UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Entomology and Plant Quarantine

ORIENTAL FRUIT FLY INVESTIGATIONS

QUARTERLY REPORT

July 1 - September 30, 1949

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This, the first quarterly report of the Oriental Fruit Fly Investigations, necessarily covers a period of organization and the coordination of activities of all agencies engaged in work on the oriental fruit fly. The foundation for this latter has been laid through the medium of a Memorandum of Understanding among the following agencies:

The Hawaii Agricultural Experiment Station
The Regents of the University of California and the California Agricultural Experiment Station
The Board of Commissioners of Agriculture and Forestry, T. H.
The Pineapple Research Institute of Hawaii
The Experiment Station of the Hawaiian Sugar Planters' Ass'n.
The Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, United States Department of Agriculture.

The Project has been singularly fortunate in these cooperative arrangements, which have already demonstrated their value and which will, without a doubt, continue to do so in an increasing measure.

The cooperation of the Washington Bureau must also be recorded at this time, because it is only through this that the gathering of a competent staff in such a short time has been achieved.

The problem of space was an acute one but this has been greatly relieved through the cooperation of the Administration of the University of Hawaii in purchasing a large surplus building and moving it to an appropriate site near the established fruit fly laboratory.

The Project has also had the advantage of taking over a small but well trained staff from the Division of Fruit Fly Investigations, so that actually three of the projects of the Investigations, namely Commodity Treatments, Biological Control and Chemical Control, were taken over as going concerns. All of these projects have been considerably strengthened and their facilities increased. The two newest projects, namely Area Control and Ecology-Biology, are necessarily in an early stage of organization, but even with these two projects considerable progress has been made in establishing fundamental concepts and the accumulation of essential preliminary data.

The Personnel Chart as of September 30, 1949, which is attached herewith, illustrates the present organization of the Investigations into five major projects. The Ecology-Biology Project is in two divisions necessitated by the physical separation of the synecological work on the islands of Maui and Hawaii. For all but the last named, line projects are available and are reported on by the division leaders on the pages that follow. The synecological work had not been organized to the point where formal division into line projects was feasible by September 30, and in this case the report is made on the basis of the working outline which heads the project leader's report.

These reports follow in the order given below:

Commodity Treatments

Biological Control

Chemical Control

Area Control

Ecology-Biology

BIOLOGICAL CONTROL, Work Project I-o-2 - D. W. Clancy, Project Leader

I-o-2 Biological Control of the Oriental Fruit Fly

1. Reception of Fruit Fly Natural Enemies

A. Foreign Shipments, Australia - - Sixteen shipments were received during the quarter from Mr. Krauss at Cairns, northern Queensland, as shown in the following table. This table also includes the emergence from Shipments 1-2 which arrived in June.

Ship. No.	Date rec'd	No. Puparia	Host fruit	Parasites Reared: Species	Female	Male
AU-1	June 22	1,900	Planchonella sp.	Opius #1	16	23
				Opius #2	33	45
				Opius #3	4	1
				Opius #4	31	22
		4,000	Solanum auriculatum	Opius #5	16	28
AU-2	June 29	831	Planchonella sp.	Opius #1		1
				Opius #2	1	
				Opius #4	1	1
		266	S. auriculatum	None		
		334	Endiandra tooram	Opius #6	1	
		218	Banana	None		
AU-3	July 2	1,163	Planchonella sp.	Opius #1	10	10
				Opius #2	24	11
				Opius #4		4
				pteromalid	(1)	
		184	S. auriculatum	None		
		781	E. tooram	Opius #6	53	46
				Spalangia	(1)	
		185	Acmena macrocarpa	Opius #7	2	
				Spalangia	(7)	

Ship. No.	Date rec'd	No. Puparia	Host fruit	Parasites Reared Species	Female	Male
AU-4	July 6	969	Planchonella sp.	Opius #1	19	29
				Opius #2	27	25
				Opius #3	1	2
				Opius #4	27	33
		200	S. auriculatum	None		
		619	E. tooram	Opius #6	19	19
		471	A. macrocarpa	Opius #7	30	13
				Opius #8	24	9
AU-5	July 9	449	Planchonella sp.	Opius #1	1	
				Opius #2		1
				Opius #4		1
		676	S. auriculatum	Opius #3	1	
				Opius #5	4	14
				Spalangia		(3)
		363	E. tooram	Opius #6	5	2
AU-6	July 16	1,300	Planchonella sp.	Opius #1	24	32
				Opius #2	86	52
				Opius #3	1	
				Opius #4	12	28
		1,722	S. auriculatum	Opius #5	7	41
		255	E. tooram	Opius #6	12	9
				Spalangia		(1)
AU-7	July 20	662	Planchonella sp.	Opius #1	8	6
				Opius #2	39	23
				Opius #3	3	1
				Opius #4	3	2
		376	E. tooram	Opius #6	12	4
		273	A. macrocarpa	Opius #7	10	9
AU-8	July 23	415	Planchonella sp.	Opius #1	5	3
				Opius #2	20	12
				Opius #4	3	1
		515	E. tooram	Opius #6	8	11
		243	A. macrocarpa	Opius #7	1	
AU-9	July 30	509	Planchonella sp.	Opius #1	3	4
				Opius #2	20	7
				Opius #3	1	2
				Opius #4		2
				Dirhinus		(2)
		373	S. auriculatum	Opius #5		1
				Dirhinus		(7)
		950	E. tooram	Opius #6	11	9
		177	A. macrocarpa	Opius #7	6	4

