

THE INTRODUCTION AND COLONIZATION IN PUERTO RICO OF BENEFICIAL INSECTS PARASITIC ON WEST INDIAN FRUITFLIES

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West Indian fruitflies are well-known pests in Puerto Rico.

Two species of West Indian fruitflies (*Anastrepha mombinpraeoptans* Sein and *A. suspensa* (Loew)) are well known in Puerto Rico. The frequency of their occurrence in the fruits of mango (*Mangifera indica* L.), particularly in many of the introduced varieties, in guava (*Psidium guajava* L.), and in jobos (*Spondias* spp.) may be readily noted throughout the island. In addition *A. suspensa* attacks orange and grapefruit (*Citrus* spp.).

The eggs of these two fruitflies are deposited in the flesh of the fruit and here the young larvae hatch and complete their development; when full-fed, the larvae usually emerge and pupate in the soil. During the larval stage the insect is living in the fleshy part of the fruit where it is protected to some extent from attack by parasites. This protection within the fruit is overcome in the case of some parasite species which have long ovipositors and thus are able to probe rather deeply into the fruit in their search for host larvae. Also, some types of fruit such as the jobo are thin fleshed and the fruitfly larvae must by necessity feed close to the outer surface. However, in most other susceptible hosts the fruitfly larvae are not readily accessible to attack by the parasites.

Facilities of the Bureau of Entomology and Plant Quarantine were utilized in the collection of parasites. The introduction of fruitfly parasites was a project undertaken by the Bureau of Entomology and Plant Quarantine in July 1935. Since October 1936 it has been continued as a project of the Puerto Rico Agricultural Experiment Station of the United States Department of Agriculture. The facilities and personnel of the Bureau of Entomology and Plant Quarantine were utilized to assemble parasite material for shipment to Puerto Rico. Such shipments received from Hawaii were assembled by O. C. McBride, from

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Mexico by A. C. Baker, and from Panama by James Zetek. Material was also received from Brazil, where it was collected by D. T. Fullaway, at that time working with the same Bureau. One shipment of parasites was received from West Africa via Moorestown, N. J., and was collected and handled by the personnel of the Bureau. Two shipments introduced from Hawaii were assembled by D. T. Fullaway of the Board of Commissioners of Agriculture and Forestry, Territory of Hawaii.

A considerable period of time has now elapsed since the introduced fruitfly parasites were liberated. While it appears doubtful if any have become established, it seems worthwhile to record the introductions for the sake of any future investigations which might be undertaken. It will be noted that many of the introduced parasite species were known to be parasitic only on the Mediterranean fruitfly (*Ceratatis capitata* (Wied.)), and while others were known to be parasitic on the genus *Anastrepha* they were not parasitic on the same species of *Anastrepha* which are known to occur in Puerto Rico. This may account to some extent for the failure of their establishment on the Puerto Rican species of *Anastrepha*.

Seventeen species of parasites were introduced into Puerto Rico. From September 1935 to May 1936 there were received from Hawaii 11 shipments of fruitfly parasites composed of 5 species,² namely, *Opius fletcheri* Silv., *O. humilis* Silv., *O. fullawayi* (Silv.), *O. tryoni* Cam., and *Tetrastichus giffardianus* Silv. In addition shipments of *Dirhinus giffardii* Silv. were received from Hawaii in 1937. All these, parasites of the Mediterranean fruitfly (*Ceratatis capitata* Wied.), had been introduced into Hawaii from various countries of the world to aid in the control of this well-known fruitfly pest.

Seventeen shipments were received from the Canal Zone, consisting of six species, *Ashmeadopria* sp., *Eucoila* sp., *Opius bellus* Gahan, *O. cereus* Gahan, *Pachycrepoides dubius* Ashm., and *Pseudeucoila brasiliensis* (R. V. Ihr.), all parasites of *Anastrepha* spp.

From Brazil there were received six species, *Eucoila* (*Hexamerocera*) sp., *Ganaspis* sp., *Opius cereus* Gahan, *Opius* sp. near *cereus*, *Pachycrepoides dubius*, and one species of diapiiid, genus unknown, all parasites of *Anastrepha* spp.

From Mexico 10 shipments of *Opius crawfordi* (Vier.), a parasite of *Anastrepha ludens* (Loew), were sent to Puerto Rico.

