INTRODUCTION

The braconid parasite *Opis fletcheri* Silvestri was introduced into the Hawaiian islands from India in May, 1916, by D. T. Fullaway, representing the Board of Commissioners of Agriculture and Forestry of the Territory of Hawaii. It was brought in as a parasite of the melon fly (*Bactrocera cucurbitae* Coquillett) which had been causing great losses to the vegetable growers of the islands. The only host here which it attacks freely under field conditions is the melon fly, although it can be bred freely in the laboratory from the Mediterranean fruit fly (*Ceratitis capitata* Wiedemann). From many thousands of Mediterranean fruit-fly puparia, secured from fruits collected in the field, only four adult *O. fletcheri* have been reared. One was bred from fruit-fly larvae developing in fruits of *Chrysophyllum oliviformae*, one from larvae in fruits of tropical almond (*Terminalia catappa*), and two from larvae secured from coffee (*Coffea arabica*). The first two were collected in Honolulu, and the last two were from the Kona district of the island of Hawaii.

A clear conception of the biology of this parasite and a record of its activities since its introduction into Hawaii are the two principal objects of this paper.

DESCRIPTION AND LIFE HISTORY

EGG

The egg is always deposited in the larva of the host, just beneath the skin. Its pointed, attenuated end becomes firmly glued to the inner surface of the larval integument by a dark, almost black substance; and its free end projects obliquely into the body cavity of the larva. The spot receiving the egg soon becomes darkened; and the dark substance by which the egg is attached to the host larva may be a darkened clot of larval fluids which originally exuded when the wound was made by the insertion of the ovipositor.

Immediately after deposition (fig. 1) the egg is cylindrical, bluntly pointed at both ends, slightly more convex dorsally than it is concave ventrally, and translucent white with a smooth, glistening surface. Its average length is 0.54 mm. and it is about one-sixth as broad as long. Just before hatching (fig. 2), its width is a little over one-third the length.

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1 Credit is due C. E. F. Piiberton, formerly with the Bureau of Entomology, for the drawings contained in this paper and for the greater part of the microscopic work performed during its preparation.

which averages 0.66 mm., the cephalic end being drawn out into a distinct tubercle while the caudal end retains the blunt point. At this time magnification renders the embryo plainly visible.

Only by careful dissections of host larvae into which many eggs of *Opius fletcheri* have been deposited during a short period is it possible to ascertain accurately the duration of the egg stage. In the month of July, 1918, 439 eggs were under observation, all of which hatched between 37 and 40 hours after oviposition. The eggs may hatch while the host is still a larva, or after it has formed a puparium. Even though a host larva contains several parasite eggs or newly hatched larvae, it is not killed but continues to feed in an apparently normal manner and eventually leaves the fruit and forms its puparium. In fact, the parasite seems to have no effect upon the development of the fly until a complete histolysis of the larval tissues within the puparium has taken place. At this time all development of the parasitized fly ceases. No histogenesis occurs, and the young parasite larva develops rapidly by feeding upon the liquid mass of the broken-down larval tissues of its host which surround it.

**LARVA**

During this period of development there are four distinct instars, during which many interesting changes occur. The first instar (fig. 3) is easily distinguished by a large, chitinized head bearing the strong, pointed mandibles, and by the chitinized ventral plate of the head which has a distinct U-shaped cephalic line. In this stage a tracheal system is present, but no open spiracles can be seen, even with high magnification. The two longitudinal, lateral trunks throw out branches into each body segment, including the head, and are connected at their cephalic and caudal extremities by a transverse connecting branch. When first hatched, the larva is surrounded by a mass of egg serosal cells, which cling to it until it is almost ready to molt into the second instar. This mass, however, has never been observed clinging to the first larval molt (fig. 4), as it does in the case of the three Mediterranean fruit-fly parasites (*Opius humilis* Silvestri, *Diachasma tryoni* Cameron, and *D. fullawayi* Silvestri). The digestive tract, which is a simple tube the greater portion of which consists of the large intestine, is closed at the caudal end, although an apparently open anus is present.

