black, flower scar (plate XXIX, fig. 22). As the ovary is devoured, decay sets in, the pulp becomes spongy (plate XXIX, figs. 23 and 24) and the channels are filled with wriggling maggots. After the larvæ bore out, the ovary turns black and either detaches from the pumpkin vine (plate XXIX, fig. 27) and drops to the ground, or remains adhering to the vine as a dried, shriveled mass (plate XXIX, fig. 26).

8. *Injury to pumpkins.*—A green pumpkin which is infested with a small number of melon fly larvæ may continue to grow after the maggots have bored out, but when attcked by a large number of the pest, the pumpkin turns black and decays. After the larvæ have bored out of a green pumpkin, the wound becomes covered by a gummy substance (plate XXVIII, fig. 10). During the further development of this cucurbit, the resinous material often cracks and a second oviposition may occur in the crevices. If a ripe pumpkin is reinfested with a large number of maggots a rapid decay changes the pulp into a semi-liquid mass possessing a most sickening rancid odor. The rind may now collapse (plate XXVIII, fig. 15), and the thick, liquid contents then oozes out. After the maggots bore out, only the rind containing the seeds remains. A glance at plate XXVIII, figures 13 and 14, shows the remains of two pumpkins which were turned over to show the side that had been resting on the ground. In such cases the seeds drop to the ground and often germinate. When a ripe pumpkin is reinfested with a small number of larvæ the rind does not collapse (plate XXVIII, fig. 16) and the seeds within the semi-liquid pulp may then decay.

9. *Injury to string beans.*—An examination was also made of the injury which the melon fly larvæ cause to the seeds and pods of green-podded string beans. It was found that the maggots feed upon the seeds and also the fleshy part of the pods (plate XXX, figs. 31 and 32). After these portions have been consumed the inner surfaces of the pods turn black (plate XXX, fig. 33).

Dead Dacus larvæ were found within the seeds and pods of string beans. Sometimes the dried bodies of the maggots were found protruding from the pods (plate XXX, fig. 39); these evidently died in the process of boring out of the host. Pupation, which normally occurs in the ground, often takes place within the dried pods (plate XXX, figs. 36 and 37).

V. Food Plants.

In the Hawaiian Islands the melon fly has been bred from the following food plants:

VEGETABLES.	FRUITS.
Cucumber	Mango. Bred by Terry (11, p. 32).
Egg Plant	?Orange. Bred by Ehrhorn (4, p. 337).
Kohlrabi	Papaya.
Muskmelon.	
Pumpkin.	
Squash.	
String bean.	
Tomato.	
Watermelon.	
Wild cucurbit (Sycos sp.). Bred by Van Dine. (11, p. 32).	

In India, Froggatt (5, p. 18) bred Dacus cucurbitæ from melons, bitter gourds and egg plants.

10. *Number of melon flies bred from the food plants.*—To determine whether the pest could obtain sufficient food material from the corolla of pumpkin flowers to complete the larval development, the corolla was removed from six staminate flowers in the field and each corolla was then placed in a breeding jar together with recently, hatched, melon fly maggots. The larvæ during their development obtained no other food than that furnished by a single corolla. One male and one female melon fly succeeded in completing their life history on this food supply.

An experiment was now performed to determine the number of melon flies which could be bred from an entire staminate flower including its long peduncle. A dozen, infested, staminate flowers were cut from pumpkin vines in the field and placed in twelve breeding jars. The following figures indicate the number of adults which were reared from each flower: 10, 14, 19, 23, 24, 25, 31, 32, 33, 37, 63 and 64; a total of 375 or an average of 31 flies for each flower.

A similar experiment was performed with a half dozen pumpkins. The cucurbits were of different sizes and were taken from the field and placed in separate breeding jars. The following figures show the size of the pumpkins and the number of adults reared from each.

From a pumpkin 2½ inches long,	277 melon flies were bred.
From a pumpkin 3 inches long,	183 melon flies were bred.
From a pumpkin 3½ inches long,	378 melon flies were bred.
From a pumpkin 3½ inches long,	464 melon flies were bred.
From a pumpkin 4 inches long,	637 melon flies were bred.
From a pumpkin 4¾ inches long,	283 melon flies were bred.
	2222 total.

From twelve, infested, green-podded string beans gathered in the field, the following number of melon flies were reared: 4, 7, 11, 11, 12, 14, 15, 15, 16, 16, 18 and 26; a total of 165 or an average of 13 flies for each pod.

VI. Life History.

Although the melon fly has been very destructive during the past sixteen years in Hawaii, the duration of the different stages of its life history have never been determined. Clark (1, p. 6) makes the following statements on the life history of this pest. The fly "stings" not only the fruit with its ovipositor, but also the young and tender growth of the vines, depositing a number of eggs, which soon hatch into small, white maggots that feed on the tissues of the fruit causing it to decay. After the maggot has attained its growth, it descends into the soil where it develops into a small chrysalis of a light, yellowish brown color, and in about ten or twelve days comes out a perfect insect, ready to repeat its mission of destruction. I do not know how many generations it will produce in a year, but in the warmer and drier districts I believe it will breed the year through, except possibly a while during the winter months, and then its development is only retarded by the cooler weather, which prevents the chrysalis maturing so rapidly."

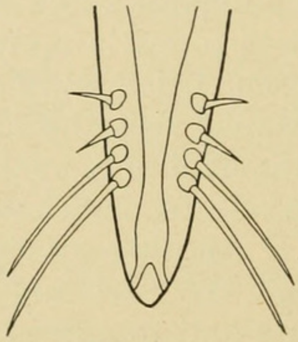
Van Dine (11, pp. 32-34) gives the following contribution on the life history of the melon fly: The life history covers a period of about three weeks. The number of eggs which the female deposits varies from 5 or 6 to as many as 15. After hatching from the egg, the larvæ burrow into the tissue of the melon and feed on the interior. When fully developed the larvæ leave the infested melon or vine and enter the soil directly beneath, where at a distance of an inch or so from the surface they pupate.