Ship. No.	Date rec'd	No. Puparia	Host fruit	Parasites Reared Species	Female		Male
AU-10	Aug. 7	337	Planchonella sp.	Opius #1	5		3
				Opius #2	3		4
				Opius #3	1		1
				Dirhinus		(3)	
		233	S. auriculatum	Opius #5			1
				Dirhinus		(5)	
		867	E. tooram	Opius #6	12		8
				Spalangia		(1)	
		203	A. macrocarpa	Opius #8			1
AU-11	Aug. 13	1,438	S. auriculatum	Opius #5			1
				Dirhinus		(1)	
		809	E. tooram	Opius #6	41		38
				Spalangia		(6)	
		422	A. macrocarpa	Opius #7	5		8
				Opius #8	2		2
				Spalangia		(4)	
		182	Banana	None			
AU-12	Aug. 24	1,130	E. tooram	Opius #2	1		1
				Opius #6	72		73
				Dirhinus		(13)	
				pteromalid		(1)	
		229	A. macrocarpa	Opius #4			2
				Opius #7	1		5
				Opius #8	14		6
		1,753	Banana	pteromalids		(4)	
AU-13	Aug. 31	238	E. tooram	None			
		130	Banana	None			
		35	A. macrocarpa	None			
		134	Calophyllum inophyllum	None			
AU-14	Sept. 4	1,131	E. tooram	Opius #6	45		36
		252	E. tooram (Babinda, Qd.)	Opius #6	19		7
		545	S. auriculatum	Opius #5			7
				pteromalid		(1)	
		244	A. macrocarpa	Opius #7	1		
		263	A. macrocarpa (Babinda, Qd.)	Opius #7	3		
				Opius #8	56		31
		654	Banana	Opius #2	3		2
				pteromalids		(6)	

Ship. No.	Date rec'd	No. Puparia	Host fruit	Parasites Reared Species	Female	Male
AU-15	Sept. 7	103	S. auriculatum	None		
		441	E. tooram	Opius #6	1	
		171	E. tooram (Babinda, Qd.)	Opius #6	3	1
		123	A. macrocarpa	Opius #7	1	
		1,163	Banana	None		
AU-16	Sept. 10	416	E. tooram (Babinda, Qd.)	Opius #6	31	19
		1,116	A. macrocarpa (Babinda, Qd.)	Opius #7	47	63
				Opius #8	257	189
				Dirhinus		(1)
		430	Banana	None		
		273	Calophyllum inophyllum	None		
AU-17	Sept. 14	908	S. auriculatum	Opius #5	2	9
		500	E. tooram	Opius #6	54	39
		600	E. tooram (Babinda, Qd.)	Opius #6	83	57
				Spalangia		(1)
		159	A. macrocarpa	Opius #7	12	4
				Opius #8	1	
				Dirhinus		(4)
		233	A. macrocarpa (Babinda, Qd.)	Opius #7	3	1
				Opius #8	12	11
				Dirhinus		(1)
		149	Fagraea cambogeana (near Deeral, Qd.)	Opius #2(?)		1
				Opius #8(?)	1	1
		1,135	Carambola (Cairns, Qd.)	Opius #5(?)	6	2
				Opius #2(?)		1
				Opius #8(?)	2	
				pteromalids		(30)
AU-18	Sept. 17	101	E. tooram	Opius #6	23	9
		138	E. tooram (Babinda, Qd.)	Opius #6	6	9
		98	A. macrocarpa	Opius #7		2
				Opius #8	7	1
				Dirhinus		(4)
		258	A. macrocarpa	Opius #7	14	9
				Opius #8	43	39
		154	Calophyllum inophyllum	None		
		142	Fagraea cambogeana	Opius #2(?)	1	3
				Opius #8(?)	2	1

Ship. No.	Date rec'd	No. Pupuria	Host fruit	Parasites Reared Species	Female	Male
AU-18	Sept. 17	90	Fagraea cambogeana (Babinda, Qd.)	None		
		94	Carambola (Cairns)	pteromalids	(6)	
Totals: 18 Shipments		41,653			1,541 (110)	1,311

Eight species of Opius are listed above on the basis of host association, but a recent examination of dead specimens indicates that some revision will be necessary. For example, 2 separate species are included under Opius #1 (1a and 1b, the latter, however, in very small numbers); Opius #2 and #7 are the same; Opius #5 appears to be identical with #1b and #6 with #1a. Several specimens were also found which are obviously different from those listed above. Although still open to revision with further study, we now have about 10 different Opius from the Australian material, most or all of which are probably undescribed. The Dirhinus, Spalangia, and pteromalids have not yet been identified.

