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THE CITRUS BLACKFLY[1] IN ASIA, AND THE IMPORTATION OF ITS NATURAL ENEMIES INTO TROPICAL AMERICA

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FOREWORD

The introduction and establishment of important Malayan parasitic and predacious enemies of the blackfly in the American Tropics, recorded in this bulletin, is one of the outstanding successes in this rapidly growing field. The effort was a cooperative one, supported by Cuba and the United States. The blackfly in Cuba has been for many years a very serious obstacle to the citrus industry and had in addition a fairly wide distribution elsewhere in the American Tropics. The interest of the United States was to reduce the risk of entry of this pest into the citrus areas of Florida or other of our subtropical areas, and also as provision for aid in future control

[1] *Aleurocanthus woglumi* Ashby.

[2] The authors wish to acknowledge the many courtesies and the valuable assistance rendered during the course of the foreign investigations by the officials of the Departments of Agriculture of the Federated Malay States and of the Dutch East Indies. J. M. McHugh has assisted in the colonization work in Cuba since June, 1930, and D. W. Jones, of the Division of Cereal and Forage Insects, was present in an advisory capacity during the early work upon the imported parasites during April and May, 1930. James Zetek, in charge of the Bureau of Entomology laboratory at Balboa, Canal Zone, rendered valuable assistance in the preparations for the second trip to Malaya and was responsible for the colonization and establishment of *Eretmocerus serius* Silv. in Panama. S. C. Bruner, of the Estacion Experimental Agronomica in Cuba, and J. J. Bowman, of the United States Bureau of Plant Industry, made the citrus canker inspections of the final shipment. Determinations of the species dealt with in this bulletin are by the following specialists: Chalcidoid Hymenoptera by A. B. Gahan, Coccinellidae by E. A. Chapin, Lepidoptera by C. Heinrich, and Diptera by J. R. Malloch.

POTENTIAL STATUS OF THE BLACKFLY IN THE UNITED STATES

In comparison with the records for Habana, a locality in which the blackfly is a major pest, it is seen that in Florida the total amount and distribution of the rainfall and the range of the humidity are quite similar. Consequently, if *A. woglumi* should become established in Florida, its status may be expected to be approximately the same as in Cuba, but with a more pronounced period of delayed development during the winter due to the lower prevailing temperatures.

In view of the fact that the blackfly requires both a relatively high humidity and considerable rainfall during its period of development, both of which factors are conspicuously lacking in all of the citrus-growing districts of California, it is felt with a considerable degree of certainty that this insect, should it become established in that State, would have difficulty in maintaining itself and presents no possibility of increase to the status of a pest.

NATURAL ENEMIES OF THE CITRUS BLACKFLY

The first observations upon the natural enemies of *Aleurocanthus woglumi* in tropical Asia were made by Silvestri in 1924–25, during the course of his travels through that part of the world in the search for natural enemies of various other citrus insects for importation into California. His reports (*10*, *12*) on the parasites reared from Aleyrodidae upon citrus contain the descriptions and figures of four species found to attack *woglumi*, with an additional species since found to be a secondary parasite. Short biological notes are given regarding several of these species.

The complete list of natural enemies observed by the senior writer in the course of these investigations is as follows:

The internal parasites:

Hymenoptera (Eulophidae)—
- *Encarsia merceti* Silv.
- *Eretomocerus serius* Silv.
- *Prospaltella divergens* Silv.
- *Prospaltella smithi* Silv.
- *Prospaltella* sp.

The predators:

Coleoptera (Nitidulidae)—
- *Cybocephalus* sp.

Coleoptera (Coccinellidae)—
- *Cryptognatha* sp.
- *Scymnus smithianus* Silv.
- *Scymnus* sp. near *pallidicollis* Muls.
- *Scymnus* sp.

Lepidoptera (Pyralidae)—
- *Cryptoblabes gnidiella* Mill.

Diptera (Drosophilidae)—
- *Acletoxenus indica* Malloch.
- *Acletoxenus* sp.

Neuroptera (Chrysopidae)—
- *Chrysopa* sp.

LEPIDOPTERA

CRYPTOBLABES GNIDIELLA MILLIÈRE

The pyralid predator *Cryptoblabes gnidiella* has been found as an enemy of the blackfly in only two instances. The first was in March, 1931, in a grove of young citrus trees near Muar, Johore, in which a number of the trees were heavily infested with *A. woglumi*. The larva, which is purplish in color, forms a light web over the undersides of heavily infested leaves, and beneath this web it moves about among the masses of blackfly larvae and pupae. Pupation occurs in situ in a fold or depression in the leaf. On a few trees these larvae and pupae could be found on practically every infested leaf. The second collection locality for this species was at Medan, Sumatra, upon *A. citriperdus*, though the number observed was very small.