Marsh (9, p. 156) writes, "In the insectary an effort was made to work out the life history of this fly, but little progress was made owing to the fact that the cages in which the specimens were confined were too small."

11. *Methods of inducing oviposition.*—Various methods were adopted to induce melon flies to lay their eggs in different food plants placed in a pumpkin patch swarming with the pest. One method followed was to cut a non-infested, ripe pumpkin in half and the trypetids which were probably attracted by the odor of the pulp, would visit the cut surfaces and deposit their eggs. Even the removal of a small piece of the rind from a pumpkin or squash would be sufficient to attract and induce the insects to oviposit. Another method used was to make a semicircular cut through the peel and pulp near the surface of cucumbers, egg plants and tomatoes and the loose flap was then pinned back like a lid. After the females had deposited their eggs in the pulp, the lid-like peel was pinned into its normal position again, thus covering the eggs.

In one experiment about a square inch of the rind of a pumpkin was removed and in a short time melon flies began to visit the injured vegetable. The flies wandered about upon the rind until they found the exposed pulp, when they began to feed upon the exuding juices. At times as many as twenty-five specimens were clustered together in this small area. So closely crowded were the insects that their wings, which are usually held at almost right angles to the long axis of the body, overlapped. More and more individuals were attracted to the cut area until the newcomers were actually forced to walk over the bodies of the earlier arrivals, some of which were now laying eggs without apparently being disturbed, for the ovipositor was not withdrawn.

12. *Tactile bristles of the ovipositor.*—The melon fly often seeks a suitable place wherein to oviposit by walking about on the cucurbit with the tactile bristles at the end of the ovipositor (Text fig. 4) in contact with the rind. These tactile bristles probably assist in locating a hole in the rind, or possibly discriminate between hard and soft surfaces. One specimen was observed with its ovipositor inserted within a pin hole which was made in a pumpkin and another female fly in orienting itself over this wound, would take a step or two backwards, grope around with the tactile bristles and finally push the ovipositor into the same hole. When a piece of the rind has been removed the flies apparently seek a soft area in the pulp with the tactile bristles of the ovipositor. The fruit flies will readily locate and oviposit in a slit which has been cut in the pulp.



Text Fig. 4. Distal end of the ovipositor of Dacus cucurbitæ showing the tactile bristles.

13. *Process of oviposition.*—The process of oviposition can readily be observed in the field with a hand lens. When once the fruit fly has found a suitable place, the abdomen is bent at right angles to the long axis of the body and then the distal, needle-like part of the ovipositor moves up and down in the proximal, tube-like portion. As the ovipositor is forced into the food plant, the female, in endeavoring to get a firmer foot-hold, will let go with the tarsi and claws of the middle and hind legs and grasp a new hold. The tube-like, proximal portion is thrust deeper and deeper until it disappears entirely and the eggs are then deposited. If, however, this tube has not been pushed entirely into the host plant, the eggs can actually be seen gliding through the ovipositor at the rate of one in about every fifteen or thirty seconds. Two specimens were timed during oviposi-

tion and it required seven and nine minutes respectively to complete the egg laying period.

14. *Number of eggs deposited in a receptacle.*—The number of eggs which the pest lays within a receptacle varies from one to forty. The insect often punctures various parts of the host plant with its ovipositor and yet does not deposit any eggs.

15. *Number of ripe eggs in ovaries.*—In order to ascertain the number of ripe eggs present in the ovaries, eighteen melon flies were captured in the field and dissected. The average number of mature eggs found in the two ovaries was forty-eight; the largest number of fully-developed eggs dissected from one specimen was seventy-four and the smallest number obtained from an individual was twenty-two. The number of eggs which one female is able to lay during its natural life was not determined.

16. *Duration of the egg, larval and pupal periods.*—After melon flies had been induced to oviposit in pumpkins, squash, egg plants, tomatoes, cucumbers and string beans in the field, the vegetables were transferred to breeding jars and a careful record was taken of the different periods of the life history. The following table shows the duration of the egg, larval, and pupal periods of Dacus:

TABLE I.

DURATION OF THE EGG, LARVAL, AND PUPAL PERIODS OF DACUS CUCURBITÆ.

Host	Egg period (hours)	Larval period (days)	Pupal period (days)
Pumpkin	30	4–7	10–13
Squash	32	5–7	11–14
Egg plant	31	5–11	12–14
Tomato	36	5–8	12–13
Cucumber	33	5–9	12–14
String bean	31	5–10	11–12

17. *The effect of temperature on the egg period.*—Pumpkins containing eggs which had been recently laid were exposed to the hot sunshine, while others were kept in the shade under field conditions, but no marked difference in the duration of the egg period was observed.

18. *The effect of decay of food on the rate of development of the larvæ.*—One important factor upon which the rate of development of the melon fly larvæ depends, is the rapidity of decay of

the host plant which follows an infestation of the pest. A large number of maggots in a ripe pumpkin cause decay more rapidly than a smaller number in a similar host of the same size. The following table shows a comparison of the rate development of the pest in rapidly and slowly, decaying, food plants:

TABLE II.

COMPARISON OF THE RATE OF DEVELOPMENT OF THE MELON FLY LARVÆ IN RAPIDLY AND SLOWLY DECAYING HOSTS.

