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THE MINOR SUGAR-CANE INSECTS OF PORTO RICO

BY

GEORGE N. WOLCOTT,
of the Bureau of Entomology U.S.D.A.,
in cooperation with the Insular Experiment Station.

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THE MINOR SUGAR-CANE INSECTS OF PORTO RICO.

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INTRODUCTION.

The sugar-cane insects in Porto Rico causing noticeable and serious injury to the cane have already been extensively treated in numerous publications by Van Dine, T. H. Jones, Smyth, Van Zwaluwenburg and others, but those causing but slight injury, or none, but living on cane, have been almost entirely neglected. The importance of the minor sugar-cane insects lies not in the injuries which they cause directly, but in the possible connection that may exist between one, or some, of them and the rapid spread of a disease, new to Porto Rico, the mottling or mosaic disease of sugar cane.

In the following discussion, all the data on the minor insects obtained in a half year's observations (December, 1919–June, 1920) will be given, but only the characteristics of the major insects will be treated which are of importance as bearing on their possible relation to mosaic disease.

There are certain essential characteristics which an insect must possess to be considered as a possible vector of mosaic disease. (1) It must occur in abundance on sugar cane in all parts of the Island where, and at the times when, the disease is spreading. (2) It must be capable of more or less rapid spread or dispersion, either by itself or by other insects or agencies. (3) Presumably it should be an insect with mouthparts adapted to piercing live healthy cane tissue and sucking up cane juices—but as no experiments have been conducted with insects with biting mouthparts, or their excrement,

the certainty that such insects may not be successful vectors cannot be asserted. (4) It should live on that part of the cane plant in which virus which causes the disease occurs, and to which the virus applied in healthy plants causes the disease. The results of the researches of Dr. Brandes, both the successful innoculation experiments and the artificial transmission by the corn aphis, *Aphis maidis*, show that this part of the plant is the central whorl of tender, growing leaves. Thus number (4) can be changed to read: its habitus should be the central whorl of tender, growing leaves of the cane plant.

The latter three points (2) rapid dispersion, (3) piercing-sucking mouthparts and (4) habitus in the central whorl of leaves, can be readily determined, but the first point is more complex. The determination of the absolute abundance of a cane insect is comparatively simple, but to correlate abundance with the localities and the dates when the disease is spreading rapidly is more difficult. The instances of rapid spread of mosaic disease are numerous, but definite data regarding the exact time when the spread occurred is usually lacking.

The first sudden appearance of mosaic in destructive abundance in Porto Rico was in the Arecibo district in the spring of 1916. Stevenson (5th Report. Bd. Comm. Agr. 1917, p. 58) says:

> "While the Arecibo–Aguadilla district is quite subject to periods of drought, it was during the months of February, March and part of April of this year (1916) visited with a more than usually long and severe dry spell. During a period of nearly eight weeks practically no rain fell, a state of affairs quite sufficient to cause great loss. This was preceeded in November and December by excessive rains, so that the cane has labored under, first an excess, and then an almost entire lack of water, conditions which would seriously injure the most resistant of crops."

In his laboratory experiments, he attempted to reproduce these conditions of excessive moisture at first, followed by drought, but without success in producing the disease. In all experiments, it was the succeeding drought, not the preceeding excessive moisture, which was stressed. No definite data is available as to the month when this rapid spread occurred, but in this connection, it should be pointed out that the total rainfall at Arecibo in 1915—the year in which the 1916 crop was made—was 90.65 inches—32.22 inches more than normal, and that the departure from normal is almost entirely accounted for by the 15.16 inches more than normal in April, 1915, a total for the month of 20.46 inches, plus the 15.69 more than normal in November, 1915, when the total for the month was 23.80 inches.

The most exact record available of the rapid spread of mosaic is given by Brandes (U. S. Dept. Agr. Bull. No. 829, p. 17):

"In October, 1918, healthy seed of about 80 varieties was brought into the infested area from disease-free regions in order to determine whether any natural immunity existed among the varieties present in Porto Rico. This seed was planted at the Santa Rita estate 'Tablón 1,' near Yauco. When the seed germinated, the young plants were seen to be healthy and normal, but within six weeks to two months practically every plant of all varieties with one exception (the Japanese Kavangire) showed unmistakable symptoms of mosaic. This was a clear case of secondary infection from fields of diseased cane surrounding the test plat."

In November, 1918, the month following the planting of the seed, the rainfall was 6.16 inches or 2.23 inches more than normal for that month, and much more than in any month of the two preceeding years, except two. Professor Earle states (orally to the writer, May 9th) that in the present year—1920—cane planted in February, 1920, in the same field (Tablon 1) as that in which the variety test of October, 1918, was conducted, has not developed mosaic to an extent of more than 2 per cent. Rainfall at Santa Rita in February, 1920, was 6.95 inches, fine for the germination of the seed but in March it was 1.25 inches and in April, when Professor Earle made his observation, 0.22 inch. This one experiment shows that 100 per cent infection was obtained with a rainfall of 6.16 inches in the month following planting, and that in the same field, a year and three months later, an infection of only 2 per cent was obtained with a rainfall of 1.25 inches in the month following planting.

