

NOTES ON NATURAL ENEMIES OF TEPHRITID FLIES

During November, 1949, five shipments were received from Messrs. Bianchi and Waters, in Bareilly, India, containing 21,883 fruit fly puparia reared from a cucurbit, *Luffa* sp. In the material bred from these shipments were 67 adults (25 females) of a large *Opius* indistinguishable from *Opius longicaudatus* (Ashmead) except by its generally paler coloration. The flies from these shipments were identified by Dr. Hardy as *Dacus curcurbitae* Coquillett and *D. caudatus* F., the majority being the former. Placed with cucumbers containing melon fly larvae in all instars, these opiines promptly attacked the larvae. Mating and oviposition occurred readily, and numerous progeny were obtained. In a recent test 13 mated female *Opius* produced 389 progeny, of which 213 (55 per cent) were females. The best results in the laboratory were obtained with infested cucumbers. This new Indian *Opius* (designated temporarily as "*Opius* No. 5") is therefore a most promising new parasite of the melon fly. Colonies have been turned over to the Board of Agriculture & Forestry for rearing and liberation.

D. W. CLANCY, January 9, 1950.

A note presented last October ("Proceedings," 14: 27) called attention to the sudden increase of *Opius persulcatus* (Silvestri)¹ on Oahu as a parasite of the oriental fruit fly. The data on which that note was based have now been analyzed with interesting results.

The relative abundance of *O. persulcatus* and *longicaudatus* (Ashmead) from various field-collected fruits used in parasite breeding tests during the five-month period from July to November, 1949, is shown in the accompanying table. *O. persulcatus* was first recovered from mountain apple and mixed fruits from Manoa Valley and the University of Hawaii campus, although in numbers far below those of *longicaudatus*. However, the total percentage of *persulcatus* steadily increased, from 8.8 per cent in July to 91.8 per cent in November. These fruits were collected mainly in the Manoa, Nuuanu to Kaneohe, and Kalihi areas.

The figures in the table also indicate a rather wide variation in the *persulcatus* ratio according to the species of host fruit sampled. Infested guavas are particularly favored, although the ratio shown may be somewhat higher than the actual one because many of these fruits were picked at an early stage of maturity, before *longicaudatus* attains its maximum parasitization. The apparent preference of *persulcatus* for small host larvae would therefore favor this species in immature fruits. It is quite evident, however, that *persulcatus* is becoming the dominant parasite of *Dacus dorsalis* in guavas, which are the most important fruit fly reser-

¹ It is suspected that the insect which has locally been called *O. persulcatus* (Silv.), is actually not that species. These notes may include data on two distinct species under the name *persulcatus*. The species described on p. 248 as *Opius oophilus* Fullaway, seems first to have begun to appear in field collections as early as December, 1949, although definite recognition of it by Dr. van den Bosch, as a species distinct from so-called *persulcatus*, was first announced in May, 1950.—Ed.

voir. *O. longicaudatus* was still dominant in mature fruits of false kamani (*Terminalia catappa*) and Surinam cherry during September and October, and also from mock orange (*Murraya*) and *Chrysophyllum monopyrenum* at Foster Garden in December.

Table 1.—Relative abundance of *Opius persulcatus* and *O. longicaudatus* in field-collected fruit on Oahu, 1949

Month	Host Fruit	No. of tests	No. of <i>O. longicaudatus</i>	<i>Opius persulcatus</i>	
				Number reared	Percentage
July	Guava	1	27	0	0
	Mountain apple.....	8	1,311	204	13.5
	Surinam cherry.....	2	1	0	0
	Mixed fruits.....	15	836	7	1.0
	Total	26	2,175	211	8.8
August	Guava	5	237	143	37.6
	Rose apple.....	3	816	180	18.1
	Total	8	1,053	323	24.2
September	Guava	32	761	1,083	58.7
	Surinam cherry.....	5	156	70	31.0
	False kamani.....	5	553	20	3.5
	Mixed fruits.....	13	1,236	349	22.0
	Total	55	2,706	1,522	36.0
October	Guava	50	353	3,134	89.8
	Surinam cherry.....	3	178	54	23.3
	False kamani.....	2	372	27	6.8
	Mixed fruits.....	5	69	117	62.9
	Total	60	972	3,332	77.4
November	Guava	10	19	259	93.2
	Mixed fruits.....	1	4	0	0
	Total	11	23	259	91.8

[Dr. van den Bosch commented that *O. persulcatus* is bred most commonly from fruits taken from the trees, while *longicaudatus* is primarily a parasite of maggots in fallen fruits.]