Rapidly decaying hosts	Number of larvæ	Larval period (days)	Slowly decaying hosts	Number of larvæ	Larval period (days)
Pumpkin	211	3¾	Pumpkin	1	4
	201	4¾		52	5
	55	5¾		26	6
	6	6¾		8	7
				1	8
Egg plant	4	5	Egg plant	4	8
	11	6		45	9
	16	7		11	10
	38	8		1	11
Cucumber	2	5	Cucumber	6	9
	14	6			

It is possible that the rapid decay of vegetables is caused not only by the enzymes secreted by bacteria, but also by the enzymes of the saliva of the melon fly larvæ. The enzymes change the pulp into a thick liquid and it may be possible that the maggots absorb some of this food directly through the body wall. Larvæ swallowing and possibly absorbing liquified food probably would require less time to complete their development than maggots feeding upon solid food.

19. *The effect of drying food on the larvæ.*—In string beans which gradually dry up during an infestation, there is a marked individual variation in the growth of the melon fly larvæ, even when hatched from the same batch of eggs. In a dried, bean pod the larval period is longer than in a decaying one. In the laboratory the maggots often died in the seeds and the pods of dried string beans, a fact that was also observed in the field. In all probability, these larvæ died from lack of moisture due to the drying up of the string beans.

20. *Respiration of larvæ in liquified pulp.*—Melon fly larvæ in a decayed tomato were observed to obtain a fresh supply of air by pushing the posterior spiracles above the surface of the liquified pulp. The stem of this tomato had been cut out and many maggots were found suspended from the surface film with their bodies immersed in the liquid. When the finger was snapped against the tomato, the larvae wriggled down into the liquified pulp, but sooner or later, they would come up to the surface film to breath.

21. *Jumping habit of larvæ.*—When nearly, full-grown, melon fly larvæ are removed from the host, they exhibit a peculiar habit of jumping, but this behavior is not manifested by the smaller maggots. The larvæ curl the body in a circle (plate XXVIII, fig. 17), the jaws attach to the posterior end of the body, and then by a sudden muscular relaxation, they spring about six to eight inches into the air.

22. *Feeding habits of the melon flies.*—As a rule, Dacus feeds during the early morning from sunrise to about ten o'clock. During the hottest part of the day thousands of these insects may be found at rest under large leaves of plants in or near an infested field of cucurbits. The flies were frequently found several hundred feet away from their breeding grounds, feeding upon the flowers of the glue bushes, sunflowers and Chinese bananas. Not a single fruit fly was ever seen entering and feeding within the carolla of pumpkin flowers or morning glories, but after a rain, specimens were occasionally observed lapping up the small droplets of water on the lobes of the corolla of morning glories. Melon flies feed upon the juices of injured or infested cucurbits in the field. Many individuals were observed feeding on the juices exuding from sweet corn. One adult was noticed feeding on a dead and partly decomposed caterpillar.

When a piece of the rind of a pumpkin was removed, large numbers of the pest were attracted to the exposed pulp and fed upon the exuding juices. When a common house fly also visted the pulp to feed and approach a melon fly already enjoying a meal, the latter would dart forward and chase the former away, but when laying eggs the fruit fly would not withdraw its ovipositor even when the house fly crawled over its body.

23. *Do melon flies manifest fear?*—A melon fly is keenly aware of movements within its field of vision. When a large Odonata flies above a melon fly at rest on a cucurbit, the trypetid may tilt its head to follow the flying insect with its eyes. When one approaches a pumpkin slowly and carefully upon which a specimen is feeding, the fly may tilt its head and sway its body from side to side by bending the legs at the tibio-femoral joints. At such times a slight movement on the part of the observer will cause the fruit fly to take wing. The swaying movements of the alert insect may possibly be interpreted as an external indication of fear. Howlett (7, pp. 415-416) believes that this swaying movement "seems to be associated with 'courtship' in all species of Dacus that occur at Pusa." When the head of Dacus cucurbitæ is lowered, however, and the insect walks about with the wings held almost at right angles to the long axis of the body one can then approach the pest without danger of causing flight.

24. *Number of days required before the adults begin to oviposit.*—An attempt was made to determine the number of days required before the egg-laying period begins, after the melon flies issued from the puparia. A large number of adults upon emerging, were kept in breeding jars and fed on diluted molasses, fruit and vegetable juices and on water. After having been kept in captivity for eight days, three females were dissected but no fully-developed eggs were found in the ovaries. A daily dissection of three fruit flies was continued from now on, and at the end of fourteen days twenty-three ripe eggs were counted in the two ovaries of one fly, but others did not show mature eggs in the ovaries at the end of sixteen days. At the end of seventeen days, thirty-one eggs were dissected from the ovaries of another specimen. In all probability, the effect of confining the insects in breeding jars plays an important part in the rate of development of the eggs.

25. *Summary of stages of the life history.*—The duration of the different stages of the life history of Dacus cucurbitæ may be summarized as follows:

	DAYS	
Egg period	1¼— 1½	
Larval period	3¾—11	
Pupal period	10 —14	
Egg laying begins	14 —17	after the adults emerge.
	29 —43½	

26. *Number of generations annually.*—In the Hawaiian Islands one brood of melon flies is followed by another throughout the year. Since the duration of the complete life cycle may vary from twenty-nine to forty three days, one would expect from eight to twelve generations a year. Assuming that a single female produces only ten descendants and that the sexes are produced in equal numbers at the end of the year she would be the ancestor of from 100,000,000 to 1,000,000,000,000 offspring.

VII. Weights of the Eggs, Larvae, Puparia and Adult Melon Flies.

Accurate weighings of the following stages in the life history of Dacus cucurbitæ were taken: eggs (plate XXXI, fig. 46) a few hours after these were deposited and again shortly before hatching; larvæ after hatching and every day thereafter (plate XXXI, figs., 47 and 52); recently, formed puparia (plate XXXI, fig. 53) and male and female melon flies.