Dr. Hardy reports as follows concerning the adult flies reared from these shipments. Most of them are new species assigned manuscript names pending final description.

Dacus tryoni Frogg. ex carambola
Dacus muscae Tryon ex banana
Dacus kraussi (MS) ex Solanum auriculatum
Dacus acmenae (MS) ex Acmena macrocarpa
Dacus laticaudatus (MS) ex Planchonella sp.
Dacus sp. (?) probably new, ex Endiandra tooram
Dacus sp. near tryoni ex Fagraea cambogeana
Asiadacus n. sp. ex Calophyllum inophyllum

Dacus kraussi is the Australian "dorsalis" of literature, and has been reared only from species of Solanum. It will be noted that 8 species of Dacus were reared from 8 different kinds of fruit - a remarkable example of specificity unlike that of most fruit flies. The parasites (Opius) are somewhat less specific than their hosts.

B. Foreign Shipments, Africa - - The first 2 shipments of adult parasites from Natal Province, Union of South Africa via Hoboken, New Jersey, (second quarter's report, page 22) have now been identified. There were 3 species of Opius - O. humilis Silv. and 2 undescribed species - also Tetrastichus giffardianus Silv. which already occurs here. These were obtained from infested

cucumbers and Chrysophyllum sp. at Pietermaritzburg and Eshowe, respectively. Messrs. McGough and Skinner then moved north to Kenya, British East Africa, where the following 6 shipments were made during the quarter. These came from Nairobi and vicinity unless otherwise indicated below.

Ship. No.	Date rec'd	No. Puparia	Host fruit	Parasites Reared Species	Female	Male
AF-3	Sept. 4	14,094	Olea chrysophylla	Opius #1	118	58
		5,564	cultivated cucurbits (Nairobi)	Opius #2	9	5
				Tetrastichus	(63)	
				Dirhinus	(201)	
		587	cultivated cucurbits (Mombasa)	Spalangia	(2)	
		929	cucumbers (Mombasa)	None		
		283	bitter gourd (Likoni)	Tetrastichus	(1)	
		40	Strychnos sp.	Tetrastichus	(13)	
		138	Warburgia ugandensis	Pteromalid	(1)	
AF-4	Sept. 19	11,450	Olea chrysophylla	Opius #1	339	295
		2,282	cultivated cucurbits	Opius #2	2	
				Tetrastichus	(389)	
				Dirhinus	(59)	
		136	Strychnos sp.	Tetrastichus	(10)	
AF-5	Sept. 25	11,900	Olea chrysophylla	Opius #1	914	929
		1,860	cultivated cucurbits	Opius #2	3	10
				Tetrastichus	(197)	
		893	cultivated cucurbits (exposed to Dirhinus)	Dirhinus	(212)	
				Tetrastichus	(27)	
AF-6	Sept. 25		Reared Hoboken, N.J. ex. Olea chrysophylla from Nairobi	Opius #1	(800 alive, 1,150 sent)	
AF-7	Sept. 28		Reared Hoboken, N.J. ex. Olea chrysophylla from Nairobi	Opius #1	(700 alive, 1,200 sent)	
AF-8	Sept. 30	6,720	Olea chrysophylla	(Emergence incomplete)		
		2,943	cultivated cucurbits			
Total: 6 Shipments		59,821		Opius #1	5,003	
				Opius #2	29	
				Tetrastichus	705	
				Dirhinus	472	
				Spalangia	2	
				Pteromalid	1	

The puparia from wild olives, Olea chrysophylla, produced Dacus oleae Gm. and 2 species of Opius. Those are both very small, blackish parasites difficult to separate with the naked eye, and were therefore listed together as "Opius #1". We have tentatively identified them as O. dacicida Silv. and O. africanus Szep. Shipments 6 and 7 contained adults of both species reared at Hoboken, N. J. by T. R. Gardner and forwarded to Honolulu.

The cucurbit material produced an Opius as yet unidentified (#2), a Tetrastichus (probably giffardianus), a Pirhinus and a Spalangia. The emerging flies are no doubt mostly Dacus ciliatus Lw. No adult flies were reared from the Warburgia or Strychnos puparia but additional shipments of these species are expected later on.

C. Foreign Shipments, India -- Only 4 adult flies have emerged from the first 3 Indian shipments containing 10,600 puparia from Berberis vulgaris (see second quarter's report, page 23). These have been identified by Dr. Hardy as probably Staurella n. sp. Attempts to break the diapause by exposure to low temperatures and soaking in water have otherwise been unsuccessful. Recent dissections have shown, however, that most of the puparia are still alive and may therefore yet give emergence.

