NOTES ON THE BIOLOGY AND CONTROL OF THE YELLOW APHID OF SUGARCANE, *SIPHA FLAVA* (Forbes) IN PUERTO RICO

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INTRODUCTION

Among the various factors limiting sugarcane production, insect pests is one of the most vital. There are no records published in which a total cane crop for an entire country had been eliminated by an insect pest, but in many cases, production has been greatly reduced and saved from total loss only when methods of control were discovered and put into practice.

All parts of the sugarcane plant are attacked by insects. We have in Puerto Rico one insect species which has been a pest of minor importance in the past, becoming a serious pest during the last few years, particularly in the southern, western, southwestern and northwestern areas. This is the yellow aphid of sugarcane, *Sipha flava* (Forbes). Those best informed in the subject believe that this insect was introduced in Uba cane brought to the Island from the southern United States.

The yellow aphid of sugarcane has been recorded from the southern states, west of the Mississippi River in North America, from Mexico, Costa Rica, El Salvador, Panamá, Colombia, British Guiana, Perú, Argentina, Brazil, Venezuela; in the Caribbean Islands from all the West Indies and throughout the Lesser Antilles, down to Trinidad.

Of the 45 species of aphids reported by Smith, Martorell and Pérez in 1963 from Puerto Rico, few of them can be considered of economic importance in relation to crop production. However, at present, we believe that the yellow aphid of sugarcane is the most injurious aphid species occurring in the Island.

REVIEW OF THE LITERATURE

The yellow aphid, *Sipha flava* (Forbes) was first described from Illinois as *Chaitophorus flavus*, in 1884 by S. A. Forbes. Later on, J. J. Davis in 1909 transferred it to the genus *Sipha* where it has remained since.

Some 69 years ago, the first paper dealing with the insects affecting sugarcane in Puerto Rico was published by the Spanish agronomist, Fernando López Tuero. He mentioned the habits of the insects, the nature of their injury to sugarcane, their natural enemies and the methods of control. It is a most interesting and instructive discussion of the insects known to affect this crop in the Island at that time, but no mention is made at all of the sugarcane yellow aphid.

What appears to be the first record of the presence of this insect in Puerto Rico was that of Hooker in 1913. During the same year, D. L. Van Dine publishes
on the yellow aphid under the name of *Sipha graminis*. This record was supplemented by later observations made by Jones in 1914 and 1915. He recorded *Sipha flavum* as the correct name for what had been previously mentioned as *Sipha graminis*, describing the habits of the insect and the nature of its injury. Jones also listed 8 natural enemies of the aphid, 4 species of ants which attend the aphid and a hymenopterous parasite of two species of predatory ladybird beetles: *Homalotylus obscurus* Howard. Johnston in 1915 and Stevenson in 1918 recorded *Sipha flavum* as a host of the entomogenous fungus, *Acrostalagmus albus*. Van Zwaluwenburg in 1916 and 1918 and Leonard in 1917, 1918 and 1931, 1932 and 1933 informed severe outbreaks of these aphids in the western and southern zones of Puerto Rico, with cane severely retarded in growth as a consequence of the attack. Smyth in 1919 recorded it on sugarcane and grasses, giving its distribution and natural enemies, including small spiders, coccinellids, syrphid flies and the fungus, *Acrostalagmus albus*. Wolcott in the *Circular 59* of 1922, in articles published in the *Journal of the Department of Agriculture* of 1921 and 1922, and later in the Annual Reports of the Agricultural Experiment Station of the University of Puerto Rico for 1938 and 1939, discussed the abundance and control of *Sipha flavum*. Menéndez Ramos in 1923 and 1924 informed on the damages caused by the insect in the southwestern areas of Puerto Rico, mentioning also 3 predators and the entomogenous fungi as enemies of the pest. He also notes on what appears to be the first attempt to control the aphid by the use of petroleum emulsions as performed by Bourne in 1915. Hernández in 1925 wrote about the first test in which nicotine sulphate was used in the control of severe outbreaks of the aphid in San Germán, obtaining 85 percent control. Dozier in 1926 also reported serious damages caused by the aphid in Villalba. Nolla in 1929 synonymized the name of the entomogenous fungus, *Acrostalagmus albus* recorded by Jones, as being the same as *Acrostalagmus aphidum*. At the same time mentioned 3 hosts of the aphid, namely: sugarcane, sorghum and lemon grass. In 1933 Leonard found a braconid parasite, *Homalotylus terminalis* on the coccinellid, *Cycloneda sanguinea*, a predator of *Sipha flavum*. On the observations of some insects associated with sugarcane in Puerto Rico, Wadley in 1937, recorded the aphid as occurring in small colonies on 10 different grasses. Experiments conducted by him and by Sein (see ref. 43) and Sein in 1932 in the transmission of the mosaic virus of sugarcane using this aphid as a vector, gave negative results. *Sipha* was found in all parts of the Island at all seasons and in all the principal varieties of sugarcane by Tate and Wadley in 1938, during their studies of sugarcane insects, finding also no transmission of sugarcane mosaic by this aphid. In 1937 Wolcott and Martorell mentioned *Cycloneda sanguinea* as a predator of the yellow aphid. The Report of the Puerto Rico Experiment Station (Anonymous in 1939 and Bartlett in 1939) informed about the introduction of 2 coccinellid aphid predators, *Coelophora inaequalis* and *Platyomus lividigaster* (now *Scymnonycha lividigaster*) from Hawaii. Bartlett also mentioned the entomogenous fungus, *Acrostalagmus aphidum* and two native predators, *Cycloneda sanguinea* var. *limbifer* and *Hyperaspis* sp., as effective in the control of the pest. Bartlett again in 1942 informed about the establishment and status of the introduced ladybird beetle from Hawaii, *Coelophora inaequalis* as being an aphid feeder in general. In the Report of the Puerto Rico Experiment Station for the year 1940 mention is made of the breeding of these predators in Mayagüez, releases made in the fields and subsequent shipments of the predators to Louisiana. Wolcott and
Martorell\textsuperscript{11} in 1943 gave the seasonal abundance of the aphid in Puerto Rico and mentioned 3 enemies of it: \textit{Cycloneda sanguinea}, \textit{Baccha latiuscula} and the fungus, \textit{Acrostalagmus aphidum}. The quality of distilled lemon grass oil was not markedly affected by lemon grass infested with \textit{Sipha flava} as reported by Jones and Arrillaga\textsuperscript{18} in 1950. Wolcott\textsuperscript{44-49} in 1933 a and b, 1938 1939, 1941 and 1948, published several general lists and books on Puerto Rican and West Indian insects, including chapters on sugarcane insect pests in which life cycle, damage, predators, host plants and control of the yellow aphid are discussed.