Pumpkins, in which melon flies had been induced to deposit their eggs, were taken from the field to the laboratory and three hours after oviposition, the eggs were removed and counted in two lots, each containing one hundred eggs. Each batch of eggs was placed upon a small piece of filter paper and weighed in a weighing bottle. The eggs were then transferred from the filter paper into a pumpkin and twenty four hours later, the same eggs were removed and weighed again. The weights of the eggs three hours and twenty-seven hours after deposition were as follows:

TABLE III.

WEIGHT IN MILLIGRAMS OF EGGS OF DACUS CUCURBITÆ AFTER DEPOSITION, BEFORE HATCHING AND LOSS IN WEIGHT.

	3 hrs. after deposition	27 hrs. after deposition	Loss in wt. in 24 hrs.
Wt. of first 100 eggs....	7.2	6.	1.2
Wt. of second 100 eggs..	7.5	6.1	1.4
Average wt. of 1 egg...	.0735	.0605	.013

The result shows that each egg on an average, lost .013 milligrams in weight, during the twenty-four hours between the two weighings.

After the second weighing, the first lot of one hundred eggs was put back into the pumpkin and the second batch was placed between moist filter paper. These lots hatched respectively in thirty and thirty-two hours after deposition. The hatching of the first batch of eggs was observed under a binocular microscope in order to remove the larvæ before they had an opportunity to feed. The weight of the maggots and the difference in weight between the eggs and larvæ are recorded in the following table:

TABLE IV.

WEIGHT IN MILLIGRAMS OF RECENTLY HATCHED LARVÆ OF DACUS CUCURBITÆ, AND DIFFERENCE IN WEIGHT BETWEEN EGGS AND LARVÆ.

Wt. of 100 recently hatched larvæ		Difference in wt. between eggs and larvæ	
		3 hrs. after deposition	27 hrs. after deposition
Hatched from first 100 eggs	4.2	3.	1.8
Hatched from second 100 eggs	5.6	1.9	.5
Average wt. of 1 larva	.049	.0245	.0115

The two hundred, recently hatched maggots weighed one-third less than the eggs after deposition and about one-fifth less than the eggs before hatching. This loss can be attributed, in part, to the shedding of the chorion and vitelline membrane.

The one hundred larvæ which hatched from the first batch of eggs were fed upon a hard, dry pumpkin while the other one hundred maggots were fed on a soft, juicy pumpkin. The following table shows the weights of the larvæ after they had fed a day.

TABLE V.

WEIGHTS IN MILLIGRAMS OF LARVÆ OF DACUS CUCURBITÆ FED UPON A HARD, DRY PUMPKIN AND A SOFT, JUICY PUMPKIN.

	Fed on dry, hard pumpkin	Fed on soft, juicy pumpkin	Difference in wt.
Wt. of 100 larvæ 1 day old	26.6	63.6	37.
Wt. of 1 larva 1 day old	.266	.636	.37

It is evident from this table that the larvæ which fed on the soft, juicy pumpkin for one day weighed over twice as much as the maggots which fed on the dry, hard pumpkin. Furthermore, the former had increased their initial weight over eleven times and the latter over six times at the end of one day.

Fifty of the one hundred larvæ which fed on the soft, juicy pumpkin were weighed at intervals of one day throughout their larval life. In order to remove all of the pulp, which adhered to the bodies of the maggots, they were carefully washed and dried with filter paper before each weighing. The following table shows the daily increase in weight of the larvæ, daily increase over the initial weight, and increase or decrease of weight over the previous day:

TABLE VI.

DAILY INCREASE IN WEIGHT, DAILY INCREASE OVER THE INITIAL WEIGHT AND INCREASE OR DECREASE IN WEIGHT OVER THE PREVIOUS DAY IN MILLIGRAMS OF THE LARVÆ OF DACUS CUCURBITÆ.

Age of larvæ	Wt. 50 larvæ	Wt. 1 larva	Increase in wt. of 1 larva over initial wt.	Increase or loss of wt. of 1 larva over previous day
At hatching.	2.8	.056		
1 day.....	31.8	.636	.58	.58 increase
2 days....	101.2	2.024	1.968	1.388 "
3 days....	801.6	16.032	15.976	14.008 "
4 days....	1021.7	20.434	20.378	4.402 "
4½ days....	1004.3	20.086	20.03	.348 loss

The daily increase in weight over the initial weight may be stated as follows:

After feeding 1 day a larva weighs 11.3 times its initial weight.

After feeding 2 days a larva weighs 36.1 times its initial weight.

After feeding 3 days a larva weighs 286.2 times its initial weight.

After feeding 4 days a larva weighs 364.8 times its initial weight.

After feeding 4½ days a larva weighs 358.6 times its initial weight.

The minimum increase over the initial weight occurred during the first day of the larval life and the maximum increase took place during the third day.

The daily increase or decrease in weight over the previous day may be put as follows:

The first day a larva acquires 10.3 times the weight at hatching.

The second day a larva acquires 2.1 times the weight of the first day.

The third day a larva acquires 6.9 times the weight of the second day.

The fourth day a larva acquires .27 times the weight of the third day.

In 4½ days a larva lost .017 times the weight of the fourth day.

The minimum increase in the daily weight of the larvæ over the previous day occurred during the fourth day and the maximum increase took place during the first day. During the last twelve hours of the larval period, the maggots decreased in weight. In all probability, this loss may be attributed in part, to the evacuation of the contents of the alimentary canal previous to pupation.