Seven more shipments were received from Messrs. Bianchi and Newell at Ranikhet, in northern India, during the quarter, as shown in the following table:

Ship. No.	Date rec'd	No. Puparia	Host fruit	Parasites Reared Species	Females	Male
I-4	Aug. 29	4,160	Guava	Opius #1	108	64
				Opius #2	7	3
I-5	Sept. 6	3,050	Guava	Opius #1	2	1
				Spalangia	(4)	
I-6	Sept. 12	3,957	Guava	Opius #1	193	69
				Opius #2	7	2
				Opius #3	2	
I-7	Sept. 15	4,451	Guava	Opius #1	147	61
				Opius #2	1	
I-8	Sept. 15	730	Guava	None		
		80	Mango	None		
I-9	Sept. 19	860	Guava	Opius #1	29	13
				Opius #2		1
				Cynipids	1	1
		195	Mango	Opius #4	3	3
		780	Mixed cucurbits	Opius #5		4
I-10	Sept. 26	360	Mango	Opius #4	1	
		760	Mixed cucurbits	None		
Total: 7 Shipments		19,433			481 (4)	222

The guava and cucurbit material was collected at Bareilly in the lower plains area (elev. 900 ft.); the mango collections came from the vicinity of Ranikhet. Dr. Hardy advises that about 90 percent of the flies from guava are Dacus zonatus (Saund.), about 10 percent are typical D. dorsalis, and 3 specimens were found of an apparently new species near incisus(Walk.). These have produced 3 species of Opius which we have tentatively identified as incisi(#1), longicaudatus (#2), and persulcatus(#3). About 95 percent of these were Opius #1 (incisi?) as noted above. There were also 4 Spalangia and 2 cynipids, as yet unidentified.

The mango collections yielded only Dacus dorsalis and 7 adults of Opius #4 which appears to be the same as Opius #2 ex guava (longicaudatus?). From the mixed cucurbit material we reared numerous D. cucurbitae (also a few D. zonatus and D. dorsalis which may have been accidental inclusions) and 4 males of Opius #5, which also closely resembles longicaudatus and may be identical with #2 and #4.

D. Foreign Shipments, China -- Arrangements have been made through Prof. H. S. Smith of the University of California to receive material collected by Mr. J. L. Gressitt and associates in China. The University is financing this work as part of their contribution to the biological control project. Exploration is under the immediate direction of Mr. Gressitt at Canton, assisted by Mr. Tsing-chao Maa on Formosa and Mr. Chien-chi Hu near Chungking in the interior.

The first 5 shipments arrived from Mr. Maa on Formosa during August, as listed below.

Ship. No.	Date rec'd	No. Puparia	Host fruit		Parasites Reared Species		Females	Males
F-1	Aug. 11	50	Eugenia	javanica	Opius	formosanus		2
F-2	Aug. 18	140	"	"	"	"	4	6
F-3	Aug. 24	47	"	"	"	"		2
F-4	Aug. 25	156	"	"	"	"	5	4
F-5	Aug. 29	79	"	"	Opius	fletcheri(?)	1	
Total: 5 Shipments		472					10	14

Due apparently to low field populations, these puparia were obtained from infested fruits of the wax jambo, Eugenia javanica, which had been exposed to field-collected Opius formosanus in the insectary. The adult parasites were collected from fallen fruits on the ground and by sweeping the nearby vegetation. The puparia were then shipped via air mail in small, water pine-root boxes enclosed in sealed cloth bags inside heavy manila envelopes, as described by Cressitt and Flanders (Jour. Econ. Ent. 1949, 42(1):150). The emerging flies have all been identified as Dacus dorsalis by Dr. Hardy.

B. Foreign Shipments, Saipan - - On July 26, we received 125 puparia of Dacus ochrosiae Hall. which had been collected by Mr. H. H. Ross of the U. S. Bureau of Entomology and Plant Quarantine from fruits of Aglaia marianensis on Mount Popagchan. Previous arrangements had been made through Dr. C. L. Ritchie and Mr. K. L. Haehler of the Honolulu office, who advise that this is a new host and geographical record for D. ochrosiae. Eight adults (3 females) of an Opius closely resembling longicaudatus issued from these puparia.

2. Biological Studies of Introduced Fruit Fly Natural Enemies

This line project includes such testing, experimental breeding, and life history studies of the introduced species as may be necessary or desirable for their complete utilization in the biological control program.

A. Introductions from Australia - - The following table will summarize the 74 separate experimental parasitization tests completed during the quarter in an attempt to propagate the Australian Opius listed under line project 1. A number of additional tests are still underway and will be reported next quarter.