In the Toa valley, where the San Juan–Arecibo carretera crosses, there were several fields planted to cane in October and November, 1919, using 95–98 per cent of seed clean of mosaic. During the months of December, January and February, when these fields were carefully observed every two weeks or oftener, mosaic was spreading rapidly, and on each return visit many more infected plants would be observed, despite the fact that diseased canes were being removed and destroyed as fast as they developed the disease. The rainfall at the nearest station, Dorado, for these months was November, 1919, 7.96 inches; December, 1919, 5.00 inches; January, 1920, 8.73 inches, and February, 1920, 7.59 inches.

The most rapid spread of mosaic has occurred during or after periods of heavy rainfall, but whether the heavy rainfall has any other effect than stimulating growth and presumably lowering resistance, is not certain. Mosaic has spread during extended droughts,

in cane growing in valley bottoms—*vegas*—along the margin of the stream, and in a swamp, where the water supply for rapid growth would continue to be ample despite the drought.

The disease does not now occur in the most eastern portion of the Island of Porto Rico, but it was only by taking the most vigorous measures that it was eliminated from some of the fields where outbreaks occurred in that section of the Island, and it may be considered that the disease, if uncontrolled will spread in all parts of Porto Rico. However, Mr. Stevenson, Professor Earle and the writer have all observed that mosaic has spread more rapidly and extensively in the hills than in the costal plains and the infection is now more severe and extends over comparatively greater areas in the hills than along the coast.

Thus, either (1) an insect vector of mosaic neeed not necessarily be abundant during a drought—except along stream margins or in swamps—or as abundant in the costal plains as in the hills, or, (2) the reason why mosaic does not spread rapidly during a drought—except along stream margins or in a swamp, or in the costal plains—as it does in the hills, may be because the insect, or insects, capable of transmission are not present in abundance under these conditions of drought, or in this environment along the coast.

THE MINOR SUGAR-CANE INSECTS OF PORTO RICO.

ACARINA OR MITES.

The Green Red Spider. *Paratetranychus viridis* Banks, det. Ewing.

This green red spider was found in small numbers at Patillas, March 30, but later, May 15, after the extended drought, was very abundant on the older leaves of young cane at Camp Las Casas (San Juan), Río Piedras, May 22, Trujillo Alto, May 22, and Barceloneta, May 19, causing considerable injury. The infested leaves were spotted above with minute red dots, which coalesced near the midrib, and beneath, where the mites were, the leaf was covered with what appeared to be minute whitish sand grains, but which were the empty cast skins of the immature stages. After the drought was broken by several heavy rains, few living mites could be found and no new infestations. The red spots on the leaves were apparently not due directly to the feeding of the mites, but to the fact that the lesions caused by their feeding allowed the entrance of the spores to red rot, *Colleototrichum*, which caused the reddening of the leaves noted from above. The mites live only on the underside of the older leaves of young cane 1-2 feet high, or at least, no mites were noted on larger cane, nor any on the youngest leaves in the central whorl. No predators were noted, but would be unnecessary where rainfall was even moderately abundant. This mite also occurs in the southern United States, where it is of economic importance.

REFERENCE: E. G. Smyth, "Report of the Division of Entomology," Ann. Rept., Ins. Expt. Sta. P. R., 1917–18, pp. 121–122.

Damæus mitens, det. Ewing.

Damæus mitens, one of the Orbatidæ or beetle mites, a shiny, reddish-brown mite, is often found under dead, brown leaf-sheaths, and is most abundant in the excrement of the moth borer *Diatræa saccharalis*, which collects between the leaf-sheaths and the stalk of the cane, when it is pushed out of the burrow by the caterpillar. It has also been collected in the rotten knothole of a jobo tree, and apparently is not confined to cane or cane debris, or cane insect debris.

The West Indian Sugar-Cane Mite. *Tarsonemus spinipes* Hirst.

Tarsonemus spinipes is a very small opalescent light-green mite, colonies of which live in cane tops underneath the green leafsheaths.

The mites produce peculiar transparent brown crater-like depressions, 0.5–2 millimeters in diameter, on the young cane stalk, which, as the cane grows older, become opaque, brown and rough, so that cane ready to cut is more or less completely covered from bottom to top with these roughened areas. The mites are never found on the older parts of the cane and only a few will be found even in the youngest portions where the lesions are being produced, and are so new that they are still soft, yellow transparent and shiny. Crystalina cane is usually more heavily infested with *Tarsonemus* than any other variety of cane, but the mites occur on all common varieties in Porto Rico except Cavangerie, and in several varieties, especially Yellow Caledonia, the pattern of the mass of lesions is characteristic for the cane. The mite occurs all over the Island and perhaps is most generally abundant in the properties of Central Aguirre, where Crystalina cane is grown exclusively. In two fields here, all the cane was badly infested, also in one field of Otaheite at Guánica and one of B–3496 at Río Piedras. Yellow Caledonia is seldom heavily infested, but it is exceptional to find a stalk of Yellow Caledonia that does not have some of the mite lesions, in the pattern peculiar to this variety of cane.

Reference: "The Acarina or Mites," by Nathan Banks, Report No. 108, U. S. Dept. Agr., p. 108. "*T. spinipes* Hirst injures sugar cane in the West Indies, attacking the stem and giving entrance to injurious fungi."

THYSANURA.

Colembola, or Spring-tails.