After the fifty larvæ bored out of the pumpkin in 4½ days they were allowed to pupate in moist sand. Twelve hours later the sand adhering to the newly-formed puparia was washed off and the moisture adhering to them was absorbed with filter paper. After the puparia were thoroughly dried they were weighed in a weighing bottle. Other melon fly maggots which bored out of pumpkins in 3¾ and 4 days were weighed, and twelve hours later the newly-formed puparia were weighed. The following table shows the average weights of the mature larvæ, the puparia twelve hours after the larvæ bored out of the pumpkins, and the loss in weight after pupation:

TABLE VII.

AVERAGE WEIGHTS IN MILLIGRAMS OF MATURE MELON FLY LARVÆ, WEIGHTS OF THE PUPARIA TWELVE HOURS AFTER THE LARVÆ BORED OUT OF THE PUMPKINS AND THE LOSS IN WEIGHT AFTER PUPATION.

Age of larvæ	Average wt. 1 larva	Average wt. 1 puparium	Loss in wt. after pupation	Loss in wt. %
4½ days.....	20.086	18.95	1.136	5.6
4 days.....	22.509	20.336	2.173	9.6
3¾ days.....	20.87	19.0534	1.8166	8.7

The results show that twelve hours after the melon fly larvæ bored out of the pumpkin and transformed into puparia, there was a loss of 5.6 to 9.6% in weight.

Is there a difference in weight of the male and female melon flies upon emerging from the puparia? The following table shows the weights of two lots of flies shortly after the wings were expanded:

TABLE VIII.

WEIGHTS IN MILLIGRAMS OF MALE AND FEMALE MELON FLIES SHORTLY AFTER EMERGING FROM THE PUPARIA.

Number of flies	Weight	Weight 1 fly	Difference in weight of a ♂ and ♀ fly
50♂	47.52	.9504	
50♀	48.9	.978	.0276
40♂	51.	1.275	
30♀	45.69	1.523	.248

It is evident from this table that the female melon flies are heavier, on an average, than the males shortly after they issue from the puparia.

VIII. Natural Enemies.

Predaceous insects sometimes prey upon the melon fly. At all times of the day the yellow dragon fly (Panatala flavescens Fab.) was observed flying over a pumpkin patch teaming with pest, and one would be inclined to believe that the melon flies are sometimes preyed upon by this predaceous insect. A number of dragon flies were captured in this field and the contents of their alimentary canal was examined, but no remains of the melon fly were found. A predaceous bug (Zelus peregrinus Kirkaldy) was observed sucking out the juices of a melon fly on a sunflower. Staphylinids or rove beetles were frequently seen within infested pumpkins but whether or not these feed upon the melon fly maggots was not determined.

The European, horn fly parasite (Spalangia hirta Haliday) was bred from the puparia of the melon fly. These puparia were gathered from beneath infested pumpkins; some of these puparia were partly exposed from the ground; while others were taken from one to four inches below surface of the soil, the usual depth, however, being one to two inches. From five hundred puparia which were collected on March 25, three parasites emerged on May 4, 1912. It is evident that this parasite is of little importance in the control of the melon fly.

IX. Methods of Control.

27. *Experiments in destroying infested vegetables.*—Van Dine (11, p. 35) formerly stationed at the Hawaiian Agricultural Experiment Station, recommends that all melons and vines infested with melon fly larvæ should be collected at intervals of five or six days and covered with earth to a depth of several inches.

A number of experiments were performed to determine the distance that melon flies, after issuing from the puparia, were able to burrow through sand and soil. In the first experiment several, hundred puparia were placed on two inches of dry, sterlized sand at the bottom of a cylindrical, museum jar (24x11½ inches) and this jar was then filled with more of the same kind of sand. A similar vessel, half filled with dry sand, was then inverted over the top of the above mentioned jar. This was done by placing a heavy, glass plate over the mouth of the jar to be turned upside down, inverting the same above the other vessel and then pulling the glass plate out from between the two jars. A similar experiment was conducted with wet sand which had been previously sterlized. The puparia in both experiments were arranged in a circle close to the wall of the jars so that when the fruit flies emerged and burrowed through the sand their paths might be seen. When the trypetids emerged, many would bore up to the region where the jars came in contact with one another and then escape through the small spaces between the jars. These small spaces were due to particles of sand which rested on the rims of the jars. One could scarcely believe that these large flies were able to flatten their bodies to such an extent as to squeeze through such small spaces as existed between the jars.

It was evident that some of the melon flies were not able to burrow as far as others, for many died at the upper end of the channels before obtaining their liberty (plate XXXI, fig. 45). Flies would frequently bore into an excavation made by other specimens and if the union of the channels would form a more or less circular path, some of the individuals would continue to burrow slowly round and round and finally die in this endless passage. Usually, however, most of the trypetids showed a definite orientation and bored directly upward. This negative reaction to gravity is common with many insects after emerging from the egg or pupa.

As there was a possibility that the melon flies might have been hindered by being against the glass, holes two and three feet deep were drilled in hard soil with a fence-post borer. At the bottom of these holes 500 puparia were placed. The puparia were then covered with sterlized dry or wet sand or soil. After these pits were filled each hole was covered at the surface with a large mouthed jar which rested tightly against the solid earth. The following table shows the number of melon flies which succeeded in boring through two and three feet of sand or soil:

TABLE IX.

NUMBER OF DACUS CUCURBITÆ WHICH BURROWED THROUGH TWO AND THREE FEET OF SAND OR SOIL.

Number of feet puparia were buried	2	3
Number of puparia buried in each hole	500	500
Number of flies that bored through dry sand	34	2
Number of flies that bored through wet sand	8	0
Number of flies that bored through soil	5	0

It is evident from this table that a larger number of melon flies were able to bore through dry sand than wet sand, and that very few specimens succeeded in making their way through the more lumpy soil.