D. W. CLANCY, February 13, 1950.

During November and December, 1949, numerous female *Opius longicaudatus* were observed inserting their ovipositors into melon-fly-infested fruits of *Momordica balsamina*. Since laboratory tests had indicated that *longicaudatus* is unable to develop in *Dacus cucurbitae*, these fruits were systematically collected and placed over sand for rearing records. Although the 51 fruits thus collected produced a total of 109 adult *D. cucurbitae*, not one parasite issued from any of the puparia. It appears, therefore, that melon fly is immune to parasitization by *O. longicaudatus*, even though it may be subject to attack in nature.

P. E. MARUCCI, February 13, 1950.

During the past several months there has been a remarkable increase in parasitization of oriental fruit fly larvae infesting guava fruits on Oahu. This is especially true of the Waimanalo-Kailua area where guava has

been fruiting heavily for about two months. At one collecting point near Waimanalo, parasitization jumped from 14.5 per cent on May 5, to 86.6 per cent on June 13. During this same period there has been a general decrease in infestation of guavas. There is little doubt that increased abundance of guava fruits would initially have some effect of reducing infestation. However, it is quite probable that parasites, along with other mortality factors, are exerting a strong depressing influence on the fruit fly population.

At most of our collecting stations *Opius persulcatus*² has been the most abundant parasite, and at several places large numbers of its males have been observed swarming over guava foliage and undergrowth. Similar swarming of male *O. longicaudatus* has been reported several times, but prior to this spring swarming of *persulcatus* has not been noted.

O. longicaudatus continues to play an important role in the parasitization of *Dacus dorsalis*. It is particularly noteworthy that large numbers of this parasite were recovered from one of the Manoa collection stations. On our recent visit to this site we observed swarms of males hovering over the vegetation.

An increasingly important parasite is the so-called "Waikane *Opius*"³ which until very recently had been considered a color phase of *persulcatus*, but is now believed to be a distinct species. This parasite has been spreading rapidly on windward Oahu and is now generally distributed over that area. In addition, it is very abundant in the region of Poamoho in central Oahu. Specimens have been recovered from Manoa Valley and other scattered localities, and from several places on Hawaii. It has actually become the most abundant species at some of the windward Oahu collecting stations, notably Waikane, Makaua and Kahana.

In addition to the parasites just discussed, a fourth, *Opius incisus* Silvestri, has been recovered in small numbers. This species has seldom occurred in our guava collections, but small numbers are frequently obtained from Surinam cherries, and a few from rose apples and guavas collected on Hawaii. Although other parasites have been released, none has been recovered in our investigations.

ROBERT VAN DEN BOSCH, July 10, 1950.

For some time numerous earwigs have been observed in certain areas living beneath infested, rotting fruits on the ground, which appeared to be subsisting, at least in part, on fruit fly larvae. To study their food habits, several immature earwigs were collected during May and isolated in tin salve boxes containing larvae of *Dacus dorsalis*, which they readily attacked and devoured. They also attack and devour the contents of the fly puparia. On several occasions earwigs were also seen in the field feeding on larvae of *D. dorsalis* in guavas, and on those of *D. cucurbitae* in cucumbers—definite evidence of their predatory habits.

Earwigs were particularly abundant last month in a gulch near Kaneohe, Oahu, where the ground was covered with rotting guavas. Their

² See footnote 1, p. 229.

³ *Opius oophilus* Fullaway; see pp. 248 and 251.

numbers are indicated by the finding of one or more earwigs in 53 of 100 fruits examined at random. Also, fruit fly larvae were noticeably less numerous in the guavas containing the earwigs.

Laboratory feeding tests are underway with immature earwigs of various sizes, to determine their feeding capacities. Battery jar units were set up with artificially infested guavas containing known numbers of *D. dorsalis* larvae; one series received earwigs, the other was reserved as controls. Feeding records are obtained periodically by comparing the surviving fruit fly populations in each series of jars. At the end of the first 13 days there was an indicated destruction of nearly 50 larvae per earwig, showing that these insects are potentially important predators of fruit flies. Two species are involved; they are tentatively identified as *Anisolabis eteronoma* Borelli and *Euborellia annulipes* (Lucas).