Springtails are small, active insects with biting mouth-parts and a tail enabling them to jump considerable distances. They occur in abundance on cane, living mostly on the undersides of the tough old leaves of cane 2–3 feet high or over. They are much less abundant during seasons of drought, but may be found even then, usually having left the underside of the older leaves for the central whorl. They are not found on very young cane—less than 2–3 feet high. Their previous abundance on a cane leaf can be determined by the numbers of molted skins which remain attached and will be found scattered in the trough between the midrib and the blade of the leaf, especially towards the base. When a leaf with a colony of springtails is turned up, the immature stages ordinarily do not jump, but run with great rapidity to the inner surface of the leaf, which is now down, and even adults do not jump unless pursued. After run-

ning over the surface of the leaf they come to rest in the trough—perpendicular to the axis of the leaf. This orientation to the underside of the leaf and to the axis of the leaf is characteristic. All stages of the life history are passed on cane, although the eggs have not been found. The species on cane is light yellowish-green, with a brown spot at the bend of the antennæ. The same, or an apparently similar species, is also found on a number of other hosts, yautía (*Xanthosoma* sp.), water hyacinth, canna and on the ground. A yellowish-grey species is found on dead seaweed on the beach at Point Cangrejos. A bluish-grey springtail was found under the dead leafsheaths of high cane, in abundance at Isabella and Hatillo during the drought in April, and sparingly at other localities.

Specimens from the various localities and hosts have been submitted to Professor J. W. Folsom of the University of Illinois, who reports them new and undescribed.

ISOPTERA.

Family Termitidæ.

Nasutitermes (Eutermes) morio Lath., det. T. E. Snyder.

Termites are abundant in Porto Rico, but the records of their attacking cane are very few and confined to the northwest corner of the Island. At Aguadilla, April 12, 1916, the top part of a stalk of cane was found hollowed out and the interior completely destroyed by them, and on March 25, 1915, at Aguadilla, the *Diatræa* tunnels in seven stalks of cane (out of 100 examined) were found inhabited by them. At Añasco, on the same date, one stalk of cane was found with termites in the *Diatræa* tunnels.

Termites are serious pests of cane in Demerara and Haiti, in the latter country, attacking the seeds (tops) and destroying them before they have a chance to germinate.

ORTHOPTERA.

The Changa. *Scapteriscus vicinus* Scudd.

The changa lives in sandy ground, arching up tunnels just beneath the surface, and feeding on a wide range of cultivated crops and wild vegetation—especially that which is young and tender. Its injury to cane is in eating into the young shoots of plant cane, killing the shoot, as the central whorl of tender young leaves is the part most desired and always eaten by the changa. The killing of the shoot

by the changa precludes the possibility that mosaic disease could be transmitted by it.

REFERENCE: "The Changa or West India Mole Cricket," by R. H. Van Zwalu wenburg, Bull. No. 23, Porto Rico Agr. Expt. Sta., Mayagüez, 1918

The Little Jumping Changa. *Ellipes minuta* Scudd., det. A. N. Caudell.

This small tridactylid-like cricket has twice been found in great abundance in cane fields, Martin Peña and Garrochales, both times in low, wet fields with sandy soil. Its scarcity, lack of evidence that it feeds on cane and preferred environments in wet, sandy fields eliminate it from consideration in connection with mosaic.

Grasshoppers. *Schistocera pallens* Thunb., det. A. N. Caudell.

This large brown grasshopper is occasionally found in cane fields, but only a few individuals are ever noted in any one field.

Conocephalus cinereus Thunb., det. Caudell.

This is a moderate-sized, green, long-horned grasshopper with a broad, brown dorsal stripe, which is occasionally found in cane fields. At times it occurs in great abundance, especially where other grasses, *malojillo* and Johnson, are growing rankly. Large numbers were collected in such a field at Coloso, December 11, 1919, but few have been noted in the spring and summer.

Neoconocephalus macropterus Redt., det. Caudell.

The adults of this large, long-horned, green grasshopper, of which light-brown and greyish-green forms occur, is seldom collected, as they apparently live in the high cane, where collecting is difficult, but the nymphs are often found far down in the central whorl of the young shoots. A cluster of eggs of this species was found between the leaf-sheaths of the large cane (Vieques Island, December 20, 1919). There were nine eggs in the cluster, about one-half inch long, light green in color when collected and considerably flattened by the pressure between the leaf-sheaths.

All of the grasshoppers mentioned, both nymphs and adults, feed on cane leaves, and although they never have been sufficiently abundant in Porto Rico to cause serious or even noticeable injury, yet the habits, especially of the two latter, of hiding by day far down in the central whorl of tender growing leaves, and the ability to travel considerable distances by jumping and flight, are very suggestive as to the posibilities of disease transmission. Grasshoppers have biting mouthparts and they eat extensive strips of the outer edges of cane leaves. Their excrement consists of quite large pellets, which any

disturbance of the leaves, or rain carries far down into the central whorl.

EUPLEXOPTERA.

The Cane Earwig. *Labia curvicauda* Motsch., det. A. N. Caudell.

A very few earwigs have been found under dead or nearly dead leaf-sheaths of high cane, and the younger stages even in the central whorl of high cane. The Porto Rican species is not nearly so common as *Doru aculeatum* Scudd. is on young cane in the southern United States, and no specific observations have been made on its feeding habits. Earwigs are omnivorous, but the only record of the food of the species found on cane is by the writer on *Doru aculeatum* feeding on parasitized *Diatræa* eggs.