Burying infested cucurbits and the vines in three feet of soil would require a considerable amount of labor. Lime, which is often thrown into the garbage-can to destroy the larvæ of the house fly and blue bottle fly, would probably destroy the melon fly maggots if it was buried in sufficient quantity with the infested vegetables, but this method would increase the cost.

In an experiment melon fly maggots were submerged in fresh water for a period varying from two to four days, in order to determine whether such larvæ would pupate and give rise to flies. Larvæ were selected which had bored out of a pumpkin and were ready to pupate. These maggots were submerged in seven inches of distilled water which was renewed daily. After remaining in the water for two, three or four days, the larvæ were transferred to filter paper and after pupation, the puparia were placed in moist sand in a breeding jar. The following table indicates the results obtained.

TABLE X.

NUMBER OF MELON FLY LARVÆ WHICH PUPATED AND ISSUED AS ADULT FLIES, THE LARVÆ BEING SUBMERGED IN SEVEN INCHES OF WATER FOR A PERIOD OF TWO TO FOUR DAYS.

Number of larvæ	Days submerged in water	Number pupated	Number of dead pupæ	Adults reared
100	2	75	28	47
100	3	16	11	5
100	4	0	0	0

From this experiment one could conclude that infested vegetables may be submerged in a barrel or tank of water for a period of four days and then plowed under without danger of having melon flies emerge from this material. By following this method a valuable fertilizer is added to the soil. Undoubtedly, certain chemicals could be added to the water which would destroy the melon fly larvæ in the infested vegetables in less time, but this again, would increase the cost.

Burning or boiling maggoty vegetables is somewhat expensive on account of the fuel consumed. The old vines in seriously, infested, cucurbit fields were often pulled out of the ground, raked together in piles, the infested vegetables were scattered within these piles and then all was burned. Some kinds of infested vegetables could be boiled and then fed to hogs.

28. *Screening or netting.*—Attempts to grow the various kinds of Cucurbitaceæ in Hawaii are carried on mostly by Japanese and Chinese. Many of these cultivators screen the newly set cucurbits with pieces of gunny sac, paper bags, newspapers or straw. Some of the growers screen their melon and cucumber beds with cheese cloth or mosquito netting but as Froggatt (5, p. 18) states, "though it kept the flies out it also kept all the bees and small insects that, under ordinary conditions, fertilize the flowers, so that very few melons ever set and matured." Hand pollination could be resorted to, but this method would require a considerable amount of labor. One individual who attempted to grow pumpkins hired a Japanese who removed from the vines, the staminate flowers which were seriously infested with the larvæ. Screening the vines is not at all practical except possibly for a few vines in a

garden. Covering the newly set cucurbits requires constant attention and cannot be recommended, if the question of labor is taken into consideration.

29 *Trap crops.*—Marsh (9, pp. 155-156) made a test of a trap crop by planting cantaloupes among cucumbers. "It was thought that the cantaloupes would prove more attractive to the flies than cucumbers, but such was not the case, as the cucumbers were more badly damaged than the cantaloupes, and in the end both crops were practically destroyed by the larvæ."

30. *Traps.*—In Honolulu a Japanese glass fly trap is used by many of the Oriental merchants to capture house flies, blue bottle flies etc.; the insects enter the trap to feed and are drowned in soapy water within the apparatus. As this trap is similar to our American style of glass fly trap, a description of the Oriental type is not necessary. A Japanese fly trap with molasses as a bait was wired in a large orange tree and in twelve days nineteen male and fifty-eight females Mediterranean fruit flies and three male and one female melon fly were found drowned in the soapy water. Two of the American style of glass fly traps with molasses as a bait were placed upon the ground in a pumpkin patch but no trypetids were caught in these. A dozen of the common, mosquito, screen, fly traps with molasses diluted either with water or stale beer as a bait were fastened to sticks above the pumpkin vines but not a single fly was found in the traps during the five days that they were kept in the field.

31. *The use of vegetable, animal and petroleum oils to trap the melon flies.*—Recent investigations have shown that certain vegetable and petroleum oils attract enormous numbers of male fruit flies of different species. Howlett (7, pp. 412 and 414) found that citronella oil has an attraction for the males of the peach fruit fly (Dacus zonatus Saund.) and the three-striped fruit fly (Dacus diversus Coq.) but the attraction in the last case, however, seems perhaps a trifle less powerful than with Dacus zonatus. Froggatt (5, pp. 13 and 17) found that the mango fruit fly (Dacus ferrugineus Fab.) is also attracted to citronella oil but that the melon fly (Dacus cucurbitæ Coq.) never came to this oil. According to Illingworth (8, p. 160) the apple maggot or railroad worm (Rhagoletis pomonella Walsh) avoids citronella oil.

We found that many of the oils derived from crude petroleum attracted the males of the Mediterranean fruit fly (Ceratitis capitata Wied.), but rarely was a specimen taken in animal or vegetable oils. Our experiment with kerosene shows that of every thousand Mediterranean fruit flies captured only three, on an average, were females, the remainder being males. It is noteworthy to mention that the Queensland fruit fly (Dacus tryoni Frogg.) and the Mexican or Morelos orange worm (Anastrepha ludens Loew.) are not attracted to kerosene.

The vegetable, animal and petroleum oils listed in the following table were poured in pans and placed upon the ground in a pumpkin patch which was swarming with melon flies. The number of pans used, the number of days each oil was tested and the results obtained are stated in the following table:

TABLE XI.

NUMBER OF MALE AND FEMALE MELON FLIES CAPTURED IN ANIMAL, VEGETABLE AND PETROLEUM OILS.

