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INTRODUCTION AND COLONIZATION OF TWO PARASITES OF THE PINEAPPLE MEALYBUG IN PUERTO RICO

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Mealybug is the most important insect pest of pineapples in Puerto Rico.

The pineapple mealybug, *Pseudococcus brevipes* (Ckll.), is the most serious insect pest of pineapples in Puerto Rico and is widely distributed over the island. It attacks the roots, leaves, and fruits of all varieties thus far grown in the island.

Experiments in the Hawaiian Islands have shown that the mealybug secretes a toxin into the pineapple plant which causes a wilted, flaccid appearance, which varies considerably with the varieties attacked. Where the mealybugs colonize in large numbers, widespread crop failure may be caused in the more susceptible varieties.

In an effort to reduce the population of the mealybug by natural means and thus to supplement cultural and other artificial control measures, the United States Department of Agriclture began the introduction into Puerto Rico of mealybug parasites early in 1936 from field explorations conducted under processing tax funds by the Bureau of Entomology and Plant Quarantine. Further introductions were made during the next year by the Puerto Rico Experiment Station of the same department at Mayagüez. The present paper records these introductions and the rearing, colonization, and recovery of the parasites in the pineapple regions of the island.

Importations of mealybug parasites were made from Brazil and Hawaii.

The first shipments of pineapple mealybug parasites, totaling 47 adults of *Anagyrus coccidivorus* Doz., were received by air express directly from Brazil in 1936. Of these 10 adults were liberated but

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the remainder could not be successfully reared for mass liberation. Further introductions of this species and of another, *Hambletonia pseudococcina* Comp., were made from Brazil and Venezuela vía Hawaii in 1937, and these parasites were successfully reared in the laboratory and liberated in Puerto Rico. The shipments coming directly from Brazil were made by D. T. Fullaway, at that time of the Bureau of Entomology and Plant Quarantine. The later shipments from Hawaii were assembled by Mr. Fullaway, then of the Board of Commissioners of Agriculture and Forestry, Territory of Hawaii, cooperating with Walter Carter, Entomologist, Pineapple Experiment Station, University of Hawaii at Honolulu. All of this later material was sent to Puerto Rico by air express, and the mortally en route was negligible. Table 1 is a summary of the introductions of pineapple mealybug parasites made during 1936 and 1937.

TABLE 1—THE INTRODUCTION INTO PUERTO RICO OF TWO PARASITES WHICH ATTACK THE PINEAPPLE MEALYBUG, *PSEUDOCOCCUS BREVIPES*, GIVING DATES, COUNTRIES OF ORIGIN, SPECIES, AND NUMBERS INTRODUCED

Dates	Countries of origin	Species introduced	
		Anagyrus coccidivorus	*Hambletonia pseudococcina*
		Numbers	*Numbers*
February and March 1936	Brazil	47	.....
January 4, 1937	Venezuela[1]	.....	54
May 6, 1937	Brazil[1]	75	.....
Total	.....	122	54

[1] Received via Hawaii.

With the exception of 10 adults of *A. coccidivorus* received in March 1936 all of the parasites were retained in the laboratory for rearing purposes.

Hambletonia pseudococcina **was successfully reared in the laboratory.**

Breeding work with *Hambletonia pseudococcina* was started in January 1937. The first generation reared was not particularly successful, and only two females survived. Fortunately, the species reproduces parthenogenetically and the succeeding generation produced 20 females. Numerous variations in the breeding technique were tried in which various types of cages were employed. Eventually, however, the use of a cage designed and used successfully in Hawaii by Walter Carter (1) was adopted and placed in general usage.

The cage used consisted of a celluloid cylinder with cloth ends which may be tied in about the stalk of the pineapple plant and held

by a support above. Entrance holes and ventilation were provided by openings in the celluloid cylinder. The method followed here was not to infest the fruit by the placing of mealybugs directly on the plant, but to place heavily infested leaf cuttings in the cage, completely surrounding the fruit. From these the young mealybugs readily passed to the fruit and were also carried there by ants, which while not entirely eliminated were never allowed to become numerous. The adult parasites were introduced at the same time as the mealybugs, and many of the mealybugs on the leaves became parasitized and remained settled in position. The parasitized mealybugs on the leaves were removed just prior to expected emergence and the fruit left intact. The fruit which soon became well infested produced some parasites which then proceeded to parasitize the new developing generation of mealybugs, and usually an excellent second generation of parasites thus resulted. The foregoing method eliminated the labor of infesting the fruit by hand, which is time-consuming and difficult to accomplish without injury to the mealybugs. Five adult parasites were usually placed in each cage to start a new generation. This breeding work with *Hambletonia pseudococcina* was discontinued in March 1938 after 6,917 adults had been reared.

Females produced parthenogenetically but males occurred occasionally.