PHYSOPODA OR THRIPS.

The yellow thrips of cane was common from Ponce to Mayagüez, and most abundant at Guánica during December, 1919, but was scarce at Guánica in April, 1920, and none could be found in June. During an extended drought, some were found at Bayamón on the north coast, and Mr. Smyth states that he found them at Río Piedras on cane during a drought. They live inside the central whorl of leaves, which must be unrolled to find them. When abundant, colonies will consist of from 12 to 20, but during most of the time when observations were made only from 2 to 6 would be found in a single shoot. Their habitus inside the central whorl of leaves is apparently better adapted to causing the disease than that possessed by any other insect found on cane and "the mouth-parts are probably used chiefly for sucking; they are intermediate in form between those of the sucking and those of the biting insects." (Comstock "Manual.") Their occurrence in abundance at Guánica in the fall of 1918 coincided with a very rapid spread of mosaic, but there have been many other times of rapid spread of mosaic in other localities, when no thrips were present.

A black thrips is also occasionally found on cane leaves. All thrips have been so scarce most of the time that the investigations were being made, that little attention has been paid to them, and no determinations have been received of the specimens submitted to the specialists.

HEMIPTERA.

All the other insects mentioned in this paper, except the thrips, either have biting mouth-parts, so that when they feed on cane they

chew out a piece of the leaf or stalk or root, or if they have sucking mouth-parts, they are adapted to sucking up a liquid on the surface, and not for penetrating the plant tissue and obtaining cell sap from the interior of the cane. The Hemiptera have an entirely different type of mouth-parts, consisting of a long, narrow tube which is strong enough to penetrate the host, suck up some of the juices and be removed without causing any tissue loss or similar noticeable injury. Most of the insects, or other invertebrates, which transmit diseases of plants or animals, have in general this type of mouth-parts—ticks, biting flies, mosquitoes, aphids and leafhoppers. It is among the members of this order that one would expect to find the vector or vectors of mosaic disease of sugar cane, and the one insect, *Aphis maidis*, that has transmitted the disease under laboratory conditions belongs to this order. Consequently more attention has been paid to the Hemiptera living on sugar cane—the aphids, mealybugs, scales, Fulgorids and leafhoppers, and especially to one of the leafhoppers, *Kolla similis*, which is one of the commonest insects on sugar cane in Porto Rico.

Fig. 1.—Adult of *Lasiochilus divisus* Champ. 12 × original.

Family Acanthiidæ.

The Pink Leafsheath Bug. *Lasiochilus divisus* Champ., det. Gibson.

All stages of this little pink bug, from small nymph to adult, have been found under the older green leaf-sheaths of high cane. Most of the other members of the family to which it belongs are predaceous on other insects or animals, and probably this species is predaceous, as an abundance of other insects live under leaf-sheaths, young mealybugs, psocids, springtails, earwigs and the larvæ of the beetle *Telephanus pallidus*.

Family (Fulgoridæ) Delphacidæ.

The West India Cane Fly or Leafhopper (Fulgorid). *Delphax (Stenocranus) saccharivora* Westw.

This Fulgorid is a very serious pest of sugar cane in some of the other West Indies. Ballou states ("Insect Pests of the Lesser Antilles," 1912, Barbados):

"The presence of the cane fly is often first indicated by the black fungus which grows over the canes wherever these insects occur in considerable numbers. In fact, the cane fly was formerly called black blight, planters and others not

distinguishing between the insects and the fungus.—It is mentioned in Schomburgk's *History of Barbados* occurring in great numbers in Grenada after the hurricane of 1831. "At that time it is said to have caused the loss of half the entire crop of sugar, in certain sections."

It has not been noted as of importance in Porto Rico, never occurring in sufficient abundance to produce the black sooty mold. Its scarcity is apparently due to parasites and predators on all stages, eggs, nymphs, and adults. Due to its scarcity in Porto Rico, its habits there depart considerably from those localities where it occurs in destructive abundance, and these notes deal only with the Porto Rican conditions.

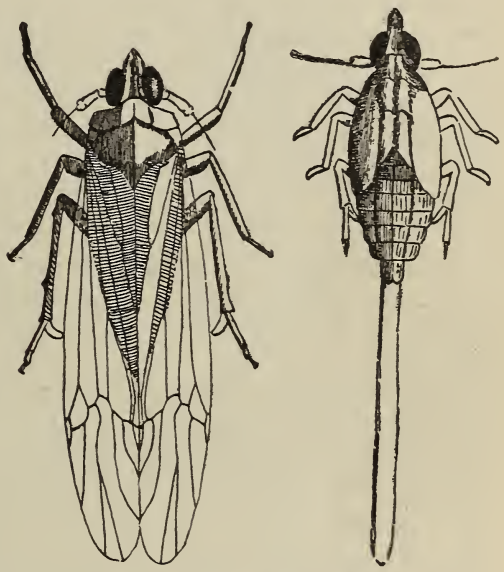

FIG. 2.—Adult and nymph of *Delphax* (*Stenocranus*) *saccharivora* Westw. 12 × original.