\textbf{BIOLOGY}

\textit{Description}

Two forms of this insect occur in Puerto Rico, the apterous vivipara and the alate vivipara (see Fig. 1a-d). No males have been found here and generally these are very rare in the tropics.

\begin{figure}[h!]
\centering
\includegraphics[width=0.8\textwidth]{aphid.png}
\caption{(a) \textit{Sipha flava} (Forbes), alate vivipara; (b) Wingless viviparous female; (c and d) Nymphal stages (From Forbes, 1884).}
\end{figure}

The wingless forms of this species are bright lemon-yellow throughout, varied only by four curved longitudinal rows of black points on the back, two on each side the middle line. They are of a regularly ovate form, with antennae and legs of medium length; but are specially distinguished from our other common plant-lice by the longitudinal rows of stout, erect bristles, rather stouter than the others, project conspicuously forward from the front of the head, between the bases of the antennae. The antennae are five-segmented, about two-thirds as long as the body, and sparsely hairy or spinose, bearing two stout hairs upon each of the two basal joints, four on the third, and one on the fourth. The fourth joint is about two-thirds as long as the third, the scape of the fifth a little shorter than the fourth, and the filament about equal in length to the third. The beak is very short, barely reaching the coxae of the second pair of legs. The siphunculi have the form of low, truncated cones, not more
than two-thirds as high as broad; and the cauda is prominent and stout, about as long as wide. The legs are conspicuously hairy throughout, and the ventral segments are also provided with fine short hairs. The body length is from 1.67 to 1.88 mm.

The alate vivipara is of somewhat different shape from the wingless form, the thorax is very well distinguished from the head and abdomen, and of a rounded outline, while the abdomen is contracted at base and pointed behind. The general color is a pale-yellow, with mesothorax and metathorax darker, verging upon brownish orange. Upon the abdomen are eight longitudinal rows of black spots, and a row of black dashes between the third and fourth rows of spots on each side and alternating with them. Beneath, the whole body is immaculate. The eyes are red; and the antennae fuscous-yellowish with darker tips to the joints. The wings are hyaline, with the cubitus yellow, and the other veins slightly bordered with fuscous. The legs are yellow, except the tips of the tarsi, which are slightly darkened. The siphunculi and areas around base of hairs on dorsum of abdomen fuscous, also small intersegmental sclerotic areas. The body length is about 1.08 to 1.71 mm. The antennae are a little shorter than the body. The head, thorax and abdomen are ornamented with spinous tubercles much as in the wingless female, the head and thorax bearing six rows, and the abdomen ten, The body beneath is slightly pubescent, and the beak is very short, hardly reaching the coxae of the second pair of legs.