		Pans		♂	♀
Vegetable oils	Citronella	2	5 days	1	2
	Turpentine	1	16 hours	0	0
	Cocoanut	2	5 days	0	2
Animal oils	Whale	2	5 days	2	4
	Fish	2	5 days	1	1
Petroleum oils	Kerosene about 120° Bé	3	5 days	2	3
	Gasoline about 86° Bé	1	16 hours	0	0
	Benzine about 63° Bé	1	16 hours	0	0
				6	12

In all probability, the specimens were not attracted to these oils but came within the sphere of influence by accident, became stupefied and dropped into the oil.

32. *Night traps.*—As the melon flies show a strong positive reaction to light, an attempt was made to capture the pest with a night trap. Herrick's moth trap was placed in a pumpkin patch but not a specimen was caught. A seventy candle-power hunting lamp was placed above the moth trap and the light rays were directed towards thousands of melon flies resting under sunflower leaves in the pumpkin patch but not a single specimen was attracted to the light.

33. *Poisoned bait spray.*—Striking demonstrations have been made of the effectiveness of the poisoned bait spray in the control of the olive fly (Dacus oleæ Rossi) in Italy and France

and the Mediterranean fruit fly (Ceratitis capitata Wied.) in South Africa.

Recently similar control measures have been used in the United States and Canada against the apple maggot (Rhagoletis pomonella Walsh), the cherry fruit flies (Rhagoletis cingulata Loew. and Rhagoletis fausta O. S.) and the currant or gooseberry fruit fly (Epochra canadensis Loew.). We have tested the effectiveness of the poisoned bait spray to control the Mediterranean fruit fly under Hawaiian conditions. The method adopted was to wire ten kerosene traps in different parts of an orchard containing about four hundred fruit trees. The total number of fruit flies captured in five weeks was 10,239; of this number 10,203 were males and only 36 were females. During the following five weeks the poisoned bait spray was applied to the trees about once a week. The total number of fruit flies captured in the kerosene traps during these five weeks was 182, of which number 93 were caught during the first week.

As already stated Dacus cucurbitæ requires at least two weeks under laboratory conditions before the egg-laying period commences. Under natural conditions, the flies seek food during this period and subsist on a variety of sweet substances already discussed under the feeding habits of the melon fly. In captivity, the adults show a fondness for diluted molasses and they fed on this liquid until their abdomens became greatly distended. One can readily understand that if this insect is attracted to diluted molasses under natural conditions, that the greediness of the fruit flies for this sweet when poisoned, would be the weak point in the life history to attack the pest. If this poisoned bait is applied in the form of a spray to the food plant, when the trypetids issue from the puparia, no doubt large numbers would be killed before the egg-laying period begins.

The poisoned bait was prepared according to the following formula:

Brown sugar	2½	lb.
Arsenate of lead	5	oz.
Water	4	gal.

The solution was prepared by dissolving the brown sugar and lead arsenate through cheese cloth in cold water so as to strain out all foreign material including ants, which in the Hawaiian Islands frequently gnaw through the paper sacs containing the sugar. The mixture was thoroughly agitated by pumping the liquid back upon itself with a common, garden, brass spray-pump. To kill the enormous numbers of melon flies quickly in a badly infested cucurbit field, one ounce of a soluable poison such as potassium arsenate or sodium arsenite dissolved in a small quantity of water, was added to the solution instead of arsenate of lead. The pump was provided with a rose, sprinkler nozzle which throws a fine, mist-like spray.

Shortly after sunrise the insecticide was applied to all of the foliage within the pumpkin patch and also to the vegetation bordering the same, such as glue bushes, algeroba trees, bananas, sunflowers, castor oil beans, weeds and grass. As already stated in the discussion of the feeding habits of the adults, the pest was found feeding on flowers about a hundred yards away from the breeding grounds. To spray all of the feeding grounds which often consisted of dense brushes of glue bushes, would be practically impossible. The results obtained after spraying were rather striking. Before spraying, thousands and thousands of melon flies could be found resting on the lower surface of the leaves of the sunflower and castor oil plants, but after spraying, only here and there could a specimen be found. In all probability, these living flies had recently emerged from puparia, or came in from the neighboring feeding grounds or from surrounding cucurbit fields. The soluble poisons, however, burned the foliage and can not be advocated.

A few days after the application of the first spray, all of the pumpkin vines and bean plants were pulled out of the ground and raked together in piles. The infested pumpkins were scattered within these piles and then all was burned.

To determine whether the melon flies coming from their feeding grounds or from the surrounding fields of cucurbits could be controlled, watermelon seeds were planted in a field adjacent to the former pumpkin patch. The seeds sprouted before we were able to make a vigorous campaign in surrounding cucurbit fields. The watermelon plants were sprayed with the bait, using arsenate of lead, but frequent rains washed off the thin film of sugar and left the plants subject to the attacks of the pest coming from outside sources. As soon as the weather became settled, a fresh application of the bait was made to the watermelon plants and surrounding vegetation, but the tender stems of many of the watermelon plants were already infested. Whether the pest, which has been allowed to increase unmolested during the past sixteen years, can be controlled under Hawaiian conditions when one individual sprays and his neighbors do not, is problematical. In all probability, better results could be obtained with the poisoned bait spray in a well isolated cucurbit field away from the valleys where rains are less frequent during the summer months.

Marsh (9, p. 155) tested a poisoned bait spray to control the melon fly in the Hawaiian Islands. He writes, "The baits were prepared by sweetening water with molasses and adding to the solution arsenate of lead or Paris green. These baits were then applied, at frequent intervals, to the foliage of infested cucumbers with a gardener's syringe. With the aid of the syringe the poisoned liquids were shot into the air above the beds of cucumbers and allowed to fall on the foliage in fine drops. In the experiment with Paris green the application was made daily from September 9 until October 14. The formula used in this experiment was as follows:

Molasses	1 quart.
Paris green	¼ ounce.
Water	1½ gallon.