The eggs are deposited in clusters of 4 to 8, 9 from the underside in the midrib of the older cane leaves of plants from 1 foot high to fully grown cane. The slit in the under side of the midrib is diagnostically marked with whitish fluff from the caudal end of the body of the female, and usually can be noted from above, as the sides of the egg cavity turn red with red rot *Colletotrichum*. The nymphs remain on the under side of the leaves, where they were hatched, feeding and creating long fillaments of white fluff. They are pale (Niagara) green, as are the adults. The adults tend to remain with the nymphs and often considerable colonies of large and small nymphs and adults will be found on the under side of one leaf. But the adults are much more lively than the nymphs, and readily jump and fly away to other plants. The adults, too, are not restricted to the under sides of the older leaves, but often are found on the central whorl, feeding with *Kolla similis*. The adults leave no indication of their having fed, but the lesions caused by the insertions of the eggs, and the chalky white fluff of the nymphs per-

sists on a cane plant long after the eggs have hatched, or the nymphs transformed to adults and flown away.

Delphax is by no means restricted to small cane, but occurs in abundance on that 2–5 feet high, and often is found on cane ready for the mill. The summarized field observations show a decided preference for cane 1–1½ feet high, and this may be considered the preferred size for breeding.

Percentage of Infestation by *Delphax saccarivora* on Sugar Cane of Various sizes.

Height of cane	Percentage of infestation of cane in ALL fields	Percentage of infestation in cane in infested fields only
6–12 inches	7	25
6–18 inches	14	55.5
12–18 inches	33	66
12–36 inches	10	35
18–36 inches	8	35

The percentage of infection is determined by the number of nymphs or adults found on one shoot (not plant, not stool), an average of 1 individual per shoot being considered 100 per cent infestation.

The preference by *Delphax* for inland cane fields, rather than for those near the coast is most marked, over four times as many being found in the fields away from the coast. The percentage of infestation for cane in all fields with a gentle slope was 27 per cent, for steep hills 18 per cent, for level *vegas* 16.3 per cent, for level uplands 1 per cent, giving an average for all inland fields of 17.4 per cent infestation. On the coastal plain the average infestation was 4.6 per cent, in swamps 1 per cent and on coastal slopes 0.2 per cent, giving an average of 4.2 per cent infestation of all coastal fields, scarcely a quarter of that (17.4) for the inland fields. The importance of this preference for the inland fields is that mosaic has spread more rapidly and extensively in the hills than in the coastal plains, and infestation is now more severe and extends over comparatively greater areas in the hills than it does along the coast.

In a field of young plant cane at Cayey, observed March 29, 1920, where the percentage of infestation of *Kolla similis,* the Porto Rican sugar-cane leafhopper, was only 5 per cent, there was about 20 per cent infection of the cane plants by mosaic, over half of which was secondary; that is, the seed when planted was healthy

and the plant had become infected with the disease since the shoots had come up. One such plant, a particularly heavy and striking cane of secondary infection, had 7 nymphs and 2 adults of *Delphax saccharivora* on one of the lower healthy leaves. Another shoot in the same stool had four nymphs on a lower healthy leaf. One peculiarity noted only here was that the lesions caused by the insertion of the eggs had not turned red with the red rot, but were yellow. Another plant with strongly marked secondary infection, in the same field, had many egg clusters of *Delphax* in the lower healthy leaves, not showing red, and not observable from above, and an abundance of nymphs and adults on seven of the lower healthy leaves. The percentage of infestation for the entire field was 200 per cent for *Delphax,* and 5 per cent for *Kolla similis*, the next most abundant insect. These observations record the most striking instance of an abundance of recent secondary infection by mosaic disease where *Delphax saccharivora* was the most abundant insect. Many other observations have been made in fields where mosaic was spreading rapidly, where *Delphax* was abundant, but less so than *Kolla similis;* where *Delphax* was present but not abundant; where no *Delphax* at all were to be found.

Delphax displays great variation in abundance in cane fields, nearly always a few individuals being present, but only very rarely are heavy infestations found—a normal condition for an insect which is heavily parasitized. The summary of abundance by months shows no particular connection between its abundance and weather, although its sudden decrease from February to April, 1920, parallels the descending rainfall curve for these months. But no *Delphax* were observed in May, when there was an abundance of rain, and only one in June, at Yauco, and the practical disappearance of the Fulgorid is more probably due to extensive parasitizm. The data by months is: December, 1919, 30 per cent infestation; January, 1920, 11 per cent infestation; February, 1920, 25 per cent infestation; March, 1920, 6.5 per cent infestation; April, 1920, 0.5 per cent infestation; May, 1920, no infestation; June, 1920, 0.03 per cent infestation.

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Pierce, W. D. "Description of Two New Species of Strepsiptera (Halcophagidæ) parasitic on Sugar-Cane Insects." Proc. Wash. Ent. Soc. Vol. XVI, No. 3, Sept. 1914, pp. 126–29. *Stenocranophilus quadratus* Pierce, parasitic on *Delphax*.

The Yellow-Backed Fulgorid. *Megamelus flavolineatus* Muir., det. Muir.

This Fulgorid, originally described from West Africa, has twice been found on cane in great abundance, at Garrochales, April 19, and Ponce, March 17, 1920, averaging one insect per shoot, and a few individuals have been found on cane at Toa Alta, February 26; Guayama, March 30; Patillas, March 30; Palo Seco, May 17; Bayamón, May 27; Córsica, June 16; and Morovis, June 29, 1920.