This insect can reproduce parthenogenetically or by means of fertile eggs. However, we do not have sexual generations here. Only females reproduce parthenogenetically all year round. The duration of life of the yellow aphid and the reproductive period are very variable, and greatly influenced by climatic factors.

Life cycle

Life cycle studies were conducted under greenhouse conditions in which sugarcane was planted in pots and kept in separate screened cages. Each individual plant was infested with only one young aphid, this reared until it started giving birth to new aphids. The newly born aphids were then transferred to individual pots, and so on. Individual records were kept of their life span, days to attain maturity, days giving birth to offspring and the number of aphids procreated during their life cycles.

According to our observations, the aphids reach their mature stage from 6 to 22 days, with an average of 13.08 days. The life span varied from 13 to 47 days with an average of 25.38 days. The parthenogenetic females produce aphids in numbers from 3 to 54, with an average of 17.94, with an average daily production of 2. So, a new generation occurs every 17 to 18 days during the period of activity of this species. We were able to obtain 16 generations in 8 months, during the period between September 13, 1963 to May 25, 1964.

Seasonal occurrence

The yellow aphid of sugarcane is found in all areas of Puerto Rico during all seasons, on all the main varieties of sugarcane and also breeding in a large number of alternate host plants. The seasonal abundance of this insect follows a general pattern throughout the year. It has two definite peaks of infestation: one occurring in the Spring and the other during the Autumn. Severe infestations which coincide with the two peaks
already mentioned had been noticed and informed by several investigators in the past.

Van Zwaluwenburg in 1916 at Mayagüez and February 1918 at Ponce. Smyth in 1919 informed of severe outbreaks in March and April at Río Piedras and Central Fortuna. The same year he cites this aphid as a possible spreader of the mottling disease of sugarcane. Wolcott in 1921 reported serious infestations during November 1920. Menéndez Ramos in 1923 writes about the damage produced to sugarcane due to severe infestations of this aphid at Cabo Rojo, Añasco, Camuy, Rincón and Patillas. In 1925, Dozier reported damage in Uba cane specially at Villalba, while Hernández in the same year wrote about its abundance during the months of little rain, specially in April, May and June in San Germán. Serious damage by *Sipha flavus* on Uba cane during September 1926 were reported at Villalba. Leonard in 1931 reported infestations during the month of May in Aguirre, also noting that the yellow aphids were rather injurious during the beginning of the summer, particularly during dry spells in the southwestern parts of the Island. Again in 1932 he stated that the aphid caused considerable damage in the western end of Puerto Rico, from Isabela, Moca and Aguada south to Cabo Rojo, Lajas and Guánica. The infestation was initiated in December and gradually increased in intensity through March, but during April abundant rains followed the pronounced dry spell after which the infestation ceased at Aguada. He also observed that the aphid predator was abundant, but the pupae were parasitized.

Once more Leonard in 1933 informs of severe outbreaks occurred in March 1931 at the eastern end of the Island and another infestation at a central near Aguadilla. Wadley in 1937 noted that *Sipha* is widely spread and that in Spring it was more abundant in western Puerto Rico than in any other part of the Island. Wadley confirms our recent field observations when he claims that the aphid became abundant in dry weather, but in spite of wet weather numerous colonies were maintained in the field ready for further reinfections when conditions are suitable. The aphid became locally injurious near Cabo Rojo following a short dry spell in August 1935 and was somewhat injurious over wide areas in the Spring of 1936. Tate and Wadley in 1938 emphatically ratify that the yellow aphid was found in all parts of the Island, at all seasons, and on all the principal varieties of sugarcane. It was most abundant during dry weather causing considerable injury. The 1938 Report of the Puerto Rico Experiment Station (Mayagüez) informs of the severe infestations at Arroyo in January 1938, while Bartlett in 1939 mentions the aphid as a pest during dry seasons and periods of extended droughts.