Neither the experiment with arsenate of lead or with Paris green proved effective. The flies were frequently observed feeding on the poisoned liquids, but evidently they did not relish them, and so failed to consume a fatal dose."

Fuller (6, p. 26) stationed in Natal, South Africa, tested the poison bait spray to control the Mediterranean fruit fly and melon fly. Trials which have been made in several citrus orchards to control the Mediterranean fruit fly with the poisoned bait spray "have been attended with remarkable effects, and where treatment has been applied for the melon fly which attacks, squashes, marrows, pumpkins and the like, it has proved equally successful."

EXPLANATION OF PLATES.

Plate XXVII.

Fig. 1. Resinous lump which heals the wound produced by the ovipositor of the melon fly, in the tender stems near the growing ends of the pumpkin vines.

Fig. 2. Resinous lump somewhat enlarged.

Fig. 3. Split stem of pumpkin vine near growing end, showing the eggs deposited by the melon fly.

Fig. 4. Eggs deposited on the outer surface of the corolla and its lobes.

Fig. 5. Longitudinal section of the ovary of a pumpkin, showing the eggs deposited within a receptacle.

Fig. 6. Green pistillate bud with the corolla cut open, showing the eggs deposited on the style and inner surface of the corolla.

Fig. 7. Eggs deposited on the inner surface of the corolla.

Fig. 8. Cross section of the ovary of a pumpkin, showing the eggs deposited within a receptacle.

Plate XXVIII.

Fig. 9. Squash showing depressions caused by the oviposition of the melon fly during the early development of this cucurbit. The tissue surround ing the receptacle in which the eggs are deposited is probably killed by a secretion, and in the further development of the cucurbit a depression results.

Fig. 10. Healed wounds due to a previous infestation of the melon fly. This trypetid is unable to puncture the hard rind of the larger pumpkins with its ovipositor, but often the resinous material covering the wound cracks and oviposition may then occur in the crevices.

Fig. 11. Depressions and healed wound in a ripe pumpkin.

Fig. 12. Pumpkin, abnormal in shape, as a result of being "stung" by the melon fly during its early development.

Figs. 13 and 14. Remains of two pumpkins which were turned over to show the side resting on the ground. After the maggots bore out of a seriously reinfested pumpkin, only the rind and seeds remain.

Fig. 15. The rind of a seriously reinfested pumpkin collapsing due to decay caused by the larvæ.

Fig. 16. When the pumpkin is not seriously reinfested with the melon fly larvæ, the rind does not collapse. Such partly decayed cucurbits often serve as hosts for other insects which complete the work of destruction.

Fig. 17. Pumpkin cut in half showing the decayed pulp and seeds, and the larvæ which have jumped out of the decayed mass.

Plate XXIX.

Fig. 18. Resinous material which exudes from the wound produced by the ovipositor of the melon fly in the ovary of a pumpkin.

Fig. 19. Resinous substance in the constriction between the flower and the ovary where the eggs are often deposited.

Fig. 20. Discoloration on the corolla indicating the region where the fly has punctured the closed flower to deposit its eggs within the stigma or style.

Fig. 21. Discoloration on the corolla where the pest has punctured the closed flower to deposit its eggs on the inner surface of the corolla lobes.

Fig. 22. The corolla of one of the flowers has detached and dropped to the ground, leaving a black flower scar. The larvæ in this case devoured the stigmas and styles and descended into the ovary.

Figs. 23 and 24. Longitudinal sections of two ovaries showing a spongy decayed pulp caused by the maggots.

Fig. 25. Corolla detaching from the ovary after the larvæ have devoured the stigmas and styles and descended into the ovary.

Fig. 26. Dried and shriveled pistillate bud still adhering to the pumpkin vine after the larvæ have bored out of the ovary.
Fig. 27. Pistillate bud detaching from pumpkin vine after the larvæ have bored out of the ovary.
Fig. 28. Two anthers of pumpkin flowers; one anther has been partly devoured by the maggots.
Fig. 29. After the larvæ have destroyed the anthers, the pest devours the column of the stamens.
Fig. 30. The maggots finally penetrate into the long peduncle of the staminate flowers and feed on the wall of the stalk. The flower often drops from its stalk due to decay caused by the larvæ.

PLATE XXX.

Figs. 31 and 32. String beans split open showing the melon fly larvæ feeding on the seeds and flesh of the pods.
Fig. 33. After the seeds and flesh of the string beans have been devoured the inner surfaces of the pods turn black.
Figs. 34 and 35. External appearance of the infested bean pods.
Figs. 36 and 37. Melon fly pupæ inside of pods.
Figs. 38 and 39. Melon fly larvæ which have died while attempting to bore out of the string beans, probably due to the drying of the pod.
Figs. 40 to 44. Dried and shriveled string beans after the melon fly larvæ have bored out. These bean pods do not drop to the ground but remain adhering to the plant.

PLATE XXXI.

Fig. 45. Channels in moistened sand made by melon flies after emerging from the puparia. The black areas in the channels represent flies which died in their attempt to burrow through the sand.
Fig. 46. Egg of melon fly.
Fig. 47. Recently hatched melon fly larva.
Fig. 48. Melon fly larva after feeding one day.
Fig. 49. Larva after feeding two days.
Fig. 50. Larva after feeding three days.
Fig. 51. Larva after feeding four days.
Fig. 52. Mature melon fly larva after feeding four and one-half days.
Fig. 53. Puparium of melon fly.

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