P. E. MARUCCI, September 11, 1950.

Although many thousands of a new *Opius*⁴ from northern India, a parasite of the melon fly, have been liberated during the past eight months, only a few adult parasites have been recovered. The apparent failure of this species to become established is extremely puzzling since it breeds readily in melon fly in the insectary. On August 18, 25 females of this *Opius*, reared from puparia of *D. cucurbitae* originating in India, were released near a *Momordica balsamina* vine behind the laboratory. On September 24 several adults of this parasite were seen ovipositing in the small *Momordica* fruits which were then collected and placed in a rearing jar. From 46 fruits 302 melon fly puparia were obtained, which later yielded 26 (9 females) "*Opius* No. 5," and 12 *Opius fletcheri* Silvestri. These rearings indicate that the new melon fly *Opius* can reproduce in Hawaii under natural conditions, and that it should eventually become established here. Its progress is being followed by periodic fruit collections from the *Momordica* vine. Females of *O. longicaudatus*, *O. persulcatus* (so-called) and *O. oophilus* Fullaway were also seen to oviposit in *Momordica* fruits, but only a single adult of the last-named species has been recovered to date.

P. E. MARUCCI, November 13, 1950.

During the past several months investigations of multiple parasitism in oriental fruit fly larvae have been made. (Multiple parasitism is the simultaneous parasitization of a single individual host by two or more species of primary parasites.) So far studies have been limited to the interrelationships of *Opius oophilus* Fullaway⁵ and *O. persulcatus* (the taxonomic status of the last-named insect is in doubt), and relatively few larvae have been examined. However, it is felt that the findings to date warrant mention at this time. As reported elsewhere in these "PROCEEDINGS," *O. oophilus* attacks the eggs of *Dacus dorsalis*, and the so-called *persulcatus* attacks the first instar larvae. This has facilitated our studies because

⁴ This is a species similar to *Opius longicaudatus*, but with different host preferences. It is described as *Opius watersi* Fullaway, on p. 249 of this issue of the "PROCEEDINGS." It has been known locally as "*Opius* No. 5."

⁵ For description and biological notes of this species see pp. 248 and 251.

we have been able to detect easily the small parasite larvae, the eggs or the egg shells in the first instar and small second instar host larvae. Although first instar larvae of the two parasites are, for practical purposes, indistinguishable, no difficulty has been found in determining the species, when larvae are observed, because of the distinctive egg shells associated with them in the host. Eggs of the two parasites differ greatly in size and shape, and identification of the egg shells make it possible to recognize cases of multiple parasitism. Fruit fly larvae used in these studies have been from both naturally (field) infested fruits and artificially (laboratory) infested fruits. Similarly, parasitization has been both natural and artificial. Examination has been restricted to first instar and early second instar host larvae.

So far 158 fruit fly larvae have been examined. Of these, 37 were unparasitized, 79 contained *O. oophilus* only, 12 contained *O. persulcatus* only, and 30 were multiparasitized (contained both parasite species). Because of superparasitism (the parasitization of an individual host by more larvae of a single parasitic species than can mature in that host) the 12 hosts with *persulcatus* only, actually produced 14 parasites. For the same reason the 30 multi-parasitized hosts contained 36 *persulcatus* eggs. Because the great majority of host larvae were parasitized by *oophilus*, many cases of superparasitism by this species resulted; but this factor has no bearing on the findings presented here and is not covered in this discussion.

The most important fact resulting from the work so far is that in all cases of multiple parasitism, eggs of *persulcatus* have shown no development; most of these eggs appeared to be in various stages of degeneration, several being partially or completely collapsed. On the other hand, in all cases where only *persulcatus* was found, they were either well developed, healthy eggs or first instar larvae. These findings indicate that the presence of *O. oophilus* has an adverse effect on the eggs of *persulcatus* in the same host, and that this effect is possibly physiological rather than mechanical. It is emphasized again that these studies are in a very early stage and much more work is needed to gain a better understanding of the problem.

ROBERT VAN DEN BOSCH, December 11, 1950.