This is the active stage of the larva, in which it is specially equipped with long, sharp mandibles for its struggle for survival over other larvae of the same species, which it often finds in the same host individual. This struggle takes place immediately after hatching, and usually within four hours all but one of the larvae of *Optus fletcheri* have been killed. Many cases have been observed where there were only one living and from two to eight dead parasite larvae in the same host individual. Thus, having all the food material of its host available for itself, the surviving larva is able to proceed with its development to the adult stage.

The duration of this instar varies greatly and depends upon the development of the host. The larva never molts into the second instar until the parasitized host larva has formed its puparium. Several instances have been observed where larvae of *Optus fletcheri* have developed to adults while other individuals, from eggs laid at the same time, still remained first-instar larvae. The host larvae of the former formed their puparia soon after they were parasitized, while those of the latter were still in the larval stage when examined. In all the experiments to prove this point the host was *Ceratitis capitata*, larvae of which were feeding in the fruits of *Mimusops elengi*. These fruits become rather dry soon after falling from the tree, so that fruit-fly larvae within them find difficulty in obtaining sufficient food for rapid development. This results in retarding pupation, sometimes for over three weeks beyond the normal period. On June 11 eggs of *O. fletcheri* were deposited into fruit-fly larvae, which were examined with the following results: On June 18, 10 of these larvae contained living first-instar larvae of *O. fletcheri*, and 3, that had formed puparia, each contained a fourth-instar larva of *O. fletcheri*. On June 22, 3 more larvae and 2 of the puparia of this lot were examined. Each of the larvae contained a well-developed living larva of *O. fletcheri*.

FIG. 3.—*Optus fletcheri*: Larva, first instar, ventral aspect, showing head characters and complete tracheal system, and the egg serosal cells. Length 0.88 mm.
in the first instar, and each puparium contained a well-formed pupa of *O. fletcheri*. *C. capitata* larvae into which *O. fletcheri* had deposited eggs on June 12 were examined on June 24. Each of 7 which were still in the larval stage contained a strong, living, first-instar larva of *O. fletcheri*; while 7 of the host larvae, which had formed puparia, each contained a mature pupa of *O. fletcheri* about to emerge. Eggs that were deposited on June 13 produced, on June 27, 10 adult male *O. fletcheri*, and on June 28, 4 males and 2 females. On June 28, also, 2 of the host larvae that had not yet pupated each contained a living first-instar larva of *O. fletcheri*. On June 14 eggs of *O. fletcheri* were deposited in fruit-fly larvae. On June 27, 1 adult male *O. fletcheri* had developed from this lot, while 4 of the host larvae, that had not formed puparia, each contained a living first-instar larva of *O. fletcheri*.

These results indicate that the first instar of *Opicus fletcheri* is controlled to a great extent by the development of its host, since it never molts into the second instar until the host has formed its puparium, and that the first instar may extend over a period of 10 to 12 days. When the host forms a puparium shortly after being parasitized, the first instar may be as short as 1½ days.

The second-instar larva (fig. 5) is very much without distinctive characters. The mandibles (fig. 6) are very small, soft, and indistinguishable even under high magnification, except upon occasions where the position and lighting are most favorable. They are 0.045 mm in length and so far as can be seen serve no purpose. No tracheal system is present. None can be detected under the best of lighting and the highest of magnification. No part of the head or body is chitinized. The entire
body is very delicate and can be easily crushed beyond recognition with a very slight pressure on the coverglass. The digestive tract is simple and tubular and is closed caudally as in the first instar. In this stage the larva is sluggish in its movements, although it rapidly ingests a quantity of fat into its mid-intestine. Toward the latter part of this instar the mandibles of the third instar can be seen pushing at the bases of the mandibles.

The third instar, when first formed, is without a vestige of tracheæ. Tracheæ can be seen developing beneath the surface of the integument toward the latter part of this stage, but they are of the last instar and serve no purpose in the third. Few differences can be detected between this and the preceding instar, except an increase in size and a change in the shape of the mandibles. The third-instar larva measures 2.5 to 3 mm. in length.