BREEDING TESTS, AUSTRALIAN OPIUS

Species Tested	No. Tests	*No. Parasites Used	Host Fruits	No. Puparia Recovered	Total Flies Reared	Total Parasites Reared	No. Tests Successful
Opius #1 (ex Planchonella sp.)	15	268(152♀)	Guava, roseapple, surinam cherry, strawberry guava, mock orange, mt. apple, Eugenia dombeyi, passion fruit, carambola, tomato, bitter melon, string bean, peach, kumquat, Solanum pseudocapsicum	6,770	3,773 D. dorsalis 313 D. cucurbitae 299 C. capitata	209,17♂ Opius #1 711 O. longicaudatus 134 O. fletcheri 112 O. persulcatus	4
Opius #2 (ex Planchonella sp.)	12	553(339♀)	Guava, roseapple, surinam cherry, strawberry guava, mock orange, mt. apple, Eugenia dombeyi, carambola, Solanum sodum, S. pseudocapsicum, fig, agar media(C. capitata)	5,341	2,974 D. dorsalis 25 C. capitata 8 D. cucurbitae	39♂ Opius #2 612 O. longicaudatus 58 O. persulcatus	4
Opius #3 (ex Planchonella sp.)	4	11(8♀)	Guava, mt.apple, Solanum pseudocapsicum, agar media (C. capitata)	610	459 D. dorsalis 39 C. capitata	1♂ Opius #3 29 O. longicaudatus	1
Opius #4 (ex Planchonella sp.)	8	157(72♀)	Guava, roseapple, surinam cherry, strawberry guava, mock orange, carambola, tomato, bitter melon, agar media(D. dorsalis)	1,843	1,007 D. dorsalis 29 D. cucurbitae	2♂ Opius #4 361 O. longicaudatus 17 O. persulcatus 1 O. fletcheri	2

BREEDING TESTS, AUSTRALIAN OPIUS

Species Tested	No. Tests	*No. Parasites Used	Host Fruits	No. Puparia Recovered	Total Flies Reared	Total Parasites Reared	No. Tests Successful
Opius #5 (ex Solanum auriculatum)	8	211(59♀)	Guava, roseapple, strawberry guava, mock orange, mt. apple, fig, tomato, bitter melon, string bean, Solanum sodum	3,599	2,077 D. dorsalis 81 D. cucurbitae	7♂ Opius #5 528 O. longicaudatus 130 O. fletcheri 57 O. persulcatus	3
Opius #6 (ex Acmena macrocarpa)	17	442(239♀)	Guava, roseapple, surinam cherry, mt. apple, Eugenia dombeyi, tomato, bitter melon, string bean, peach, Solanum pseudocapsicum	6,289	2,747 D. dorsalis 121 D. cucurbitae 112 C. capitata	19♂ Opius #6 1,158 O. longicaudatus 143 O. persulcatus 74 O. fletcheri	4
Opius #7 (ex Acmena macrocarpa)	5	61(33♀)	Guava, roseapple, surinam cherry, strawberry guava, mt. apple, kamani	1,399	1,129 D. dorsalis 2 D. cucurbitae	1♀, 14♂ Opius #7 520 O. longicaudatus 3 O. persulcatus	2
Opius #8 (ex Acmena macrocarpa)	5	109(57♀♀)	Guava, roseapple, mt. apple kamani, bitter melon, string bean	1,439	720 D. dorsalis 25 D. cucurbitae	189 O. longicaudatus 10 O. persulcatus 3 O. fletcheri	0

* Same parasites used in successive tests until they died; based on test records rather than individual parasites.

These tests were conducted in large lantern globe and gallon size mayonnaise jar units, and in 2 x 2 ft. cloth covered outdoor cages, using a wide variety of fruits infested with larvae of Dacus dorsalis, D. cucurbitae, and Ceratitis capitata. The parasites were transferred to successive units after 2-5 day exposure periods. It was found that natural parasitization in guava's could be largely eliminated by picking them at the green-ripe stage before most of the fly eggs had hatched, but we now also expose them to field-collected flies in cages before use because of recent general decline in fruit fly infestation. It has become increasingly difficult to obtain heavily infested fruits reasonably free from natural parasitization.

The Australian Opius are obviously ill-adapted as parasites of the local fruit flies. Oviposition was very limited, mating was observed on only 2 or 3 occasions, and even the males emerged in comparatively small numbers. The biggest obstacle was mating. The males of most species showed little interest in the opposite sex and even when copulation was attempted they were generally repulsed by the females. Various methods were tried without success. These included the use of larger outdoor cages under more natural conditions, the introduction of newly emerged females with active males and vice versa, placing the breeding jars in direct sunlight, cooling the females to immobilize them and then introducing active males, etc. The next step is field liberation in the hope that they may "take" in nature where they have failed in the laboratory.

The Australian Dirhinus, Spalangia, and pteromalid are being propagated in the quarantine room; 243 Dirhinus, 12 Spalangia, and 22 pteromalids were bred on Dacus dorsalis during September, all of which are pupal parasites. Dirhinus is particularly well adapted to mass breeding, but recent dissections indicate that it can develop with equal readiness as either a primary or a secondary parasite.

B. Introductions from Africa - - Numerous tests are underway with Opius #1 ex wild olives and Opius #2 ex cultivated cucurbits, but only 1 male of the latter species has issued from 5 tests completed to date. These will be summarized in the next quarterly report. The excess adults of Opius #1 are turned over to the Territorial Board for liberation. The African Tetrastichus and Dirhinus are also being propagated with ease on Dacus dorsalis in the quarantine room until their specific identities and habits can be determined.

C. Introductions from India - - Ten tests with Opius #1(incisi?) ex guava were completed during September on Dacus dorsalis infesting guava, roseapple, and kamani. These yielded 2 female and 552 male progeny. Females are now emerging in larger numbers from the more recent tests, and second generation placements have been started. It seems likely that a breeding stock of this species will soon be established. Even though O. incisi has already been introduced from Malaya, these may represent a different biological race or strain which might conceivably be better adapted to local conditions.