Wolcott and Martorell discussing the seasonal cycle of insect abundance in Puerto Rican cane fields, when making reference to the yellow aphid, said:

> Quite different from the Lepidoptera in its pattern of reaction to season is the yellow aphid of sugar-cane, *Sipha flavus* Forbes, which our observations indicate as having two periods of abundance. Most of the records are for the months of December, January and February, none in March, a few for April, and again abundance in May and June, with none for the summer and only a few for the autumn. Regionally, it is a much more serious pest in the extreme eastern part of Puerto Rico, and is much less of a problem in the upper valleys and mountainous regions. The aphid spreads rapidly in the field and is usually present in considerable numbers by the end of March. It is also present during the summer months, but is much less abundant. During the period, but outside the region of our observations, especially heavy and prolonged infestations occurred during the autumn of 1940 around Guajataca and Janos, which were aggravated by dry weather, and almost destroyed some fields of young gran cultura cane. Heavy rainfall in late October eliminated these infestations. The effect of the rain by continuously maintaining
None of the infestations reported in the past had been so intense and massive as the ones occurring in the Island during the Springs and Autumns of 1963 and 1964, the latter being the most destructive. When we initiated our field observations and contacted many farmers, mill owners and managers they had the impression that these infestations were something new and that they had never occurred in the past. The truth is that time elapses, events pass one after the other, people forget very fast: but the recent infestations of the yellow aphid of sugar cane are just a repetition of what we have had years and years ago, but of course, now on a larger scale.

The big question is: Why the infestations of this insect are more and more intense, year after year, as it has been happening during the last 2 or 3 years? There are several factors involved in an answer to this question:

1. The climatic conditions for the last years have been ideal for the development of large populations of the yellow aphid, that is, prolonged periods of droughts during the Springs and Autumns.

2. More and more standing cane is being burned previous to harvest. There is no doubt, that if burning sugarcane trash is harmful or detrimental in cane fields, since it destroys thousands and thousands of beneficial insects, more so is the burning of standing cane, where predators are more abundant than in trash lined or laying on a field and with very little chances of escaping from the fast advancing flames.

3. By increasing the acreage of Pangola grass in Puerto Rico, we have been supplying to the yellow aphid suitable media to breed at will. The grass serves as an excellent alternate host to this insect.

4. The absence of an efficient internal parasite, plus the increased degree of parasitization found in the pupae of Cycloneda sanguinea, one of the common and effective predators of the aphid, makes the situation more precarious for a good natural control.

From our field observations and in relation to the seasonal occurrence of the yellow aphid we come to the following conclusions. Definitely, there are two peaks of infestation of this insect in Puerto Rico: one in the Spring and the other during the Autumn. Normally the first infestation is more potent than the second, at times the Autumn infestation is very small and perhaps limited to small areas. Lately the most infested areas have been the south, southwest, west and northwest, but this does not mean that this condition will stay this way indefinitely. Infestations can occur again in the eastern and southeastern zones of the Island as they had occurred in the past. The northern portion of the Island, from Dorado to Canuy never have had serious problems of infestations.

Contrary to the believe of many farmers and investigators, rainfall is not a factor in the control of the yellow aphid. Many farmers do not spray or attempt any sort of control of the aphid because they believe that rainfall will eliminate the pest. Rainfall is only efficient when it comes at the right time and accompanied by high temperatures and high relative humidity. Rainfall during the cool months (February, March and even April) usually is not effective in the control of the pest. During last April 1964, the precipitation for the Canovas, Guanajito area at Añasco was around 18 inches. The aphid infestation then was at its best, and thus it kept on going. The
continuous rainfall of that month, accompanied by cool temperatures and low relative humidities were of no use in the elimination of the pest from the field.

The yellow aphid is very susceptible to high temperatures and high relative humidities. This is the main reason why, when it rains heavily during the last days of May and the month of June, aphid infestations are controlled rapidly. Also under this special condition the entomogenous fungus, Acrostalagmus aphidum spreads very fast among the favorable large populations of the aphid. During May and June of 1963 and 1964 the yellow aphid infestations ceased in the southern and northwestern areas of Puerto Rico. Of course, there was no need for further application of insecticides. The unfavorable climatic conditions for the aphid and vice versa for the fungus were most efficient in eliminating the pest.

Nature of damage

The yellow aphid is characterized by its abundance, fast dispersion and by the damage produced by its piercing and sucking mouth parts. The winged adults can fly, but often are also carried considerable distance by wind currents. The younger stages are constantly crawling on the leaf surfaces, but when overcrowded or when the leaves die or wither, they migrate to greener and higher plants in search of food.

It occurs generally in colonies on the undersides of the leaves of young as well as old cane. When leaves are heavily infested often colonies are detected on the upper surfaces. During its feeding process the aphid punctures the plant tissues to extract the juices. As the attack advances and the number of insects increases, the excretion of “honey dew” produced by the aphids takes place in greater quantities, until at times the surfaces of the leaves can be seen to glisten with this substance.