Laboratory experiments established the fact that the larvae feed upon the living blackfly in the late larval and pupal stages. From field observations, however, it would appear that the species is, to an uncertain extent, a scavenger rather than a predator. In several instances young larvae were found to be active and able to attain maturity in colonies from which adult emergence had been completed some time previously.

An examination of the literature relating to *C. gnidiella* shows that it attacks cotton and a variety of other plants in Egypt and grapevines in southern Europe, and it is listed as a citrus pest in Spain. Dudgeon (*4*), however, mentions it as being possibly an enemy of the bollworm *Earias insulana* Boisd. in Egypt, while *C. prolucella* Hamp. is on record as feeding upon *Coccus viridis* (Green) in Ceylon.

DIPTERA

ACLETOXENUS INDICA MALLOCH

GENERAL

The predacious drosophilid *Acletoxenus indica*, originally described from southern India, is of fairly common occurrence in infestations of Aleurocanthus and various other aleyrodid genera in Java. It was found most abundantly at Bandoeng attacking *Aleurocanthus citriperdus* and, to a lesser extent, *A. woglumi* also. Where both species occurred upon the same tree the greater proportion of Acletoxenus eggs and larvae were always to be found among the *citriperdus* clusters.

In Malaya and Ceylon occasional empty puparia, identical in form and appearance with that of this species, have been noted in colonies of several genera of Aleyrodidae, but no adults could be secured for determination. Likewise, a few empty puparia of similar appearance have been seen among several aleyrodid clusters upon jungle plants in Cuba.

At Bandoeng, Java, *Acletoxenus indica* is the dominant predator upon Aleurocanthus, though it is of little importance from the standpoint of control. In other localities the number found upon infested trees was very small.

Under field conditions in Java *A. indica* is heavily parasitized by a species of Myiocnema. The egg of this eulophid must be laid either

in the host egg or young larva, though the adults emerge from ... puparia, as isolated larvae have often yielded the parasite. ... 220 eggs, larvae, and puparia collected at Bandoeng in April, ... 68 per cent yielded Myiocnema instead of the fly. The ex... position of the egg, if this is attacked, and the very sluggish ... of the larva, render the species particularly susceptible to pa... attack.

Two attempts have been made to effect the importation of ... toxenus into Cuba, but both have failed. The confined quarters ... vided in the Wardian cages, as well as the reduced light therein, ... parently were unsuited to the habits of the adult flies and practic... no oviposition occurred. The first shipment was upon croton pl... heavily infested with a species of Dialeurodes and the second u... citrus bearing an ample supply of blackfly. Examination of ... shipments upon arrival showed no living flies in any stage and ... an occasional empty puparium. In the last shipment 50 larva... various stages of development, in addition to 15 adult flies, ... placed in the cage at the time of shipment, but so far as could ... determined by examination of the infested plants en route, n... single egg was laid.

LIFE HISTORY AND HABITS

The egg of *Acletoxenus indica* is 0.4 mm in length and 0.2 mm ... maximum width at the posterior pole, and tapering somewha... ward the anterior end. The surface is covered with a white ... incrustation which is somewhat roughened with irregular and ... times indistinct reticulate markings. Oviposition occurs dur... midday, and the eggs are placed singly upon the leaf surface a... cent to a late-stage larva or pupa. It lies horizontally and adh... firmly to the leaf.

The larva in its early stages is translucent white, but later take... a distinct greenish hue due to the body contents being visible thro... the transparent integument. Feeding occurs largely upon ma... larvae and pupae. The larva is quite inactive and never moves ... the leaf upon which the egg was laid. Such movement is unn... sary in view of the fact that a single cluster of average size pro... sufficient food material to bring the larva to maturity. Pupa... occurs in situ upon the under surface of the leaf.

The larvae of this predator apparently secrete over the bo... fluid substance of a decidedly mucilaginous character, and ... later stages this serves to attach particles of extraneous matt... the body, particularly on the dorsum. Many mature larvae c... a large number of Aleurocanthus eggshells in this way, and ... may also be found upon the puparium.

The puparium is 2.8 mm in length and of the form show... Figure 14, B. Its ventral surface is flat and adheres strongly t... leaf surface. During the early portion of the pupal period ... greenish color of the body contents shows distinctly through ... semitransparent integument, and later the large eyes of the deve... ing pupa, which are deep red, may be distinctly seen. Emerge... is effected by the breaking away of the distinct lid at the ante... end. The empty puparium is white.