The mandibles (fig. 7) are somewhat more pointed and strong than those of the second instar; they bear no colored chitinization and measure 0.047 mm. in length. Toward the latter part of this instar the strong, chitinized mandibles of the last instar can be seen pushing at the bases of the mandibles.

The mature, fourth-instar larva (fig. 8) averages 4 mm. in length and at its greatest width is about three-eighths as wide as long. When first molted into this instar it is 3 to 3.5 mm. long. The body is slightly curved, being concave ventrally, and, including the head, is composed of apparently 14 segments, although segment 14 is not clearly defined. A rather large, distinct spiracle is present on each side of segments 3, 5, 6, 7, 8, 9, 10, 11, and 12, counting the head as segment No. 1. These spiracles are joined on each side by a large lateral trunk extending nearly the length of the body. The trunks are connected near their caudal and cephalic extremities by a single, transverse, connecting trunk, these being the only connections between the two lateral systems. Branches from the lateral trunks extend dorsally and ventrally into each body segment, and prolongations of the lateral trunks extend into the head region. Portions of the body are covered by minute, strong, wide-based spines (fig. 9), which are closely set and abundant on the dorsal and lateral portions of body segments 2 and 3, counting the head as segment No. 1, and on the lateral areas of segments 4 to 12, inclusive. No spines occur on the head, on the articulation areas between the segments, or on the ventral portion of any segment of the body, and very few occur.
on the last segment. The only colored chitinized parts occur in the head, where a pair of strong, pointed mandibles (figs. 10, 11)—of which the distal half only is chitinized—and the tentorial structures are chitinized a yellowish brown color. Small maxillae bearing minute papillae are present, together with a well-defined labrum and suboval labium.

The most important changes that take place, then, during the larval development of *Opius fletcheri* occur in such a manner as to adapt it to the changing environment within its host. Larvae of the first instar are very active and have long, sickle-like mandibles, which enable them to search out and destroy other parasite larvae which occur in the same host individual. Second and third instar larvae live in and feed upon the liquid or semiliquid medium contained in the host puparium. The mandibles, therefore, being useless, are small and inconspicuous, and there is no tracheal system whatever. In the fourth instar the liquid within the host puparium has been nearly all consumed, and the mature larva is found with fairly strong mandibles and a well-defined tracheal system connected with easily observed spiracles.

Two species of opine parasites of the Mediterranean fruit fly hibernate as mature larvae for varying lengths of time during the cooler seasons of the year.¹ No hibernation of *Opius fletcheri* has been observed during any stage of its development, although thousands of parasitized puparia have been under observation. In September, 1918, 592 parasitized melon-fly pupae were held in a refrigerator, where the temperature was constantly about 65° F., until two weeks after all adults had emerged. All unhatched puparia were then examined and no hibernating larvae were found. One hundred and sixty

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adults of *Opius fletcheri* emerged in the refrigerator, and each of the remaining 432 unhatched puparia contained a well-developed, dead pupa of *Opius fletcheri*. A control lot of 500 parasitized puparia that were held at the same time at normal temperatures, 75° to 85° F., produced 487 adult parasites and 13 dead pupae of *Opius fletcheri*. Seventy-two and six-tenths per cent of the parasites developing in the refrigerator and 2.6 per cent of those developing at normal temperatures died while in the pupa stage. These data seem to indicate that it is difficult for *Opius fletcheri* to develop through the pupal stage at a temperature as low as 65° F. This mortality of pupae, however, is not evident under field conditions. While records of parasitism of the melon fly, which was developing in cucurbits collected in the field at all seasons of the year, were being obtained, thousands of unhatched melon-fly puparia were opened. Although some of these records were secured when the temperature ranged from 60° to 70° F., less than 3 per cent mortality of *Opius fletcheri* pupae was found. The cause of the high mortality of pupae in the refrigerator has not been determined.