The attack of the yellow aphid generally begins under the leaf, at its extremity or apex. As soon as the colonies are well established they migrate to all parts of the leaves. The punctures made by the insects produce distinct reddish marks which gives the impression of having been made by some sharp instrument. The visible damage done by the insect is manifested by the drying of the leaf point. If the attack persists the leaves turn yellowish and irregularly red, purplish, later on iron-like spots appearing. When the leaves have been severely damaged this discoloration often extends to all the leaf surface which later turns brown and dies. Severely infested fields have a brown burned appearance. The aphids, on extracting the plant juices weaken the vitality of the plants, stopping their normal growth, thus causing enanisms or retarded growth.

Attacked sugarcane plantations usually range from 2 to 4 feet in height, but the insects have been observed during the past years, especially during the 1964 outbreak, infesting newly planted cane hardly a foot in height, and also cane 8 to 10 feet high. Under these circumstances, when severe outbreaks develop on newly planted cane and no measures of control are applied on time, the entire field can be destroyed, needing replanting in many cases or plowing it once more for establishing a new plantation.

During May 1964 a total of 4000 to 5000 acres were totally destroyed by the aphid in the northwestern and western areas of the Island (Isabela to San Germán). Other 34000 acres in this same zone were badly infested, sprayed with adequate insecticides, using airplanes and a helicopter for the spraying operations. In the campaign for the control of the yellow aphid, around $1200000 were spent jointly
between farmers, sugarcane mills and the Commonwealth Government (Department of Agriculture).

So far, we have not been able yet to estimate in dollars or in tons per acre of sugarcane, the losses caused by massive infestations of this insect in sugarcane fields.

Host plants

With very few exceptions, host plants of the yellow aphid belong to the grass family, the Gramineae. A wide island survey was conducted in Puerto Rico during the Spring and Summer of 1964, in order to determine the incidence of this insect and also to obtain a better knowledge of its alternate host plants. Sugarcane fields, as well as along roadsides in the lowlands and in mountains far from sugarcane areas were investigated. The survey included a careful examination of grasses, sedges and any other possible host of the aphid. The insect was found in many cases, in small colonies on different alternate host plants growing from sea level to the higher altitudes (2000 to 3750 feet). They were always found on the under-sides of the leaves. It is very interesting to note that *Siphia flavia* was present on grasses during most of the months of the year, even in places where there was no sugarcane planted, many miles away from cane fields. Apparently the aphid populations remain latent in very small colonies and when conditions are favorable they start again their reproduction, spreading very fast to different areas, especially sugarcane.

The yellow aphid was found on the following 33 new host plants:  
*Andropogon annulatus* *, Andropogon bicornis, Andropogon leucoschatys, Axonopus compressus, Chloris infaeta, Chloris radiata, Cynodon dactylon, Digitaria horizontalis, Echinocloa crus-galli, Eragosiris lepidozanthos, Eriochloa polystachia, Holcus alleponsis, Leptochloa filiformis, Panicum adspersum, Panicum fasciculatum, Panicum glabrosomum, Panicum laxum, Panicum maximum var. gramalote, Panicum reptans, Paspalum densum, Paspalum jimbriatum, Paspalum miliagruna, Paspalum setaceum, Paspalum vaginatum, Pennisetum purpureum var. mckerii, Setaria geniculata, Setaria palmifolia, Sporobolus bertonanus, Trichachne insularis, Cyperus rotundus, Cyperus forax, Cyperus esculentus and Commelina longicaulis*. Three species of the family Cyperaceae and 1 species of the family Commelinaceae are hereby recorded for the first time.

Previously to this survey, Nolla** in 1929 had informed the aphid from three different grass species, while Wolcott** in 1936, 1941 and 1948 recorded it from six and Wadley** in 1937 from 10 host plants, including nine not previously collected. In their studies of the Puerto Rico Aphididae, Smith, Martorell and Pérez-Escolar** in 1963 recorded the insect on 8 different grasses, including 3 new records. The insect had been thus reported on the following 18 host plants:  *Cymbopogon citratus, Digitaria decumbens, Digitaria sanguinalis, Echinochloa colonum, Erioseus indica, Eragrostis sp., Holcus sorgum, Panicum maximum, Panicum purpurascens, Paspalum conjunctum, Paspalum melanospermum, Paspalum paniculatum, Pennisetum purpureum, Polytrias amaura, Saccharum officinarum, Setaria selosa, Syntherisma sp.* and *Zea mays*.

This makes a total of 51 different alternate host plants for this insect in Puerto Rico.