One shipment of *Opius perproximus* Silv. was received from West Africa via Moorestown, N. J., through the facilities of the Bureau of

² Determinations of all parasite species introduced were made by A. B. Gahan, C. F. Muesebeck, and L. A. Weld of the Bureau of Entomology and Plant Quarantine.

Entomology and Plant Quarantine. A summary of the introductions is found in table 1.

TABLE 1. THE INTRODUCTION INTO PUERTO RICO, DURING 1935-37, OF PARASITES TO AID IN THE CONTROL OF THE WEST INDIAN FRUITFLIES, *ANASTREPHA* SPP., GIVING SPECIES, ORIGIN OF SHIPMENT, NUMBER OF SHIPMENTS, AND NUMBER OF PARASITES RECEIVED ALIVE

Species	Origin of shipments	Number of shipments	Number of parasites received alive
<i>Ashmeadopria</i> sp.	Canal Zone	7	100
<i>Dirhinus giffardii</i>	Hawaii	2	78
<i>Diapriids</i>	Brazil	1	15
<i>Bucoila</i> sp.	Canal Zone	6	13
<i>Bucoila (Hexamerocera)</i> sp.	Brazil	5	16
<i>Gamaspis</i> sp.	Brazil	1	2
<i>Opius bellus</i>	Canal Zone	17	522
<i>Opius cereus</i>	Canal Zone	16	66
<i>Opius cereus</i>	Brazil	10	654
<i>Opius crawfordi</i>	Mexico	10	3,509
<i>Opius fletcheri</i>	Hawaii	2	118
<i>Opius fullawayi</i>	Hawaii	4	231
<i>Opius humilis</i>	Hawaii	10	556
<i>Opius perproximus</i>	West Africa	1	30
<i>Opius tryoni</i>	Hawaii	11	3,191
<i>Pachycrepoides dubius</i>	Brazil	4	20
<i>Pachycrepoides dubius</i>	Canal Zone	6	105
<i>Pseudeucoila brasiliensis</i>	Canal Zone	10	204
<i>Tetrastichus giffardianus</i>	Hawaii	10	3,728
Total		133	13,158

One shipment of *Opius cereus* originating in Brazil was also transhipped through the facilities of the Bureau of Entomology and Plant Quarantine at Moorestown, N. J.; this shipment also contained specimens of *Opius* sp. near *cereus*, with slightly shorter ovipositor. The number of each species in this shipment was not recorded separately.

The parasites from Hawaii were all introduced species and the native home of each is recorded by Back and Pemberton⁸ as follows:

<i>Dirhinus giffardii</i> (West Africa)	<i>O. humilis</i> (South Africa)
<i>Opius fletcheri</i> (India)	<i>O. tryoni</i> (Australia)
<i>O. fullawayi</i> (Africa)	<i>Tetrastichus giffardianus</i> (West Africa)

Some of the introduced parasite species were reared in the laboratory on West Indian fruitflies. All the introduced parasite species were larval parasites, i.e., they attack their host in the larval stage, with the exception of two, *Dirhinus giffardii* and *Pachycrepoides dubius*, which were pupal parasites. In all species, however, emergence of the adult parasite takes place after the fruitfly puparium has formed. Extensive rearing work was carried on with the two pupal parasites in order to increase the numbers available for liberation. Most of the larval parasites received were exposed in the laboratory to various kinds of

⁸ Back, E. A., and Pemberton, C. E. 1917. The Mediterranean Fruitfly in Hawaii. Bull. 536 United States Department of Agriculture, pp. 1-116. Illus.