**PUPA**

In the process of transforming from the mature larva to the pupa (fig. 12) this insect passes through a prepupal state of from one to two days. The larva becomes motionless. The anterior portion of the body, which is to form the head and thorax of the pupa, becomes slightly contracted, so that it is somewhat smaller than the remainder of the body. The eyes can be seen, forming beneath the integument, as indistinct reddish brown spots; these become more distinct and darker in color until, just before the molt into the pupal stage, they can be plainly seen.

In the last larval molt the skin is split from the head backward and, by slight expansions and contractions of the body, it is pushed back over
the tip of the abdomen and finally comes to rest on the dorsal portion of the pupa. This exuvium often adheres to the antennae of the male or the ovipositor of the female for a short time after the adult has emerged from the puparium of its host. The length of the pupa is 3.8 mm. When first formed it is pale white, excepting the eyes, which are a very dark reddish brown; but within a few hours it begins to acquire a yellowish tinge and continues to assume the colorations of the adult until ready to emerge.

The length of this stage varies from four to eight days, even though it is passed under the same temperature and other conditions. During the month of July, 1918, when the temperature ranged from 75° to 85° F., 90 parasitized puparia were under observation. Adults of *Opius fletcheri* emerged from these puparia from 80 to 200 hours after pupation. Emergence was taking place at frequent intervals between these two extremes but was most frequent between 130 and 150 hours after pupation. This would indicate that the length of the pupal stage in the majority of cases was about six days. Between 80 and 100 hours after pupation, 17 males emerged, but it was between 100 and 110 hours before the first two females emerged. The last male emerged after a period of from 170 to 180 hours, and the last two females emerged between 190 and 200 hours after pupation. The pupal stage of the male is usually about 24 hours shorter than that of the female.

**ADULT**

The following description of the adult by Silvestri is translated from the Italian:

![Pupa, female. Length 3.8 mm.](image)
Opius fletcheri, n. sp.

**Female.**—Body ochreous yellow or testaceous, with the anterior part of tergites 2-6 of the abdomen brownish. Antennae, except at the apex, where they are brownish, and legs, except the pale brown hind tarsi, of the same color as the body. Wings hyaline, with the nervures in great part brown. The stigma brown, except the middle part, which is yellowish white. Length of body 4.5 mm.; width of thorax 1.05 mm.; length of antennae 6.5 mm.; of the wings 5 mm., width of same 2 mm., length of ovipositor (the part protruding) 2 mm.

Head just a little wider than the thorax, about two-fifths wider than high, with eyes large, convex, nude, reaching below almost to the level of the margin of the clypeus. Face, excepting at the base of the antennae, full, and subcarinate in the middle. Antennae longer than the body, attenuate, composed of 42 to 48 segments, of which the scape is about five-eighths longer than the second segment.

Thorax.—Esothoracic scutum with parapsidal grooves, indistinct, nude. The transverse prescutellar groove furnished with a series of about ten pits, not very deep. Metanotum lightly convex, and smooth in the middle for the greater part of its length, and carinate for a short space behind, pitted in the sides; propodium provided with a median longitudinal carina which divides behind, with a sublateral carina near the side, but within the stigmata, which are sufficiently large and round. The surface between the carinae smooth. Mesopleura with the longitudinal groove crenulate.

Anterior wings with the discoidal cell and the first cubital very large, subrectangular, longer than the second cubital, with the recurrent nervure long, arcuate as seen in the figure.

Abdomen suboval, with the first tergite lightly carinate at the side and lightly rugose in the middle. The rest smooth and furnished with a few long hairs, second suture rather distinct. Ovipositor, which is very sharp and straight, about as long as the abdomen.

**Male.**—Similar to the female but a little smaller.

**Observations.**—This species of Opius is quite distinct from the numerous species I know from Palaeartic and Ethiopian faunas by the shape of the recurrent nervure, and by the length of the discoidal and first cubital cells.