* The authors are greatly indebted to Dr. Roy Woodbury, Plant Taxonomist at the Agricultural Experiment Station, for cooperating in the 1964 survey and identifying most of the grasses collected.
During the 1964 survey the authors had the opportunity of observing the aphid in most of these hosts already informed, but were unable to find it on sorghum.

CONTROL

Biological control

Numerous predaceous animals feed on the yellow aphid of sugarcane destroying a good number of them in the fields, but never stopping massive infestations. Since the first infestations of this insect were noticed in the Island almost 57 years ago, investigators have been recording the different predators attacking this species. Numerous citations on this respect are found in the section of Review of the Literature already discussed.

Wolcott writes about the small, shiny black spider, *Theridula opulentata* (mentioned as *T. opentula*) also cited in literature under the name of *T. triangulata*, as a predator of the aphid. This arachnid is common in the Island, occurring from the lowlands to the high mountains. Although it feeds on the yellow aphid it is too small and not abundant enough to be of much value in reducing aphid infestations.

A native bird and two species of lizards: the Puerto Rican warbler or “reinita”, *Coereba portoricensis* (now known as *C. flaveola portoricensis*), *Anolis pulchellus* and *Anolis cristatellus* respectively, are also listed as predators of *Sipha*.

The larva of *Chrysopa*, a neuropteroid insect is also one of the most active enemies of the aphid, *Chrysopa collaris*, listed as one of the predaceous species, although according to Wolcott the species does not occur in the Island, and presumably some of the biologic records assigned to it refer to other species.

Syrphid fly larvae are also important enemies of *Sipha* in Puerto Rican cane fields. Among the predaceous species, *Baccha latissimulus* and *Mesogramma subannulata* are probably the most commonly observed.

Throughout the years numerous coleopterous insects of the family Coccinellidae have been observed and recorded as enemies of the yellow aphid, namely: *Scymnus roseicollis*, *Coleomegilla innotata*, *Hyperaspis connectens*, *Hyperaspis festiva* aberration *apicalis*, *Cycloneda sanguinea*, *Scymnides lividigaster* and *Coelophora inaequalis*. *Scymnus roseicollis* is a little oval ladybeetle with orange prothorax, black elytra with an orange apex, with the body covered by a fine pubescence. Its little, almost black larvae with retractile protuberances on their backs, are ferocious looking in spite of their small size. They feed voraciously on this aphid species as well as others. *Hyperaspis connectens* is characterized by two large dull orange spots on each black elytron connected to form a large “C”. Its allied species, *festiva* is smaller, with more yellowish spots on the elytron, these usually joined only narrowly on the lateral margin. More so interesting and common is *Cycloneda sanguinea*, a hemispherical medium size ladybeetle, black with the lateral margins of the pronotum and a spot on each side white, the entire elytra shining orange-red. *Cycloneda* is a general aphid feeder and occurs everywhere in the Island from the lowlands to the middle elevations. Wolcott considers it as the most common and important predator of *Sipha flavia*.

Still less common, but apparently already established here are the introduced *Scymnides lividigaster* and *Coelophora inaequalis*, natives of Australia coming to the Island via Hawaii. These interesting species were introduced by the Puerto Rico
Although Scymnodes does not appear to be particularly voracious on the yellow aphid, it has been observed feeding on this insect in the laboratory. Coleophora feeds on Sipha as well as in other aphid species and the sugarcane leafhopper. This species is not limited to the cane fields but also is found looking for its prey on forest trees in the mountains and in the city gardens feeding on aphids on hibiscus.

Two parasitic wasps, have been erroneously cited by Wolcott as parasites of the yellow aphid. In Insects of Puerto Rico page 783 he records the following: “Pachyneuron siphonophorae Ashmead, as identified by Mr. C. F. W. Musebeck, has repeatedly been reared from various species of aphids, first in Puerto Rico by Mr. Thos H. Jones from Aphis gossypii Glover on okra, and reported by Dr. F. M. Wadley (1937–106) from Sipha flava Forbes and Hysteroneura setariae Thomas on sugar-cane”. Reading Wadley’s publication, on pages 106–107 he cites Pachyneuron siphonophorae as a parasite of Aphis maidis and Hysteroneura setariae, but not of Sipha flava. In fact, Wadley referring to Sipha flava, notes in page 7 of his paper the following: “It was attacked by predators and a fungus (Acrostalagus), but parasites were not seen in this work. Predators observed were a few syrphids and some coccinellids, including Cycloneda sanguinea L. and a small black species.”