Nine male progeny of Opius #2(longicaudatus?) ex guava have issued from D. dorsalis infesting guava's in the first two tests completed so far. Placements of the other Indian species are still incomplete.

D. Introductions from China - - The original 9 females of Opius formosanus from shipments 2 and 4 have produced 64 male progeny as parasites of D. dorsalis infesting guava, surinam cherry, roseapple, and strawberry guava. Although developing readily in D. dorsalis its normal host, the females of O. formosanus refused to mate and only male progeny resulted. Additional shipments are expected, however, and with larger numbers available we should be able to establish a breeding stock. We consider this parasite one of the most promising recent introductions.

E. Introductions from Saipan - - The 3 female Opius ex Dacus ochrosiae failed to reproduce on D. dorsalis.

F. Observations on Introduced Malayan Opius - - The following notes were presented at the October 10 meeting of the Hawaii Entomological Society.

Opius longicaudatus - It has been rather generally assumed that O. longicaudatus will oviposit only in larger host larvae - from about one-half to full-grown - as do most other species of Opius that have been investigated. Recently, however, we obtained a number of adult O. longicaudatus from larvae dissected out of field collected kamani nuts as first instars and reared to maturity on agar media. In order to varify this finding, we then exposed separate agar cultures of first, second, and third instar Oriental fruit fly larvae to ovipositing female parasites for 24 hour periods. Oviposition occurred with equal readiness in each series and there was no significant difference in the number of progeny obtained according to host instar attacked.

The ability of Opius longicaudatus to parasitize newly-hatched first instar larvae may have considerable economic significance. At this stage the larvae are just under the skin of the fruit and therefore most vulnerable to attack, especially in larger fruits such as mangoes and avocados where most of them soon penetrate beyond reach of the parasites.

In August several lots of infested peaches from Maui were obtained from Miss Inada of U.H.A.E.S. for experimental parasitization tests. These yielded a total of 383 Ceratitis capitata, 27 Opius longicaudatus, and only 4 Dacus dorsalis; indicating that O. longicaudatus may have developed as a parasite of the Mediterranean fruit fly rather than D. dorsalis, its normal host. This possibility was therefore checked in the laboratory by exposing pure Med. fly cultures in agar media to O. longicaudatus. Oviposition was readily obtained and a number of adult O. longicaudatus issued from these tests - definite proof that this species can successfully parasitize C. capitata.

Opius persulcatus - Increasing numbers of this species have been reared during the past two months from a wide variety of fruits collected at various points on Oahu. These fruits were used in breeding tests with other foreign species and the persulcatus records are, therefore, incidental to this work. We have reared O. persulcatus from guavas, roseapples, kamanis, strawberry guavas, mountain apples, and passion fruit, generally in numbers considerably below those of O. longicaudatus, although several lots actually yielded more persulcatus than longicaudatus. Both species have been observed in the field

ovipositing in the same fruits.

In the original shipments from Malaya, Opius persulcatus was always far more numerous than longicaudatus - with a ratio of about 23 to 1. It will, therefore, be very interesting to see how these species ultimately compare in effectiveness here, after populations become stabilized.

G. Breeding of Thyreocephalus albertisi - - The first eggs produced by the 10 adult females of this staphylinid predator, provided by the Territorial Board on May 12, were found in the breeding jar on the 5th of July. A total of 130 larvae were obtained as progeny from these adults during the quarter. Eight-five were reared to the adult stage, of which 54 or 64 percent were females. Most of the remaining 45 larvae died as a result of excess moisture in some of the tins and from the inadvertent use of sand contaminated with insecticides. The first adults emerged on August 8 and second generation progeny were obtained in about 37 days. There is now a total of 85 adults, 35 larvae, 5 pupae, and an unknown number of eggs in the laboratory.

Observations on the progeny of the original 10 females were made regularly from the time they hatched until they emerged as adults. The newly hatched larvae were placed in individual 2 1/2 inch tin salve boxes with moist sand or soil and kept supplied with an excess of D. dorsalis larvae in fruit, usually guavas. The first instar larvae moulted in about 5 days and the second instar larvae apparently continued to grow until pupation. No other moult was discernible between these stages. At maturity the larval abdomen becomes greatly distended until it resembles that of a queen ant. In this stage the larva constructs a cell in which it may remain for many days, apparently without feeding, before it pupates. The data obtained are summarized in the following table.

Life History of Thyreocephalus albertisi

Stage	4 Days	5 Days	6 Days	7 Days	8 Days	9 Days	10 Days	11 Days	12 Days	13 Days	14 Days	15 Days	16 Days	17 Days	18 Days	19 Days	20 Days	21 Days	22 Days	Total No. Observed	Range in Days	Average in Days	Median in Days
Egg	6	7	2																	15	4-6	4.73	5
1st Instar	1	50	34	7	1															93	4-8	5.54	5
2nd Instar					8	4	5	12	8	13	14	8	7	5	3	0	2	0	2	92	8-22	13.16	14
Pupa					4	12	5	19	27	4	6	3	2	1						83	8-17	11.72	12

H. Artificial Culture of Fruit Flies and Their Parasites - - Flies from the larvae reared on agar-base media during the last quarter and kept in small cages in the laboratory required 39 days to produce fertile eggs. Oviposition was moderate to strong on four successive days and then tapered off quickly. Longevity of these flies was about the same as that of other flies kept in the laboratory, many being still alive but not ovipositing after 60 days.