**Habitat.**—India. Prof. Fletcher obtained examples of this species from the pupae of Chaetodacus cucurbitae Coquillett, the larvae of which live in the fruits of Momordica charantia L.
The adult (fig. 13) liberates itself from the host puparium by gnawing a transverse slit near the end and by pushing with its head until the entire end of the puparium breaks off, allowing it to emerge. Immediately after emergence the meconium is discharged. This meconium is an ovoid, hard pellet, consisting of all the waste material which has collected in the digestive tract during the larval stage. No waste material is voided before this time, although many braconids discharge it just prior to pupation.

Copulation may occur frequently, and at any time, from immediately after emergence to the death of the adult. Two newly emerged females were put into a glass tube with one male that had just emerged, and the male successfully copulated with both females within 10 minutes. Nine females that emerged May 18 to 20 were put into a tube with males, where several instances of successful mating were observed. On July 1, when these females were 6 weeks old, they were put into a glass tube with 30 newly emerged and vigorous males. Within 45 minutes 12 successful matings were observed, and one of the females mated four times within 15 minutes. In all of these instances the females made no great effort to escape from the males. The period of coitus lasts from \( \frac{1}{2} \) to 2 minutes, although in the majority of instances it is less than 1 minute. In six of eight cases under observation the duration was between 30 and 45 seconds, while in the other two cases it was extended to 1½ and 2 minutes, respectively. As far as it has been possible to observe, all of the sex attraction is produced by the male. When within about 2 inches of the female, the male becomes greatly excited and while slowly approaching her, and during coitus, vibrates the wings vigorously and spasmodically. No strong, sweet odor, such as is emitted by the males of the fruit-fly parasites *Opis humilis* Silvestri and *Diaclasma tryoni* Cameron, has been detected during work with this species.

*Opis fletcheri* is capable of parthenogenetic reproduction, and the absence of mating does not influence oviposition. Large numbers of adults, all of which were males, have been reared from unmated females. The fact that mated females will produce a considerably larger percentage of females than males is of much interest. Eight females that were observed mating within two hours after emergence were put into individual glass tubes, where host larvae were available at all times. From these females 39 males and 72 females were reared, giving 35.1 per cent males and 64.9 per cent females. Under field conditions about 10 per cent more females than males are produced. While records of parasitism of the melon fly developing in cucumbers collected in the field during 1918 and 1919 were being secured, 7,746 adult *O. fletcheri* were reared. Of this number 4,273, or 55.2 per cent, were females, and 3,473, or 44.8 per cent, were males. Many species of opine parasites consistently produce more males than females. For example, the parasites of the Mediterra-

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Opius fletcheri, Parasite of the Melon Fly in Hawaii

nean fruit fly, D. tryoni and O. humilis; that were reared from material collected in the field, produced 37.6 per cent and 43.5 per cent females, respectively. Since the females are responsible for all the parasitism of the host, the ability of O. fletcheri to produce so many more females than males greatly enhances its value as an enemy of the melon fly.

The longevity of the adult depends largely upon the conditions under which it lives and may extend from a few days to 16 weeks. When confined without food it will not live much over 5 days. Of 6 males and 17 females that were confined in a glass tube without food, 3 females died before they were 3 days old, and 3 more lived to be a few hours over 5 days old, but the majority of both males and females died between the ages of 3½ and 4 days. The life of females that have had continual access to host larvae is much shorter than that of those which have had no opportunity to oviposit; and the life of males is considerably shorter than that of the females. Of 9 females that were allowed to oviposit at will, 2 died at the end of 2 weeks, 2 at the end of 8 weeks, and the other 5 lived 3, 5½, 6, 6½, and 7 weeks, respectively. With no opportunity to oviposit, 85 females, together with 43 males, were confined in a glass tube and kept in partial darkness, with daily feedings of a mixture of one-fourth honey and three-fourths water. Three of these females lived to be 16 weeks old, 33 of the males died between the ages of 6 and 8 weeks, while 1 male lived to be 11 weeks old. The majority of the females died between the ages of 11 and 13 weeks, while 15 lived a little beyond this period.

