

Progress and Status of Two Recently Introduced Parasites of the Oriental Fruit Fly, *Dacus dorsalis* Hendel, in Hawaii¹

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(Presented at the meeting of December 12, 1949)

In June of 1948, N. L. H. Krauss, Entomologist with the Territorial Board of Agriculture and Forestry, began shipping fruit fly puparia containing parasites to Honolulu from Malaya. Two of the braconids, *Opius persulcatus* (Silvestri) and *Opius longicaudatus* (Ashmead), reared from the puparia were released in relatively large numbers throughout the Territory during the following twelve months. The establishment, spread and increase in abundance of these parasites have been studied fairly intensively since the initial releases were made.² This paper shows the progress and status of these parasites in Hawaii through 1949.

RELEASES

Table 1 summarizes the numbers of *O. persulcatus* and *O. longicaudatus* that have been liberated in the Territory and on Oahu where more intensive studies have been made on their establishment, spread, and abundance. The early releases were predominantly *O. longicaudatus*. However, several small liberations of *O. persulcatus* were made during the fall and winter of 1948-49 in the general vicinity where the bulk of the information given in this paper was obtained.

Table 1.—Summary of liberations of *O. longicaudatus* and *O. persulcatus* in Hawaii.

Liberations	No. parasites liberated ³			
	<i>O. persulcatus</i>		<i>O. longicaudatus</i>	
	Oahu	all islands	Oahu	all islands
July-Sept., 1948	65	65	1,414	1,714
Oct.-Dec., 1948	1,357	1,482	18,494	40,058
Jan.-Mar., 1949	665	5,281	5,543	18,138
Apr.-June, 1949	10,593	14,208	10,675	22,660
July-Sept., 1949	200	1,634	5,488	21,781
TOTAL	12,880	22,670	41,614	104,351

¹ Published with the approval of the Director of the Hawaii Agricultural Experiment Station as Technical Paper No. 194.

² G. B. Mainland and S. Shimono, former members of the entomological staff, obtained an appreciable part of the information presented on the establishment and spread of the two parasites during the fall and winter of 1948-49, and spring of 1949.

³ All parasite liberations were made by the Board of Agriculture and Forestry.

ESTABLISHMENT AND SPREAD OF PARASITES

Within a few weeks after liberation of *O. longicaudatus* recoveries were made from fruits collected at several liberation sites and adults were also readily observed at these places. Furthermore, the parasites spread to a distance of at least one-quarter mile within two months after liberation and one to four miles in four months. By the fall of 1949, *O. longicaudatus* adults were commonly seen on mangoes and other fruits throughout the island of Oahu, and at a number of places on Hawaii, Kauai, and Maui.

O. persulcatus apparently became established from the small liberations made in the fall and winter of 1948-49 but until the fall of 1949 was recovered from only a few places. However, it has now spread a distance of at least six miles from two different liberation points and occurs generally throughout the Honolulu, Kailua, and Waimanalo areas on Oahu. To date it has been recovered on the outer islands only in the vicinities of a few liberation points.

INCREASE IN ABUNDANCE OF PARASITES

O. longicaudatus increased rapidly after its release in Manoa Valley (Table 2) and similar increases were observed in several other liberation areas. Parasitization by this species was frequently as high as 50 per cent

Table 2.—Parasitization of *D. dorsalis* from guava fruits collected in Manoa Valley (Oahu).

Date	No. in sample	No. parasitized by		Total per cent parasitized	Ratio of persulcatus to longicaudatus
		<i>O. persulcatus</i>	<i>O. longicaudatus</i>		
12- 1-48	727	0	1	0.1
12-15-48	206	0	41	19.9
2-16-49	722	0	31	4.3
4- 5-49	581	0	313	53.9
7-29-49	215	19	78	45.1	0.2
9- 9-49	340	272	32	89.4	8.5
10-25-49	476	351	42	82.6	8.4
12- 2-49	192	138	17	85.2	8.1
12- 7-49	246	159	49	84.6	3.2