TABLE 2. THE LIBERATIONS OF FRUITFLY PARASITES IN PUERTO RICO DURING 1935-38 GIVING PARASITE SPECIES, DATE, LOCATION, AND NUMBER LIBERATED

Species	Date of liberation	Municipalities															Total
		Adjuntas	Añasco	Arecibo	Boqueron	Cabo Rojo	Caguas	Juana Diaz	Lajas	Maricao	Mayaguez	Ponce	Rincon	San-German	Vega Alta	Yauco	
		No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
<i>Ashmeadopria</i> sp.	June-July 1936 .....	...	...	...	...	...	104	...	...	...	...	...	...	...	...	...	104
<i>Dirhinus giffardii</i>	Aug. 1937-Nov. 1938 .....	...	1,354	...	195	...	897	1,291	1,268	...	2,717	307	457	1,019	...	430	9,935
<i>Diapriids</i>	May 1936 .....	...	...	...	...	...	...	...	...	...	...	15	...	...	...	...	15
<i>Eucoila (Hexamerocera)</i> sp.	May 1936 .....	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	2
<i>Eucoila</i> sp.	June-Sept. 1936 .....	...	...	...	...	...	13	...	...	...	...	...	...	...	...	...	13
<i>Opius bellus</i>	June-Sept. 1936 .....	...	...	...	...	...	497	...	...	...	...	...	...	...	...	...	497
<i>Opius</i> spp. ¹	May 1936 .....	...	...	...	...	...	...	...	...	409	...	...	...	...	...	...	409
<i>Opius cereus</i> ²	June-Sept. 1936 .....	...	...	...	...	...	71	...	...	...	...	...	...	...	...	...	71
<i>Opius crawfordi</i>	Aug. 1935-Aug. 1936 .....	...	...	...	1,289	490	655	...	...	1,023	...	...	...	...	...	...	3,457
<i>Opius fletcheri</i>	Oct.-Nov. 1935 .....	...	...	...	...	...	...	...	...	108	...	...	...	...	...	...	108
<i>Opius fullawayi</i>	Oct.-Nov. 1935 .....	...	...	77	...	...	...	...	...	180	...	...	...	...	...	...	257
<i>Opius humilis</i>	Sept. 1935-May 1936 .....	...	...	72	...	...	...	...	79	306	...	...	...	...	...	...	457
<i>Opius perproximus</i>	Feb. 1936 .....	...	...	...	...	...	30	...	...	...	...	...	...	...	...	...	30
<i>Opius iryoni</i>	Sept. 1935-May 1936	496	...	646	...	303	277	...	227	436	...	161	...	...	536	...	3,082
<i>Pachycrepoides dubius</i> ³	June-July 1936 .....	...	...	...	...	...	98	...	...	...	...	...	...	...	...	...	98
<i>Pachycrepoides dubius</i>	June-July 1936 .....	...	...	...	...	...	583	622	...	...	724	...	...	...	...	...	1,929
<i>Pseudeucoila brasiliensis</i>	June-Aug. 1936 .....	...	...	...	...	...	164	...	...	...	...	...	...	...	...	...	164
<i>Tetrastichus giffardianus</i>	Sept. 1935-May 1936	531	...	700	...	...	500	...	318	1,069	...	204	...	...	399	...	3,721
Total		1,027	1,354	1,495	195	1,592	1,387	4,283	1,890	624	6,248	1,048	822	1,019	935	430	24,349

¹ Material received from Brazil. Two species are recorded together; *Opius cereus* and *Opius* sp. near *cereus* with slightly shorter ovipositor.

² Material received from Canal Zone.

³ Reared material.

fruit infested with West Indian fruitflies in order to determine if the hosts occurring in Puerto Rico were acceptable to them.

Dirhinus giffardii was reared in large numbers in the laboratory on both species of *Anastrepha* and also on the housefly (*Musca domestica* L.) and on the papaya fruitfly (*Toxotrypana curvicauda* Gerst.). Oviposition was readily obtained in freshly formed puparia of all species.

Pachycrepoides dubius was successfully reared on both species of *Anastrepha*, also on the housefly (*M. domestica*), on the hornfly (*Haematobia irritans* (L.)), and on *Sacrophagula occidua* F. Both these pupal parasites apparently attack a large variety of dipterous puparia.

Opius bellus was successfully reared in the laboratory on *Anastrepha mombinpraeoptans* infesting jobo. It was not tried on other host fruits.

Opius crawfordi was not successfully reared on either species of *Anastrepha*. Infested fruits of jobo and guava were both tried without success. Probing in the fruit was observed, but no parasites ever issued.

Opius humilis was successfully reared on *Anastrepha suspensa* infesting pomarosa but did not successfully oviposit in *A. mombinpraeoptans* infesting mango.