OVIPOSITION

Oviposition takes place in only the larva of the host and may occur at any time after the larva is one-half grown; but it is most frequent in well-developed larvae. Observations of the female, just prior to oviposition, indicate that she locates the host larva beneath the skin of the containing fruit by a sense of touch. She walks rapidly over the surface of an infested fruit, stopping at frequent intervals, evidently endeavoring to detect vibrations caused by a feeding host larva. While searching for the host, and during the act of oviposition, the female often vibrates her wings rapidly and spasmodically, although this does not always happen. When a favorable spot is found, she elevates her abdomen and pierces the skin and pulp of the fruit with her ovipositor, raising and lowering it until the host is located. She then inserts the ovipositor into the larva and deposits an egg just beneath the skin. Then she withdraws the ovipositor from the fruit and usually begins to search for another larva; but occasionally, after a short rest, she will oviposit again in the same one. The female is unable to discern between parasitized and unparasitized larvae.

Although mating may occur immediately after emergence, oviposition does not begin until 2 days later and, in the majority of cases, 3 to 5 days after emergence. Eight fertile females were given constantly
available host larvae from the time of emergence. Two of these began ovipositing in 2 days, one in 3, three in 5, and two in 7 and 9 days, respectively. None of these females oviposited after they were 30 days old, excepting one, which deposited one egg at the age of 33 days. The majority of eggs are deposited within the first 3 weeks after oviposition begins. As noted before, females that have had daily opportunity to oviposit do not live so long as those that have had no opportunity; but they frequently live from 4 to 5 weeks after oviposition has ceased.

**IMPORTANCE AS A PARASITE**

*Opus fletcheri*, in the three years since its introduction into the Hawaiian Islands, has become firmly established on all the large islands of the group. While this parasite alone will never exercise a complete control over the melon fly in Hawaii, it has already proved of much value by decreasing the numbers of this pest considerably. Good examples of the most abundant melon-fly host plants are cucumber, squash, pumpkin, and watermelon. The fruits of these plants are large and fleshy, and melon-fly larvae that develop in them feed so far from the surface that a larval parasite, such as *O. fletcheri*, that oviposits entirely from the outside, finds it impossible to parasitize enough of the larvae to exert a control over the pest.

Table I gives data showing the extent of parasitism by *Opus fletcheri* of melon-fly larvae developing in cucumbers collected in and about Honolulu during the last eight months of 1918 and the first eight months of 1919.

**Table I.—Percentage of parasitism by *Opus fletcheri* of larvae of Bactrocera cucurbitae in cucumbers**

<table>
<thead>
<tr>
<th>Month of collection</th>
<th>Number of larvae emerging during first two to four days</th>
<th>Percentage of parasitism</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1918</td>
<td>1919</td>
</tr>
<tr>
<td>January</td>
<td>1,014</td>
<td>539</td>
</tr>
<tr>
<td>February</td>
<td>1,481</td>
<td>2,719</td>
</tr>
<tr>
<td>March</td>
<td>2,052</td>
<td>431</td>
</tr>
<tr>
<td>April</td>
<td>2,719</td>
<td>5,255</td>
</tr>
<tr>
<td>May</td>
<td>1,014</td>
<td>1,014</td>
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<tr>
<td>June</td>
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<td>1,014</td>
</tr>
<tr>
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<td>1,014</td>
</tr>
<tr>
<td>August</td>
<td>431</td>
<td>19,321</td>
</tr>
<tr>
<td>September</td>
<td>3,594</td>
<td>431</td>
</tr>
<tr>
<td>October</td>
<td>2,556</td>
<td>431</td>
</tr>
<tr>
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<td>8,282</td>
<td>431</td>
</tr>
<tr>
<td>December</td>
<td>4,319</td>
<td>431</td>
</tr>
</tbody>
</table>

The highest percentage of parasitism existed in September, 1918, when 1,070 out of 3,594 melon-fly larvae under observation were parasitized. This shows a parasitism of 29.8 per cent, while the parasitism
from all cucumbers collected during 1918 was 18.1 per cent. Parasitism from larvae developing in cucumbers collected in the first eight months of 1919 amounted to 7.3 per cent. These records were secured from only those larvae that emerged from the cucumbers the first two to four days after collection. Larvae emerging after this time would not give a true representation of parasitism under field conditions, because at the time they were collected they were comparatively small and had been subject to parasitism only a short time. These cucumbers were specially selected by the collector as being the most heavily infested ones in the fields. Considering the fleshy nature of cucumbers and the fact that those from which these data were obtained were from 4 to 10 inches long, it is remarkable that *Opius fletcheri* is able to destroy such a high percentage of the melon-fly larvae developing in them.