Again in “Entomología Económica Puertorriqueña ”Boletín 125, May 1955, published by the Agricultural Experiment Station of the University of Puerto Rico, in pages 44–45, referring to the yellow aphid of sugarcane, the parasitic wasp Aphidius testaceipes is cited as a parasite of the aphid. We do not believe that Wolcott included this parasite in this section with the intention of meaning that it is a parasite of the yellow aphid, since his probable intention was to mention this specific parasite as an enemy of aphids in general. However, looking at this section, the common reader might get the impression that Aphidius is a parasite of the aphid.

Two entomogenous fungi are also reported in many instances in literature as enemies of the yellow aphid: Acrostalagus albus and Acrostalagus aphidium. Nolla in 1929 noted that the two names are in synonymy, preferring to use the last when making reference to this specific fungus. It is a well known fact that Acrostalagus plays an important role in the control of the yellow aphid, although its effectiveness is limited by climatic factors.

During the 1964 survey the following predators were observed and collected in the sugarcane fields investigated: the spider, Theridula opulentia, the coccinellids: Cycloneda sanguinea, Scymnus roseicollis, Coleophora inaequalis, Coleomegilla innolata, Cladis nitidula, Hyperaspis festiva aberration apicalis and Scymnus phloeus. Of these, Cladis nitidula is a new record as a predator of Sipha in Puerto Rico. Two species of syrphid flies whose larvae feed voraciously on yellow aphids were also collected: Baccha latiusculus, many times listed as its predator and the new record, Baccha clavata, noted for first time. The entomogenous fungus, Acrostalagus aphidium was found attacking infestations of the aphid during late Spring of 1964 in the western and northwestern zones of the Island.

In Ponce area during June 1964 numerous larvae of Cycloneda sanguinea were found parasitized, these peculiarly attached to the leaves of sugarcane. Parasitized larvae assumed a characteristic somewhat contracted C-shaped position attached to the leaf surfaces with their last pair of feet. The larvae shranked, mummified and turned black in color, showed numerous warty formations on the larval skin. These
were caused by the form of the internal pupae of the parasites within. Later on numerous parasites emerged from the larvae. A total of 89 parasitized larvae were collected and reared in the laboratory to obtain the parasites, out of which 667 came out, with an average of 7.5 parasites per larva. The number of parasites in each larva ranges from 1 to 25, some larvae being parasitized by more than one species of parasite. Four different species of parasitic hymenoptera were recovered from parasitized larvae and identified by specialists of the U.S. National Museum at Washington, D.C. These were: Homalotylus terminalis Say, Pachyneuron siphonophorae (Ashm.), Pachyneuron allogratae Ashmead and Tetristichus minutus (Howard), the latter being a new insect record for Puerto Rico.

Two hymenopterous parasites of the larvae of coccinellids were previously recorded by Jones and Leonard as Homalotylus obscurus Howard and H. terminalis Say respectively. Later these were synonymized by Wolcott as being H. obscurus.

While Cycloneda sanguinea, one of the most important predators of the yellow aphid is intensively parasitized in the field, there is also a lack of an efficient endoparasite of Sipha3ava. We have never been able to find an endoparasite of this aphid in the Island. The predators of Sipha in Puerto Rico are effective in controlling small scale infestations, but when conditions are suitable for the aphid it propagates so fast that the predators can not even start to stop it. Thus the enemies at present of the yellow aphid in Puerto Rico are not efficient enough and the farmers can not depend upon them for control. The fungus, Acrostalagnus aphidum is very effective when climatic factors are suitable for its development. However, climate is something which the farmer cannot control, nor create. With these facts in mind there is but only one alternative: the use and application of insecticides to control the pest in the field.

Chemical Control

Since the yellow aphid of sugarcane, Sipha flava (Forbes) was noted in Puerto Rico for first time some 51 years ago, it has been causing problems to sugarcane growers in a more or less limited degree. Sporadic infestations were circumscribed to fairly small areas, once in a while extending to larger zones, but the insect was never considered a potential pest of this crop. Control of the aphid at that time mostly depended on such natural factors as rainfall, predators and entomogenous fungi, with occasional sprayings with nicotine sulphate and dustings with calcium cyanide (Cyanogas). Satisfactory control was obtained then with the above mentioned chemicals. Insect predators and the fungi were of some help in reducing small populations, but never efficient enough in controlling infestations of greater magnitude in extensive areas.

Since the status of the natural enemies of the insect had remain just about the same throughout the years and lately outbreaks of the aphid had been so intensive, the farmers have been forced to use insecticides for its control. With the advent of the newer and modern insecticides it has been possible to control Sipha effectively and economically.