Both nymphs and adults have been found together on cane, both having the broad median dorsal yellow stripe, black eyes and black lateral stripes, with the legs and ventral surface of the body yellow. There can be no question but that cane is a normal host plant for this species, and it may easily become a serious pest of cane.

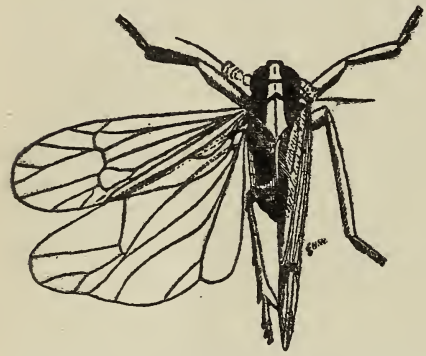

FIG. 3.—Adult of *Megamelus flavolineatus* Muir. 12 × original.

The Little Black Fulgorid. *Liburnia teapæ* Fowler, det Muir.

The little black Fulgorid with the yellow-tipped wings is only rarely seen on cane, and then when weeds and grass are abundant in the field. It is most abundant in the upland pastures where carpet grass, *Axonopus compressus,* is most abundant, and most of the specimens have been collected at Caguas and Trujillo Alto, but it has also been collected at light and on *malojillo* grass at Point Cangrejos. The nymphs are entirely black and have been found on cane, carpet grass and *malojillo* grass.

The Grey Fulgorid of Porto Rico. *Oliarus cinereus* n. sp., det. Muir.

The grey Fulgorid is the most universally present insect in cane fields in Porto Rico, and sometimes it is the most abundant. Ordinarily one sees only one or two individuals in a field of cane, but sometimes it is so abundant as to average one individual per 3 or 4 shoots. In the cane fields at Sardinera, which until a few years ago were a sandy desert of wild grasses and sedges, but which have recently been planted to cane, this Fulgorid is the most abundant insect, most of the common cane insects not yet having invaded these fields. At Manatí in June, this Fulgorid was also found in abundance, but except for these records, it has not been abundant.

It is often found in coitu, one sex being upside down, but nothing that might be the eggs of this species has been found on cane, nor have any nymphs been observed. The insects have never been found in greater abundance on any other plant than cane, although occasional individuals have been seen on various plants.

Seen in the field, the Fulgorid appears to be grey, but when dead it is black, or black with areas of reddish-brown around the eyes and on the prothorax, and the grey appearance may be due to a bloom which comes off at contact.

FIG. 4.—Adult of *Oliarus cinereus* n. sp. 12 × original.

The legs are light yellow and opalescent, the wings transparent, and the antenæ have such a short club that it does not show from above.

Bothriocerus venosa Fowler, det. Muir.

This Fulgorid has been seen on cane by the writer only once, at Añasco, but Mr. Smyth reports it as quite common on cane at Río Piedras. Its occurrence on cane is probably accidental, as no nymphs have been seen, and it is quite common on various other plants, as many as several score being seen on a wild orange tree at Point Cangrejos.

FIG. 5. — Adult *Agallia tenella* Ball. 12 × original.

REFERENCE: (Smyth, E. G.) Report of the Commissioner of Agr. & Labor of P. R. for 1919, p. 695. "Adults of a fulgorid leafhopper that holds the wings expanded like a fly, and which has been determined as *Bothriocera* sp., were quite common on the twigs of grapefruit, but none of the younger stages could be found. This insect has also been observed feeding upon sugar cane in March."

Family Jassidæ.

The Vegetable Leafhopper of Porto Rico. *Agallia tenella* Ball.

This little grey leafhopper has been collected on cane on the north coast between Arecibo and Río Piedras and has once been found

very abundant, at Garrochales, April 9, 1920. Even in this case, however, it was not as abundant as *Kolla similis,* or the yellow-backed Fulgorid, *Megamelus flavolineatus.* Nymphs have not been seen on cane. Mr. R. H. Van Zwaluwenburg reports it as common on vegetables at Mayagüez, and it has been taken by the wirter on *Solanum torvum* at San Germán, and potatoes near Jájome Alto.

The Porto Rican Coffee Leafhopper. *Tettigonia occatoria* Say., as identified by Fowler in the Biologia Centralii-Americana.

Of this large black-and-green leafhopper, 6 millimeters long, the second largest in Porto Rico, only one specimen has been collected by the writer, on cane at Morovis, January 2, 1920. It has four irregular black lateral stripes on a yellow head, one medium and four lateral black stripes on a yellow-and-green thorax, green wings laterally striped with black, with light yellow legs and yellow underneath. Mr. R. H. Van Zwaluwenburg writes (letter of April 28, 1920):

"It is common on the stems of coffee and has in addition a considerable range of other hosts. It has never been known to injure coffee noticeably. Other host plants, *Inga laurina* and jobo."

This leafhopper is recorded from the southeastern part of the United States and in some of the other West Indies.

Tettigonia sirena Stal.