Considerable effort has been made to establish a series of records a comparison of which would show the amount of infestation by the melon fly from time to time and which would determine the extent of control exerted by *Opius fletcheri*. Infestation records of the Mediterranean fruit fly have been secured by recording the average number of larvae per fruit, this average being obtained from a large number of fruits of the same species. The great variation in size of cucumbers made this method impracticable, and the following method was used: All cucumbers that were collected for records of parasitism were weighed and then held until all the melon-fly larvae had emerged. Accurate records of these larvae were kept, and at the end of December, 1918, and of August, 1919, the average number of larvae per pound of host fruit was obtained. From July to December, 1918, inclusive, 200 pounds of cucumbers were collected, which contained 47,888 melon-fly larvae, or an average of 239.4 per pound. From 337 pounds of cucumbers, collected during the first eight months of 1919, 57,921 melon-fly larvae were secured, giving an average of 172 larvae per pound. These averages indicate that the melon-fly infestation of cucumbers in and about Honolulu was approximately 28 per cent less during the period from January 1 to August 31, 1919, than it was between July 1 and December 31, 1918.

It appears from observations of melon-fly infestation in Hawaii made during the past several years that this decrease in the numbers of the melon fly is due to a great extent to the activities of *Opius fletcheri*. Before this parasite was introduced into Hawaii in 1916 it was almost impossible to find a cucumber in the Honolulu markets that did not show more or less evidence of attack by the melon fly. From observations made by them in 1915 and 1916, Back and Pemberton state that one rarely sees cucumbers offered for sale in the Honolulu markets that do not show some evidence of attack, even when carefully selected, and that during midwinter 150 out of 152 cucumbers ready for market

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at Moiliili were found variously infested. They state also that the ordinary cucumber, when very young, is the most resistant to melon-fly attack of all the cucurbits cultivated in Hawaii, but that inasmuch as the fly has been permitted to increase unchecked since its introduction it has become so abundant that slight differences in inherent resistance to attack are not evident among host fruits growing in the field. The condition of cucumbers offered for sale in Honolulu during the first eight months of 1919 indicates that *O. fletcheri*, while not being able completely to control the melon fly on the island of Oahu, has been able to reduce its numbers to such an extent that the infestation of cucumbers has been greatly decreased. During this period there have been good quantities of this vegetable on the market at all times, a very small portion of which has shown evidences of melon-fly attack. The writer has observed on several occasions at different plantations wagon loads of cucumbers that had been selected for market, among which it was difficult to find any great number that had been attacked. While collecting cucumbers during the past year from the different gardens for parasitism records, it has often been difficult to get a sufficient quantity of well-infested fruits. These observations, as compared with those made previous to the establishment of *O. fletcheri*, would lead to the conclusion that this parasite has already become of much value, even while attacking its host in the larger cucurbits.

The ability of *Opius fletcheri* to reach and parasitize the majority of host larvae developing in the smaller fruits is clearly shown by data collected during the past five years in the Kona district of the island of Hawaii. In this district it comes nearer to controlling the melon fly completely than in any other locality that has been observed. This great degree of control is without doubt due to the great abundance of the wild Chinese cucumber (*Momordica* sp.). The fruits of this plant are small, about \( \frac{1}{2} \) to \( \frac{3}{2} \) inches in diameter by 1 to 2 inches long. The following observations give a good conception of their susceptibility to melon-fly attack and of the ability of *Opius fletcheri* to decrease their infestation greatly by parasitizing a large percentage of the larvae developing in them.