The areas mostly affected by the aphid are the southern (from Patillas-Arroyo, west to Cabo Rojo in the southwest) western and northwestern (Aguadilla, Isabela, Moca and San Sebastián). During the early Winter and mid-Spring of 1964 around 45-50000 acres of sugarcane were attacked by Sipha, not taking in consideration quite a large acreage infested in the southern zones from Guayanilla to Arroyo. The
extended and dangerous drought of 1964 was very favorable in creating ideal conditions for the development of massive infestations not only of the yellow aphid, but of other insect pests: the lesser corn-stalk borer, \textit{Elaeomphalus lignosellus} and the "agrimensor" or looper caterpillar, \textit{Mosis repanda}. Similar infestations of the yellow aphid were observed during the Spring and Autumn of 1963, but these were not as detrimental as the latter. In many instances during 1964, sugarcane farms with young cane were totally destroyed, this occurring in about 6000 acres. The damages for this outbreak had been estimated in $1200000.00 to the sugarcane industry.

One sugarcane enterprise, Luce and Co. at Aguirre spent in three years (1960-62) a total of $154950.00 in the control of the pest, spraying 51040 acres during that period. Central Mercedita at Ponce sprayed 9428 acres in 1963 and 10125 acres in 1964 for the control of the yellow aphid in its own farms. The same firm sprayed infested sugarcane to other farmers in the south, west and northwestern zones, in a total extension of 7635 acres for 1963 and 4405 acres for 1964. The total cost of this spraying program to farmers for both years was $38010.41. During the 1964 outbreak, the Commonwealth Department of Agriculture sponsored a spraying control program for the yellow aphid to be financed by the government, the sugarcane mills and the farmers, in equal parts. One of the spraying outfits, the Southern Water Co. of P.R. Inc., sprayed 20956 acres of aphid infested sugarcane, with a total cost of $45962.22. Comunidad Bianchi, the largest landowner of Coloso Central at Aguadilla sprayed 4799 acres in 1963 and 14140 in 1964. The above mentioned figures give an idea of the nature of the damage produced by this aphid and the cost of its control.

The insecticides used in the spraying campaign were applied by means of airplanes and one helicopter, the former operating mostly in the flat lands near the coast, but often going into semi-hilly country and the latter exclusively dedicated to the hilly and mountainous territory of Moca and San Sebastián. While the airplanes did a very good spraying work in the lowlands, not so efficient in the semi-hilly territory, the helicopter was found to be of great effectiveness in the rugged terrain of Moca and San Sebastián.

The following insecticides are now used in the Island for the control of the yellow aphid: Diazinon AG 500, Malathion 57 percent, SW-2 (methyl parathion) and Disyston. All the insecticides used were the concentrated emulsions except Disyston which was used both as a liquid and as a 10 percent granular dust. Although Disyston was used in a smaller scale, it proved to be most promising in the control of this pest because of its longer residual power.

There is no doubt that the yellow aphid of sugarcane, \textit{Sipha flavu} (Forbes) actually is one of the most important insect pests of sugarcane in Puerto Rico. The insect should be studied in more detail in order to have a better knowledge of its life history, factors affecting its survival in the fields and the exact relationship between the insect, temperature and relative humidity. We also feel that an attempt should be made in order to find suitable endoparasites in other areas of the Americas where this insect occurs for introduction here. Insecticides with a longer residual action are also needed for a more effective and economical control.

**SUMMARY**

The yellow aphid of sugarcane, \textit{Sipha flavu} (Forbes) is an American pest. The description, life cycle, seasonal occurrence, nature of damage, host plants, and the biological as well as the chemical
control of the insect are discussed. A review of the literature concerning this species in the Island is given.

Under greenhouse conditions the aphid has a generation every 17 to 18 days. In the field it has two peaks of infestation, a prolonged one in the Spring and a short one in the Autumn. Several factors, such as climatic conditions, the burning of standing cane, the increased plantings of Pangola grass, the ineffectiveness of the predators and the lack of an endoparasite of the aphid, are discussed in relation to the intensity of infestations by this insect year after year. The damage to sugarcane fields in the Island on account of the aphid infestations is estimated to be around $1,200,000 for the Spring of 1964, where from 4- to 50,000 acres of young cane were destroyed and nearly 50,000 acres were infested by it. During the 1964 investigations 33 new host plants were recorded, thus making a total of 51 alternate host plants for Sipha flava in Puerto Rico. Also two new insect predators are informed, as well as three new parasites recorded for the larvae of Cyclene-da sanguinea, one of them being a new record for the Island. Information on the chemical control of this insect and a full account of its field enemies and predators is given.

REFERENCES

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