This beautiful large leafhopper is found only occasionally in cane fields, but where it does occur, it is quite abundant and mosaic has either infested all the cane or is spreading rapidly. The leafhopper is light yellowish brown, in places becoming bluish, striped with black, but the yellowish ground color is from slightly to almost entirely displaced by a beautiful dark pink, suffusing the wings and sometimes even the head and thorax. The upper surface of the abdomen is also dark pink, but the whole ventral surface of the body is yellowish brown. The nymphs have a median stripe of light yellow extending from the head to the tip of the abdomen, the younger ones being otherwise mostly dark brown, but the older ones are more yellowish brown, with various spots or stripes of darker yellow or brown, but nowhere showing the dark pink of the adults. There will be no difficulty in the field connecting the nymphs with the adults, as they have invariably been found together. Nymphs have never been found except on cane plants, and the majority of adults have been found on cane.

It was at first thought that this species was confined to the hills, but it has been seen on gramma grass and bougainvillea vine at Point Cangrejos, and June 16, 1920, taken in abundance at Tres Hermanos (between Córsica and Añasco) on a narrow coastal plain between steep hills and the ocean, and not more than a few hundred yards wide. Between Lares and Aguadilla, and Lares and Arecibo, it was found in considerable abundance in cane fields in December, 1919, being most abundant high up in the hills, where in one or two fields it became more abundant than *Kolla similis*. It has since been found in abundance near Bayamón (Candelaria) in a cane field with only about 1 per cent of infested seed (November plant), which by April contained about 15 per cent of secondary infection. At Tres Hermanos, the cane was 100 per cent primary mosaic. Occasional individuals have been seen in cane fields elsewhere—Yauco, Barceloneta, Trujillo Alto, Morovis, Caguas, Adjuntas (nymph), Garrochales and San Germán (on *Solanum torvum*)—but except for the fields at Bayamón, Tres Hermanos and in the Lares region—San Sebastián and Bayaney—it has not been found in abundance.

FIG. 6.—Adult of *Tettigonia sirena* Stal. 12 × original.

Both adults and nymphs prefer the central whorl of cane and are usually found there, and they have been found in much larger cane, 3–4 feet high, than *Kolla similis* will ordinarily live in. Thus it possesses all the characteristics of the transmission of mosaic, except abundance. It is quite possible that this leafhopper is responsible for the first outbreak of mosaic in the Arecibo–Aguadilla–Añasco district, as it is now one of the most abundant leafhoppers in this region. No observations were made on it at the time of the outbreak in 1915–16.

Kolla fuscolineella Fowler, det. Metcalf.

This large, sharply marked leafhopper, superficially resembling the common *Kolla bifida* Say, of the eastern United States, with black-and-green striped wings, head lemon and cadmium yellow and black above and pink beneath, thorax yellow and green with transverse

black stripe above, and beneath a lighter pink than the head, but the same as the abdomen, is not very common on cane. The light-yellow nymphs entirely covered with white fluff, have been found once on gramma or St. Augustine grass, *Stenotaphrum secundatum* (Point Cangrejos), several times on Bermuda grass, *Capriola dactylon* (Aguada), and many times on hill gramma or carpet grass, *Axonopus compressus,* indicating the probable normal hosts of the leafhopper. It is quite abundant in pastures in the hills, where the predominant grass is hill gramma, but even in the optimum environment it is only one-half to one-fourth as abundant as *Kolla similis* in the same environment, while on the coastal plain only an occasional individual will be found in a meadow of *malojillo* grass, where *Kolla similis* will be 20 to 50 times as abundant. *T. fuscolineella* has never been taken on cane on the coastal plain, but in cane fields in the hills (Trujillo Alto, Toa Alta, Corozal, Ciales, Morovis) a few individuals will usually be found.

FIG. 7.—Adult of *Kolla fuscolineella*. 12 × original.

The Sugar-Cane Leafhopper of Porto Rico. *Kolla similis* Walk., det. Heideman. *Tettigonia prolixa,* Fowl., det. Gibson. *Kolla herbida* Wak., det. Metcalf.

Kolla similis is probably the most abundant leafhopper in Porto Rico, as it is the commonest not only on cane, but also on *malojillo* and Bermuda grass in the valley meadows and on carpet grass in the hill pastures. It is a large (4.5 to 5.5 mm. long), bright-green leafhopper, with a pattern in black on the head and thorax (in museum specimens the green area covered by this pattern is yellow, but the live leafhoppers are all green above except for the black pattern) with greenish-yellow legs, darker green to black underneath and with black hindwings. In a large number of specimens from all parts of the Island, the pattern of black lines and dots on the head and thorax is remarkably constant and shows little variation.

The first record of *Kolla similis* in Porto Rico is by Mr. D. L. Van Dine, who found it on leaves of sugar cane at Central San Cristóbal, Naguabo, P. R., December 12, 1910, and the next record is on

March 17, 1913, when it was found on young plant cane at Río Piedras by Mr. Thomas H. Jones. It is possible, but not probable, that it has increased enormously in abundance since these first records, but it is rather surprising that if it were abundant on cane previous to the years of the wide spread of mosaic disease, no more recorded observations are available.

The eggs of *Kolla similis* have not been observed on *malojillo* grass, but on cane they are usually deposited in the leaf around the central whorl, appearing as thickened and more opaque portions of the leaf. Sometimes the lesion caused by the insertion of the eggs turns red, and often after hatching it is dark red. By holding the leaf up to the light, the outline of the oval eggs can be seen and their number counted. There are from 3 to 7 eggs in a cluster, but usually 4 or 5. The egg stage lasts about a week.