During the quarter a surface scum of unknown origin sometimes appeared on the agar cultures, causing occasional high mortality to small first and second instar larvae but rarely to those of larger size. If the scum did not develop when the larvae were very small it rarely became established, and it seemed to appear first on the unfed portions of the media. It was most serious when larvae which hatched from eggs taken from mangoes collected in the field, were placed in media, but it also occurred when laboratory produced eggs were used as source of larvae. With high larval populations (over 100 per plate) the surface scum produced little or no mortality. The crowded larvae were able either to ingest the scum more rapidly than it could develop or they secreted some antibiotic factor which checked its growth.

Several fungicides were used as surface sprays in an attempt to control this organism. These were: Moldex and Proprionic acid (.5% and 2 %), Moldex plus Proprionic acid at both concentrations, and copper chloride at .5% and 1%. After spraying newly-hatched larvae from eggs dissected out of field collected

mangoes were placed on the cultures. However, there was very little scum development in any of these plates, including the unsprayed checks, and the experiments were therefore inconclusive. The copper chloride plates were especially clean but the 1% solution appeared to inhibit larval development.

Observations have indicated that when more than 100 larvae were placed in a 3 1/2 inch petri dish containing about 30 grams of medium, the larval period was prolonged and the puparia undersized. The optimum concentration is about 50-100 larvae per plate or 2-4 larvae per gram of media.

Preliminary attempts to rear Opius longicaudatus in agar cultures were briefly summarized in last quarter's report (p. 24). This work was continued during the present quarter and is summarized in the appended table. The media is apparently unattractive to the parasites which do not oviposit appreciably until they are at least 6 days old, when the pressure of the oviposition instinct overcomes their antipathy to the media (cages 22-28). Various attractants applied to the gauze patches were largely ineffective (cages 1-15). After about 6 days, however, they oviposited very readily without any apparent inhibition and produced a generally high degree of parasitization. With further study these techniques could undoubtedly be adapted and improved for the mass production of Opius longicaudatus.

Interesting biological facts concerning Opius longicaudatus were ascertained by the agar culture method. In cages 31-35 and 39-40 newly-hatched first instar larvae were exposed to the parasite with a resultant parasitization equal to that obtained from second and third instar larval exposures. This fact was not heretofor generally attributed to Opius parasites. Opius longicaudatus was also found capable of parasitizing Ceratitis capitata (cages 42 and 43).

The Malayan cynipid parasite, Trybliographa sp., and the African Tetrastichus were also readily propagated on both Dacus dorsalis and Ceratitis capitata in agar-base media. These parasites are actually attracted to the media and are able to work in and upon it without difficulty. They can parasitize naked larvae crawling freely on the surface; they can oviposit thru the surface; and they can parasitize larvae which they find while burrowing thru the agar. In fact, Trybliographa, in particular, will over-parasitize the larvae with resultant high mortality if the ratio of parasites to hosts is too high. Further tests with both of these species are being carried on and will be reported next quarter.

Parasitization of D. dorsalis Larvae in Artificial Media by Opius longicaudatus

Cage No.	Period of Exposure	No. Parasites Used	*Age of Parasites	Emergence Record: No. Flies	Emergence Record: No. Parasite	Emergence Record: % Parasit-	Remarks
1	5 days	10♀♀, 3♂♂	Unknown	6	1♀ , 1♂	25.0	No attractant
2	5 days	10♀♀, 3♂♂	Unknown	6	2♀♀, 5♂♂	53.8	Oil from orange skin
3	5 days	10♀♀, 3♂♂	Unknown	8	2♀♀, 2♂♂	33.3	No attractant
4	5 days	10♀♀, 3♂♂	Unknown	10	1♀ , 1♂	16.7	Oil from orange skin
5	4 days	10♀♀, 5♂♂	1-5 days	6	3♂♂	33.3	Orange extract
6	4 days	10♀♀, 5♂♂	1-5 days	6	1♀ , 1♂	25.0	Lemon extract
7	4 days	10♀♀, 5♂♂	1-5 days	6	1♀ , 2♂♂	33.3	Orange extract
8	4 days	10♀♀, 5♂♂	1-5 days	6	1♀ , 2♂♂	33.3	Lemon extract
9	4 days	10♀♀, 5♂♂	1-5 days	10	1♀ , 1♂	16.7	No attractant
13	5 days	10♀♀, 5♂♂	Unknown	2	19♀♀, 18♂♂	94.9	2nd. instar larvae transferred to fresh media
14	5 days	10♀♀, 5♂♂	Unknown	8	18♀♀, 13♂♂	79.5	.5% pyridine
15	7 days	4♀♀, 6♂♂	2-9 days	11	None		
16	5 days	10♀♀, 10♂♂	5-10 days	23	6♀♀	20.7	Parasites died quickly
17A	3 days	10♀♀, 10♂♂	5-8 days	30	3♂♂	21.1	
17B	3 days	5♀♀, 4♂♂	10-13 days	32	None		Survivors of 17A
18	4 days	1♀	Unknown	23	1♂	4.2	Field collected ♀
19	4 days	1♀	Unknown	17	3♀♀, 2♂♂	22.8	Field collected ♀
20	4 days	5♀♀, 3♂♂	5-9 days	16	15♀♀, 6♂♂	56.8	
21	4 days	5♀♀, 3♂♂	5-9 days	43	2♀♀, 6♂♂	15.7	
22A	2 days	10♀♀, 10♂♂	0-2 days	38	None	-	Newly-emerged parasites
23A	2 days	8♀♀, 8♂♂	2-4 days	31	None	-	Survivors of 22A
24A	2 days	8♀♀, 5♂♂	4-6 days	27	None	-	Survivors of 23A
25A	2 days	8♀♀, 5♂♂	6-8 days	7	6♀♀, 30♂♂	83.7	Survivors of 24A