The progress of the introduced enemies of the oriental fruit fly has been remarkable on the island of Oahu, but on the other islands of the Territory, probably because fewer parasites were liberated, progress has lagged. However, during the past year parasitism has risen sharply on the island of Hawaii, and percentages of parasitization there now compare favorably with those on Oahu.

The first collections this year on Hawaii were made over several days in late February and early March. These consisted of 24 collections containing 684 guava fruits, from which 3,274 flies and parasites were obtained, with a total parasitization of 32.5 per cent. Of this total 5.2 were *Opius longicaudatus*, 27.3 were the so-called *O. persulcatus*, and 0.03 per cent were *O. incisi*. *Opius oophilus* was not recovered from this series. In June 356 guavas were collected at 13 places; 2,714 flies and parasites

emerged and the parasitization from this series was 37.8 per cent. Of this figure, *longicaudatus* parasitized 3.1 per cent, *persulcatus* 33.1 per cent, and *incisi* 0.1 per cent. *O. oophilus*, which was recovered for the first time, parasitized 1.5 per cent.

The most recent collections were made in October, and show a remarkable increase in parasitization. From 460 guavas from 12 localities, 825 flies and parasites were reared; the parasitization totalled 71.5 per cent. Of this total 0.8 per cent was by *longicaudatus*, 57.4 per cent by the so-called *persulcatus*, and 13.3 per cent by *oophilus*. No *incisi* were recovered. Not only is the high percentage of parasitization interesting, the sharp increase in *oophilus* is also noteworthy.

ROBERT VAN DEN BOSCH, December 11, 1950.

The increase of the Mediterranean fruit fly in some areas where *Dacus dorsalis* is now at a low ebb, suggests some interesting possibilities. Should the present trend continue, *Ceratitis capitata* might conceivably become the major pest of fruits, because the parasites attacking it are less effective than those which attack *dorsalis*. The possibility, therefore, that the parasites of the oriental fruit fly might attack *Ceratitis* becomes of some importance. About a year ago ("PROCEEDINGS," 14:27) we reported the experimental rearing of *Opius longicaudatus* on *Ceratitis*, and an instance apparently involving these two insects in naturally infested peaches on Maui. Last August peaches from Kula, Maui, collected by Mr. Maehler, at 3,700 ft., produced 4,897 adult *Ceratitis*, 18 *D. dorsalis*, 1,091 *Opius longicaudatus* and 23 so-called *O. persulcatus*; these rearings added weight to the belief that *longicaudatus* is actually developing in *Ceratitis* in the field in the Kula district.

A series of comparative laboratory tests was then run to determine the extent to which *Ceratitis* may serve as host for the several recently introduced parasites of *Dacus dorsalis*. In these tests papayas and guavas were separately infested with *Ceratitis* and *D. dorsalis*, and then exposed simultaneously to *O. longicaudatus*, the so-called *O. "persulcatus,"* and *O. oophilus* Fullaway (this species is described on page 248 of this issue of the "PROCEEDINGS"). Fruits used with *O. longicaudatus* contained larger larvae; those offered to "*persulcatus*" contained older eggs and newly hatched larvae; and *oophilus* tests were conducted with newly-deposited eggs of both *Ceratitis* and *D. dorsalis*. There were four replicates in the last-named series, and five with each of the other species. The results are summarized as follows:

Parasite Species	From <i>Dacus dorsalis</i>			From <i>Ceratitis capitata</i>		
	Number puparia obtained	Per cent parasit'd	Per cent females	Number puparia obtained	Per cent parasit'd	Per cent females
Opius "persulcatus".....	1,032	52.9	31.1	528	44.3	27.8
" longicaudatus.....	2,320	52.6	25.0	838	23.4	12.5
" oophilus.....	851	18.7	35.6	483	9.2	16.6

It will be noted that all three parasites were successfully reared on *C. capitata*, though in varying degree. *O. "persulcatus"* appears best adapted to this host, reproducing on it nearly as readily as on *Dacus dorsalis*, while both *longicaudatus* and *oophilus* were only about half as effective on *Ceratitis* as on *dorsalis*. Although these tests are not necessarily indicative of a similar relationship in nature where other environmental factors are operative, the possibilities are encouraging.

D. W. CLANCY, December 11, 1950.