in fruit collections made in the spring and summer of 1949 on Oahu. The increase on the outer islands has been slower but in a few localities parasitization has exceeded 40 per cent. During the late spring and summer of 1949, the adults of this parasite became conspicuously abundant locally at several places on Oahu and Maui. In these areas hundreds of adults could be seen flying over and resting on low vegetation. However, where close examinations were made, it was found that males predominated in these high populations. In early October *O. longicaudatus* adults (males and females) were seen generally on the slopes of Haleakala (Maui) below 3,000 feet elevation. However, fruit collections at that time indicated

that parasitization was for the most part below 50 per cent. Furthermore, collections made at the same places a month later gave parasitization of less than 10 per cent.

In the shipments from Malaya, *O. persulcatus* predominated to the extent of about 22 to 1.⁴ In Hawaii the initial increase of *O. persulcatus* was considerably slower than that of *O. longicaudatus*. However, relatively few of the former species were liberated until late in the spring of 1949. As stated above, prior to the fall of 1949 *O. persulcatus* had only been recovered in numbers from a few localized areas. Nevertheless, collections made in Manoa Valley (Table 2), Waimanalo (Table 3) and at points throughout a large part of Oahu (Table 4) in the fall of 1949 revealed that *O. persulcatus* had increased in abundance tremendously. In can be

Table 3.—Parasitization of *D. dorsalis* from guava fruits collected at Waimanalo, Oahu.

Date	No. in sample	No. parasitized by		Total per cent parasitized	Ratio of persulcatus to longicaudatus
		<i>O. persulcatus</i>	<i>O. longicaudatus</i>		
6- 7-10-49	354	61	74	38.1	0.8
9-20-49	135	34	15	36.3	2.3
10- 5-49	111	67	7	66.6	9.6
11- 7-49	403	248	25	67.7	9.9
12-13-49	335	192	49	71.9	3.9

Table 4.—Summary of parasitization of different instars of *D. dorsalis* by *O. persulcatus* and *O. longicaudatus* from 52 collections taken on Oahu during October, November, and December, 1949.

Instar	No. flies emerged	No. parasites emerged		Per cent parasitized by		Total parasitization
		<i>O. persulcatus</i>	<i>O. longicaudatus</i>	<i>O. persulcatus</i>	<i>O. longicaudatus</i>	
1st	406	192	12	31.5	2.0	33.5
2nd	2,317	1,501	335	36.1	8.1	44.2
3rd	2,031	1,914	866	39.8	18.0	57.8
TOTAL.....	4,754	3,607	1,213	37.7	12.7	50.4

seen from Table 2 that in the samples taken from Manoa Valley in September, October and December, 1949, *O. persulcatus* alone parasitized 65 to 80 per cent of the larvae of *D. dorsalis*. Many other collections taken on Oahu during this period gave similar high percentages of parasitization by this species. Not only has *O. persulcatus* increased in relative abundance during the fall and winter of 1949 but there has been a great increase in the ratio of this species to *O. longicaudatus*. The combined parasitization by the two species in several collections has exceeded 80 per cent.

⁴ Figures obtained from records submitted by the Territorial Board of Agriculture and Forestry and from the U. S. Bureau of Entomology and Plant Quarantine.