Cage No.	Period of Exposure	No. Parasites Used	*Age of Parasites	No. Flies	Emergence Record No. Parasite	% Parasit.	Remarks
26A	2 days	7♀♀, 5♂♂	8-10 days	9	13♀♀,23♂♂	80.0	Survivors of 25A
27A	2 days	5♀♀, 2♂♂	10-12 days	12	23♂♂	65.7	Survivors of 26A
22B	2 days	10♀♀,10♂♂	0-2 days	23	None	-	Newly-emerged parasites
23B	2 days	10♀♀, 9♂♂	2-4 days	30	None	-	Survivors of 22B
24B	2 days	10♀♀, 5♂♂	4-6 days	28	None	-	Survivors of 23B
25B	2 days	10♀♀, 5♂♂	6-8 days	19	15♂♂	44.1	Survivors of 24B
26B	2 days	7♀♀, 5♂♂	8-10 days	4	14♀♀,27♂♂	91.1	Survivors of 25B
27B	2 days	3♀♀, 5♂♂	10-12 days	5	24♂♂	82.7	Survivors of 26B
22C	2 days	10♀♀,10♂♂	0-2 days	30	None	-	Newly-emerged parasites
23C	2 days	10♀♀,10♂♂	2-4 days	35	None	-	Survivors of 22C
24C	2 days	8♀♀, 4♂♂	4-6 days	28	None	-	Survivors of 23C
25C	2 days	4♀♀, 3♂♂	6-8 days	29	7♂♂	19.4	Survivors of 24C
26C	2 days	3♀♀, 1♂	8-10 days	10	12♀♀,17♂♂	74.3	Survivors of 25C
27C	2 days	3♀♀, 1♂	10-12 days	2	14♂♂	87.5	Survivors of 26C
28	2 days	9♀♀, 7♂♂	12-14 days	2	36♂♂	94.7	Survivors of 26A,B,&C
29	2 days	6♀♀, 5♂♂	14-16 days	20	24♂♂	54.5	Survivors of 28
30	2 days	2♀♀	16-18 days	18	12♂♂	40.0	Survivors of 29
31	1 day	10♀♀, 5♂♂	7-9 days	1	15♀♀, 9♂♂	96.0	1st. instar host larvae
32	2 days	10♀♀, 5♂♂	7-10 days	6	7♀♀, 5♂♂	66.7	1st. instar host larvae
33	1 day	10♀♀, 5♂♂	7-9 days	16	5♀♀,17♂♂	45.8	2nd. instar host larvae
34	2 days	10♀♀, 5♂♂	7-10 days	10	12♀♀,25♂♂	78.7	2nd. instar host larvae
35	1 day	10♀♀, 5♂♂	7-9 days	8	1♀ ,22♂	74.2	3rd. instar host larvae
36	3 days	1♀	10-13 days	33	6♂♂	15.4	

Cage No.	Period of Exposure	No. Parasites Used	*Age of Parasites	Emergence Record: No. Flies	Emergence Record: Parasite	Emergence Record: % Parasit.	Remarks
37	3 days	1♀	10-13 days	13	4♂♂	23.5	
38	3 days	1♀	10-13 days	2	12♀♀,17♂♂	93.6	
39	1 day	10♀♀	10-11 days	36	4♂♂	36.8	1st. instar host larvae
40	1 day	10♀♀	10-11 days	36	7♀♀,10♂♂	30.9	1st. instar host larvae
41	2 days	20♀♀	10-14 days	11	1♀	8.3	C. capitata larvae
42	2 days	12♀♀	12-17 days	7	2♂♂	2.2	C. capitata larvae
43	2 days	12♀♀	12-17 days	19	3♀♀,11♂♂	26.4	C. capitata larvae

* From beginning to end of test.