From observations made in this district, Back and Pemberton state that—

From *Momordica* vines covering a patch of pasture land 6 feet square, 331 fruits were gathered during November, 1914, of which only 12 had not been infested. These fruits, which were of all sizes up to 1\( \frac{1}{2} \) inches in diameter, averaged between three and four punctures per fruit, with a maximum of 15 punctures on the more exposed fruits. From 7 feet of stone wall 442 fruits were gathered, and of these 193 were so badly affected that they had dried up without developing seeds, and only 11 were not affected. From 250 fruits placed over sand 1,586 larvae, or an average of 6.5 larvae per fruit, were reared.

A careful examination of 442 fruits of Momordica, collected at random over an area of \(\frac{3}{4}\) square mile in the Kona district, made by C. E. Pemberton on May 8, 1916, gave the following results: 194 were not infested, and the 248 that were contained a total of 559 eggs and 1,222 larvae of the melon fly. This is an average infestation per fruit for the 442 fruits of 4 flies either in the egg or larval stage.

The first adults of *Opius fletcheri* were liberated in this district in the summer of 1916. Data secured by C. E. Pemberton during the latter part of April and the first part of May, 1918, showed that it had become widely established, was parasitizing a very high percentage of the melon fly developing in Momordica, and that it had so greatly reduced the number of flies that cultivated cucurbits were being raised with little or no infestation. Out of 1,706 Momordicas collected by him on April 25 and 26, 1918, 347 fly larvae emerged the first two days after collection, of which 299, or 86.2 per cent, produced parasites. On April 28 and 29, 700 Momordicas were collected, from which 226 melon-fly larvae emerged during the first two days. Of these 226 larvae 219, or 96.9 per cent, produced parasites. From these two lots 103 larvae emerged after the first two days, making a total of 676 larvae developing in 2,406 fruits. This is an average of less than 0.3 larva per fruit, as compared with an infestation of from 4 to 6.5 larvae per fruit before the liberation of *O. fletcheri*.

Further observations made at the same time of 1,706 ripe Momordicas collected in the same locality showed that only 36 of this number contained either eggs or larvae of the fly. Thirty ripe fruits of the same plant, collected at Honokaa, about 12 miles from Kealakekua, showed no infestation whatever. On May 10, 1918, 400 cucumbers, both large and small, 28 young watermelons, 20 young muskmelons, and 21 young pumpkins were carefully examined in a garden in Kealakekua. This garden was bounded on one side by a coffee plantation and on the other three sides by pasture land that was overrun with heavily-fruiting vines of wild Momordica. Only one cucumber was found that had been punctured by the melon fly. None of the other vegetables or melons that were examined had puncture scars, either new or old, and none of the blossoms of any of the plants were stung.

In June, 1919, this same low degree of infestation still existed in this district. From 890 Momordicas collected at that time the average infestation was less than 0.2 larva per fruit. In several gardens less than 3 per cent of the cucumbers and melons that were examined showed evidences of attack, and none of the blossoms were found that had been stung.

When the vines of wild Momordica are abundant on pasture lands, their ability to cover and kill large patches of grass has caused them to be considered a pest, and consequently they have not been allowed to
become abundant in many localities in Hawaii. When Momordica is abundant and *Opius fletcheri* is present, it has proved of considerable value as a trap plant for the melon fly. Infestation records made before the parasite was liberated show that Momordica is much favored as a host by the melon fly, while subsequent records of parasitism show that its size and texture permit the parasite to kill about 90 per cent of the larvae developing in its fruits. Whether or not it would be of advantage to plant these vines around vegetable gardens as a catch plant is a problem open to further investigation.

*Opius fletcheri*, besides becoming firmly established on all the larger islands of the group, has shown itself capable of reducing the number of melon flies by at least 25 per cent, even when the host larvae are developing in fruits the size and nature of which make parasitism difficult. In a location where the fruits and conditions are most favorable to its reproduction it has reduced the flies so greatly that they have almost ceased to be a pest. While *O. fletcheri* is far from being able to control the melon fly in Hawaii completely, the benefits derived from its activities since its establishment there have been sufficient to warrant the efforts connected with its introduction.