The strain or race of *Hambletonia pseudococcina* received from Hawaii was able to reproduce parthenogenetically but males also occurred. Of the 6,917 adults reared in the laboratory, 40 were males. Mating seemed to take place normally, but the sex ratio among the resulting progeny was apparently no different from that among progeny from parthenogenetic females. Carter (1) states that the Brazilian strain of *H. pseudococcina* is bisexual but that the material he has studied from Colombia and Venezuela reproduced parthenogenetically.

In mating a long courtship was noted to take place. The male took up a position directly in front of the female caressing her with his antennae and preventing any forward movement on her part. As the female turned to escape the male also turned and maintained his position. This procedure continued for several minutes until the male suddenly mounted the female, the period of copulation was always short and was seldom observed to be over 10 seconds.

Oviposition by this parasite has been observed only in half-grown or larger mealybugs. The procedure followed was for the female parasite to crawl about the plant until it had located a suitable

mealybug. This done, the parasite caressed the mealybug for some seconds with its antennae, them quickly reversing its position it backed up, and inserted its ovipositor at the nearest point in the body of the mealybug. Oviposition was noted to continue over a period of time, during which a considerable number of mealybugs could be parasitized by one female.

The females are apparently gravid and able to oviposit at the time of emergence or shortly thereafter; specimens have been reared from mealybugs which were exposed to newly emerged females for a period of only a few hours. At the end of about 18 to 20 days after oviposition the parasitized mealybugs became mummy-like in appearance and in some cases gave the superficial appearance of dipterous puparia. The period from oviposition to initial emergence varied from 24 to 30 days, with the greater majority of the parasites emerging at the end of 26 days.

Three parasites were reared from a single parasitized mealybug.

A group of 25 pineapple mealybug mummies, parasitized by *Hambletonia pseudococcina* was removed from a plant just prior to their expected emergence and placed in separate vials. Parasites emerged from 17 of the isolated mummies: 9 produced a single parasite each, 7 produced 2 parasites each, and 1 produced 3 parasites. In all but one instance the multiple emergence occurred on the same day; in this instance a male, the only one reared from this material, emerged 2 days after a female had emerged from the same mealybug.

Anagyrus coccidivorus **was reared in the laboratory.**

Adults of *Anagyrus coccidivorus* were received from Hawaii in May 6, 1937 and a breeding program was imediately started. "Carter Cages" were used almost exclusively and gave excellent results. The period of development for this species was somewhat shorter than for *Hambletonia,* varying from 19 to 21 days from oviposition to emergence. From May 1937 through December 1938 a total of 9,673 individuals was reared, 4,545 males and 5,128 females. The males usually emerged 1 to 2 days previous to the females. Mating took place readily shortly after the females emerged in the cages or in glass vials.

It is of interest to note that Dozier(2) originally described this species from Haiti as a parasite of *Pseudococcus virgatus* Ckll. The present parasite material, which came from Hawaii, was originally collected in Brazil by D. T. Fullaway from *Pseudococcus brevipes.*

Liberations of pineapple mealybug parasites were made throughout the island.

Liberations of *Hambletonia pseudococcina* and *Anagyrus coccidivorus* were made throughout the pineapple-growing sections of the island as fast as the parasites could be reared. Table 2 which follows summarizes these liberations.

TABLE 2—THE LIBERATION OF *HAMBLETONIA PSEUDOCOCCINA AND ANAGYRUS COCCIDIVORUS* IN PUERTO RICO, GIVING LOCATIONS, DATES, AND NUMBERS LIBERATED

Locations	Dates	Liberations	
		Hambletonia pseudococcina	*Anagyrus coccidivorus*
		Numbers	Numbers
Arecibo	April 1937 to May 1938	[1] 2,116	
Arecibo	March 1936		10
Arecibo	June 1937 to July 1938		3,184
Bayamón	November to December 1938		277
Lajas	May to August 1938		3,687
Lajas	April to October 1937	[2] 1,711	
Mayagüez	June 1937 to June 1938	345	
Corozal	June 1937	950	
Toa Alta	July 1937	[3] 1,071	
Total		6,193	7,158

[1] Including 13 males.
[2] Including 11 males.
[3] Including 9 males.

***Hambletonia pseudoccocina* has become well established in various localities.**

The first recoveries of *Hambletonia pseudococcina* were made at Lajas on May 7, 1937, when two specimens emerged from mealybugs brought into the laboratory from that locality. Since that time, frequent recoveries have been made; in February 1938, adults were found at Lajas, and one plant examined showed 38 parasitized mealybug mummies to be present; examinations a month later showed that nearly all infested plants harbored parasitized mealybugs. In January 1939, observations showed this parasite to be present in all the fields examined in four separate localities about Lajas, and parasitized mealybugs were readily collected in large numbers throughout this area.

In March 1938, recovery of four adults was made from mealybugs collected at Arecibo. In September 1938, a recovery was made at Las Mesas, Mayagüez. It appears from the foregoing that this species is well established, and it is hoped that some reduction in the pineapple mealybug infestation will result from its introduction.

Anagyrus coccidivorus has not been recovered to date. Liberations will therefore be continued with the expectation that this species may also become established and aid in the control of the pineapple mealybug.

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