Opius tryoni was successfully reared on *Anastrepha mombinpraeoptans* infested jobo, and a few specimens were reared from *A. mombinpraeoptans* infesting mango.

Oviposition with the various species of *Opius* was obtained by placing infested fruit in a suspended position in cloth cages containing the parasites. The many failures in the case of the fruitfly infesting mango can probably be attributed to the fact that the host larvae were deep in the flesh of the fruit and the parasites were unable to reach them for successful oviposition.

Liberations of fruitfly parasites were made throughout the island. Extensive liberations of the various species of imported parasites were made in 15 different municipalities of the island. A summary of the liberations is found in table 2.

Eight species of native parasites were reared from West Indian fruitflies. Eight species of native parasites were reared in Puerto Rico from the West Indian fruitflies (*Anastrepha mombinpraeoptans* and *A. suspensa*). Table 3 is a summary of the parasite species reared.

The only native parasite which is of any importance in controlling either of these fruit pests is *Opius anastrephae*, which is often found in abundance attacking *Anastrepha mombinpraeoptans* infesting jobo. The other beneficial species are found only occasionally and the percentage of parasitization by these was always less than 1 percent. This variation in parasitization is believed to be largely due to the difference in the types

TABLE 3. INDIGENOUS PARASITES REARED FROM WEST INDIAN FRUITFLIES IN PUERTO RICO, 1935-38

Parasites of <i>Anastrepha mombinpraeoptans</i>	Parasites of <i>Anastrepha suspensa</i>
<i>Ashmeadopria</i> sp.	<i>Ashmeadopria</i> sp.
<i>Bucoila</i> sp.	<i>Bucoila</i> sp.
<i>Bucoila</i> (<i>Hexamerocera</i>) sp.	<i>Bucoila</i> (<i>Hexamerocera</i>) sp.
<i>Opius anastrephae</i> Vier.	<i>Ganaspis</i> sp.
<i>Trichopria</i> sp.	<i>Opius anastrephae</i>
	<i>Phaenopria</i> sp.

of fruit infested by the two species of *Anastrepha*. *A. suspensa* is found largely in fleshy fruits whereas the jobo, a favorite host of *A. mombinpraeoptans*, is thin fleshed and the fruitfly larvae, which by necessity feed close to the surface, are readily accessible to attack by parasites. All the native parasites known to be present in Puerto Rico have short ovipositors and are not able to probe deeply into the fruit in search of host larvae.

Shipments of parasites were made to Hawaii and the Dominican Republic. Two shipments of *Opius anastrephae*, the native parasite attacking *Anastrepha* spp. in Puerto Rico, were made to Hawaii for trial against the Mediterranean fruitfly. On October 12 and 15, 1935, two shipments containing 640 and 137 adults of this parasite, respectively, were sent to Hawaii by air express.

A consignment of 1,300 *Dirhinus giffardii*, the pupal parasite, imported from Hawaii, was sent to the Dominican Republic in October 1938. A second shipment of 150 adults of the same species was sent to the Dominican Republic in August 1939.

Only one introduced parasite species was ever recovered. Collections of various fruits infested with West Indian fruitflies have been made at frequent intervals and in large numbers throughout the island since liberations were made. In addition large collections of material made by workers of the Bureau of Entomology and Plant Quarantine stationed in Mayaguez have been available for observational purposes. However, with the exception of one species, *Opius tryoni*, introduced from Hawaii, there were never any recoveries. Recoveries of *Opius tryoni* were made from *Anastrepha mombinpraeoptans* infesting jobo at Mayaguez in August, September, and October 1935 and at Sabana Grande in July and August 1936; the latter recovery was made by J. W. Balock of the Bureau of Entomology and Plant Quarantine while carrying on other work with *Anastrepha* spp. Despite the fact that these recoveries were made some months after the last liberations and also at considerable distances from the original liberation points, the species has since disappeared and apparently has been unable to maintain itself.

Recoveries of *Pachycrepoides dubius* were made at a number of points in the vicinity of liberations. However, this cosmopolitan parasite species is so well distributed over the world that it may possibly have already existed in Puerto Rico, although its presence had never previously been recorded in the island. The species is now known to be present in many sections of the island; however, the percentage of parasitization has always been low and it is questionable whether it is established as a result of importations or is an indigenous species.