The adult fly (fig. 14, A) is conspicuous upon the foliage because of its black, yellow, and white markings. The general habits of this species correspond to those of other species of the family.

The duration of the life cycle has not been definitely ascertained, but eggs collected in the field have yielded adult flies in approximately two weeks.

ACLETOXENUS SP.

A second species of Acletoxenus was found only in very small numbers in an infestation of *Aleurocanthus citriperdus* and *woglumi* at Kaban Djahé, Sumatra, while empty puparia of what was presumed to be the same species were occasionally noted at Medan.

The egg and larval stages, as well as the general habits of the species, are identical with those given for *Acletoxenus indica* from Java.

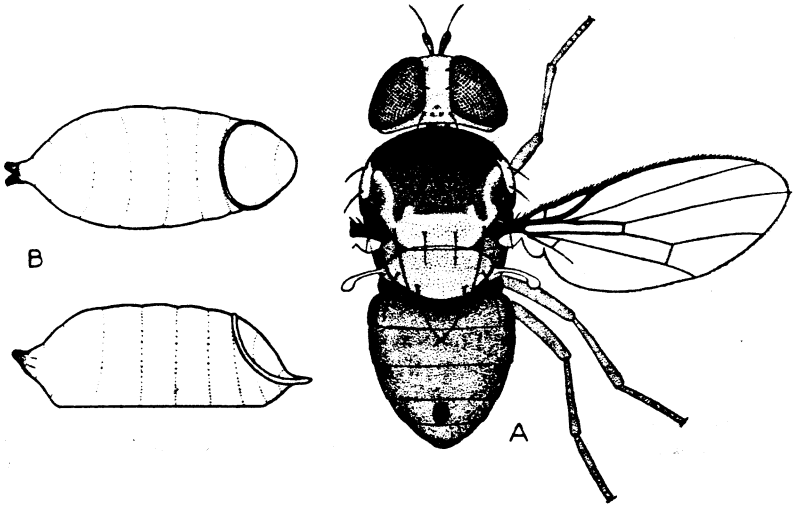

FIGURE 14.—*Acletoxenus indica:* A, Adult female, × 24; B, dorsal and lateral views of the puparium, × 16

NEUROPTERA

CHRYSOPA SP.

While this chrysopid is a general predator upon many insects in addition to *Aleurocanthus woglumi*, it is invariably found in all infestations of Aleurocanthus in the Malayan region. It is of little or no appreciable value in controlling the infestations of blackfly, yet because of its general occurrence it ranks first among the predators of *A. woglumi* in Malaya.

The larva carries upon its body a considerable mass of miscellaneous material, the greater proportion of which, in blackfly infestations, consists of the cast larval skins of its prey.

NATIVE PREDATORS IN CUBA, PANAMA, AND JAMAICA

The original blackfly stock from which the infestations in tropical countries of America originated was apparently entirely free

this abundance permits each collector to secure several thousand per day. In making these field collections, as well as those from the plants and cages in the insectary, a suction bulb arrangement upon the collecting vials greatly facilitates rapid handling.

In the distribution of the parasites to localities too far distant for the forwarding of adults, the shipment of infested leaves from well-parasitized host colonies is the more practicable method. The leaves are collected when the blackfly is largely in the pupal stage and the parasites consequently nearly ready to emerge. The ordinary mailing tubes are satisfactory for shipping. Material collected in this way and kept under moderately humid conditions will yield parasites for a period of 10 to 15 days after collection.