PARASITES REARED FROM DIFFERENT LARVAL INSTARS

During October, November, and December, 1949, several collections of ripe guavas, *Psidium Guajava* L., gathered for the most part from the ground, were made at points well distributed over the greater part of Oahu. Within a day after collection, the *D. dorsalis* larvae were removed from the fruit, segregated into instars, and allowed to complete their development in papaya pulp medium. In this manner parasitization of the different larval groups (instars) at the time of collection, was obtained. A summary of the numbers of parasites reared from the different instars is given in Table 4. This summary is based on rearings from 52 collections, each of which produced both species of parasites. The parasites that emerged from the first instar groups represent parasitization due to attack of only first instar larvae, those that emerged from the second represent parasitization of the first and second instars, and emergence from the third represents parasitization due to attack in all three stages. It is obvious that such figures do not show the maximum parasitization expected in the different stages in the field. From the information given in Table 4, from additional data on parasitization from other collections and from observations of adult behavior, there is considerable evidence that *O. persulcatus* commonly oviposits in younger larvae than those normally attacked by *O. longicaudatus*. The ratios of *O. persulcatus* to *O. longicaudatus* in the different instars obtained from the data in Table 4 are as follows: first instar, 16.0 to 1; second instar, 4.5 to 1; third instar, 2.2 to 1. Females of *O. longicaudatus* are commonly seen inserting their ovipositors in fruits on the ground, whereas adults of *O. persulcatus* apparently rarely occur on fruits on the ground. Furthermore, it can be seen from these figures that there was relatively little increase in parasitization by *O. persulcatus* in the later instars. On the contrary, there was an appreciable increase in the parasitization by *O. longicaudatus* in the larger larvae. There is the possibility that many young larvae stung by *O. longicaudatus* are killed and therefore that the species may actually attack a larger number of young larvae than the figures indicate. Despite this possibility, it now appears probable that *O. persulcatus* has a greater influence on first instar larvae than does *O. longicaudatus*.

SEX RATIO OF PARASITES

The available information indicates that more females than males occur in the populations of *O. persulcatus* and that the sexes occur in about equal numbers in the populations of *O. longicaudatus*. This condition prevailed in the shipments from Malaya as well as in the collections taken from the field on Oahu. In the imported collections, out of a total of 12,710⁵ *O. persulcatus* received, females predominated 2.1 to 1, and in a total of 587 *O. longicaudatus*, females occurred at a ratio of 1.0 to 1. From the 52 Oahu collections referred to above, a total of 3,607 *O. persulcatus* and 1,213 *O. longicaudatus* were reared. The figures show that

⁵ Figures obtained from records submitted by the Territorial Board of Agriculture and Forestry and the U. S. Bureau of Entomology and Plant Quarantine.

the ratio of females to males was 1.8 to 1 for *O. persulcatus* and 1.0 to 1 for *O. longicaudatus*. These ratios are quite similar to those obtained from the Malaya collections.

Table 5.—Sex ratio of *O. persulcatus* and *O. longicaudatus* reared from *D. dorsalis* larvae of different instars at the time of collection.

Instar	<i>O. persulcatus</i>		<i>O. longicaudatus</i>	
	No. reared	Ratio of females/males	No. reared	Ratio of females/males
1st	192	1.8	12	0.2
2nd	1,501	1.8	335	0.7
3rd	1,914	1.8	866	1.1
TOTAL.....	3,607	1.8	1,213	1.0

Table 5 shows the sex ratios of the parasites reared from the different instars of *D. dorsalis* larvae. The sex ratio of *O. persulcatus* was the same for the groups reared from all three host instars, whereas the ratio of females to males of *O. longicaudatus* increased with the later instars. The true sex ratio of *O. longicaudatus* that develop from larvae parasitized in the first instar may be quite different from that shown in Table 5 since relatively few individuals were reared. It would appear from the more favorable sex ratio of *O. longicaudatus* obtained from the third instar that this parasite is better adapted to development in older larvae. Furthermore, the favorable sex ratio of *O. persulcatus* reared from all three instars indicates that it is well adapted for development in the smaller larvae.

DISCUSSION

Sufficient time has not elapsed to determine what the final status of *O. persulcatus* and *O. longicaudatus* will be in Hawaii, or what relation the species will have to each other. However, both parasites have become well established and give promise of playing an important role in reducing the abundance of *D. dorsalis* in the Islands. During the late summer and fall of 1949 *O. persulcatus* increased tremendously in abundance and by the end of the year had become far more numerous than *O. longicaudatus* in several localities. Since *O. persulcatus* is the predominant species in Malaya and there has been a shift in that direction recently in Hawaii, it may possibly become the more important of the two species here.