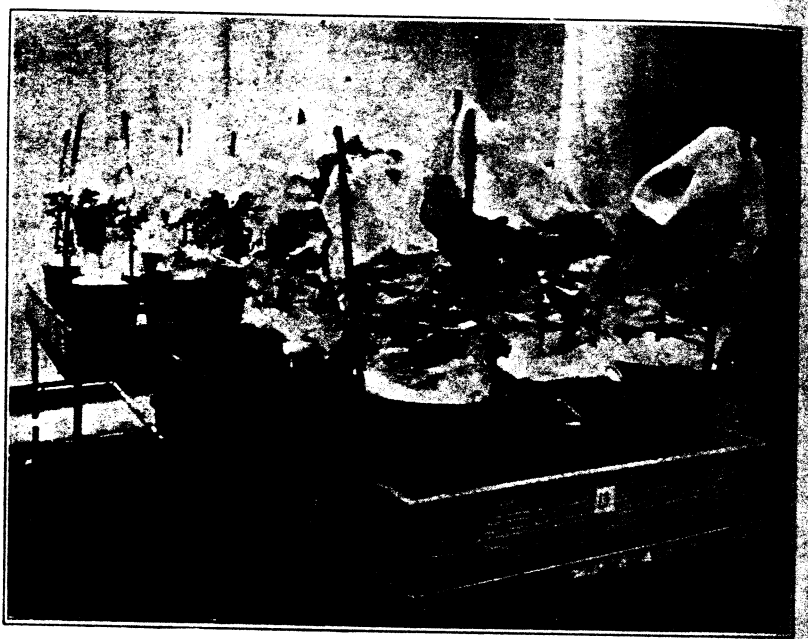

FIGURE 19.—Bags of transparent cellulose paper and cloth, over infested citrus seedlings, used for rearing parasites and predators in the insectary and for field colonization. (Photo by Cuban Agricultural Experiment Station)

SUMMARY

The citrus blackfly (*Aleurocanthus woglumi*) occurs generally in all regions of tropical Asia, having been found in the Philippine Islands, southern China, French Indo-China, Siam, Malaya, the Dutch East Indies, Burma, India, and Ceylon. In the New World it was first discovered in Jamaica in 1913, and the infestation has now spread to Cuba, Haiti, Panama, Costa Rica, and the Bahama Islands.

In the Far East the species can be found only rarely upon plants other than citrus, and is of very minor importance upon this host, whereas in Central America and the West Indies a large variety of other plants is attacked, those most seriously affected being the Philippine mango and coffee.

In the development of the fly the dominant natural influences are humidity and rainfall. Increase is very rapid during the rainy season and a marked decline occurs during periods of dry weather.

The meteorological conditions in the citrus-producing sections of the United States indicate that the blackfly may become a major pest in Florida and the Gulf States if established there, but would be unable to withstand the adverse conditions prevailing in California.

The status of the blackfly as of no economic importance in the Far East is due almost exclusively to the mortality effected by the natural enemies. Of these there were found 6 species of parasitic chalcidoid Hymenoptera (*Encarsia merceti*, *Eretmocerus serius*, *Prospaltella divergens*, *P. smithi*, and *Prospaltella* spp.); 5 coleopterous predators (the nitidulid *Cybocephalus* sp. and the coccinellids *Cryptognatha* sp., *Scymnus smithianus*, *Scymnus* sp. near *pallidicollis*, and *Scymnus* sp.); 2 dipterous predators (*Acletoxenus indica* and *Acletoxenus* sp.); 1 neuropterous predator (*Chrysopa* sp.); and 1 lepidopterous predator (*Cryptoblabes gnidiella*).

The internal parasites are responsible for an average mortality of 54 to 67 per cent in each generation in the field. In all sections approximately 50 per cent of the parasites are destroyed in the late larval or pupal stage by hyperparasites of the genus Ablerus.

Of the parasites listed above, *Eretmocerus serius* has been imported into Cuba and successfully established. Commercial control has been effected in most of the groves in which the early liberations were made, this being normally effected within 8 to 12 months from the first liberation. The extent of parasitization in these groves at the time of control has ranged from 72 to 78 per cent.

Colonies of Eretmocerus have been liberated in many groves in all of the provinces of Cuba, and have also been sent to the Canal Zone, the Bahamas, and Haiti.

Eretmocerus is an external parasite in its first two larval stages and internal in the final stages. Oviposition takes place preferably beneath the second larval stage of the host, though any stage may be attacked. Two generations are developed upon each one of the host.

Among the coccinellid predators, *Cryptognatha* sp. and *Scymnus smithianus* are now established in Cuba. Cryptognatha has fully controlled a heavy blackfly infestation in at least one grove, but its effectiveness is very uncertain. This species can be only an aid to Eretmocerus in the initial subjugation of the host infestation, and can not be relied upon for permanent control. *Scymnus smithianus* is apparently not adapted to Cuban conditions, as reproduction is largely suspended during the summer months.

In the New World no native parasites have been found to attack the blackfly, though a number of coccinellid beetles prey upon it.

Fungous diseases, primarily those produced by forms in the genera Aschersonia and Aegerita, at times effect a fairly high mortality upon the larval and pupal stages of the blackfly in the West Indies. These occur in Malaya also, though only rarely upon *Aleurocanthus woglumi*, in spite of the apparently more favorable climatic conditions for development.