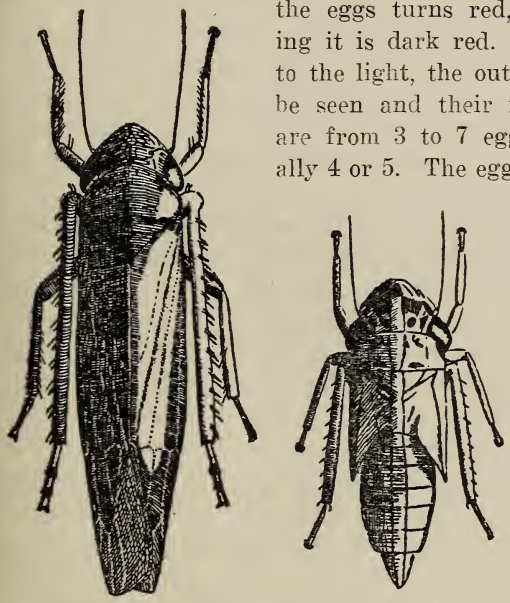

FIG. 8.—Adult and nymph of *Kolla similis* Walk. 12 × original.

The just-hatched nymphs are opalescent, light-creamy yellow with big darker eyes and are first noted on the central whorl of the cane. They feed nearly half the time. With their thick beak inserted in the cane plant, they let go with their legs, using them to get rid of the minute drop of colorless excreta which collects at the anus. With all their legs in motion at once and these little drops of moisture being hurled into the air at the rate of one every seven seconds, a colony of *Kolla similis* nymphs feeding is a most exciting spectacle.

The drops collect in the space between the leaf-sheath collar and the cane shoot, or on the vestiture of the cane, or on other nymphs which happen to be below, but they do not appear to be disturbed by it. This excreta becomes very abundant and can be collected in quantities as the nymphs become larger and produce larger drops.

A small vial of this excreta was examined by the Bureau of Chemistry of the U. S. Department of Agriculture. Dr. Alsberg stated that the quantity was so small that only a qualitative test could be made. He reports—

"The sample was tested both before and after acid inversion by means of color reactions for ketose and pentose sugar, as well as by reduction of Fehling's solution, and also color reactions of somewhat more general character than those just mentioned. All of these tests were either definitely negative or practically so. It was impossible to establish with certainty the presence of any sugar in appreciable amount."

Under laboratory conditions, where the cane plant used for breeding is kept under a lamp chimney and more heavily infested with nymphs and adults than it ever would be in the field, fungi do begin to grow on the lower part of the plant, on the dead leaf-sheaths, etc., which are kept continuously moist by this constant stream of excrement, but no similar fungous growth has been noted under field conditions.

In 4 or 5 days the nymphs molt. The second-instar nymphs are more opaque, greener, and show indications of the olive-green and brown stripes and spots of the older nymphs. Each of the five nymphal stages lasts from 4 to 7 days, but the minimum time for a generation was 34 days, and even with the slight variation in temperature experienced in Porto Rico, may last 45 days. On March 6th at 9.15 a. m. a fifth-instar nymph molting to adult was noted. When first seen only the head and thorax had been pulled out of the nymphal skin, but immediately the abdomen was pulled out and the empty skin remained with its beak inserted in the cane plant. The wings of the adult were curled up like little yellow balls, which unrolled to form wings in about 3 minutes. The adult was then a bright lemon yellow, with two black spots showing prominently on the head, but turned green in a few hours.

In the field, nymphs are much less abundant than adults, which is rather difficult to explain, as no adult lived longer than a month in captivity, but it is quite possible that they live much longer under normal conditions in the field. They display considerable variation in color, probably due to age, as the young adults are a bright green—slightly bluish—and as bright and shiny as wet paint, while the old adults are a faded-out yellow green.

A large number of observations were made on the abundance of *Kolla similis* in cane fields in all parts of the Island. For purposes of comparison, these are recorded as percentages of infestation, or

number of leafhoppers per shoot. In plant cane there are from one to five shoots from a single seed (top), and there may be from one to five tops or seed planted in a stool or *cepa*, and in ratoon cane there may be from one to thirty or forty shoots coming out of a single stool or *cepa*, which may be one or more plants. Thus in practice, it was found to be much more exact and to give a better idea of the number of leafhoppers to the amount of vegetation, to use the shoot as a unit, rather than the whole cane plant, or a stool. One leafhopper per shoot is 100 per cent infestation, one leafhopper per 20 shoots is 5 per cent infestation and 5 leafhoppers per shoot is 500 per cent infestation. The greatest number of adults ever noted on a single shoot was at Yabucoa, P. R., on March 30, 1920, when 18 adults of *Kolla similis* were found on one shoot, 9 inches high, and one egg cluster. The percentage infestation of this one shoot would be 1,800 per cent, but the average infestation of the field was 2 adults per shoot, or 200 per cent.

Both nymphs and adults live as far down in the central whorl of cane as they can conveniently get, and are not promptly dislodged, but some will be found higher up and on the outer leaves, from which they jump at the slightest disturbance. They much prefer small cane to large cane, and comparatively few are found in cane higher than one's head, although occasionally they will be quite abundant in strong vigorously growing cane 5 feet high.

TABLE.

Abundance of *Kolla similis* as Affected by Size of Cane. (Plant Cane Only.)

Size of cane	Percentage of infestation	Number of fields examined
Under 6 inches high	76%	17 fields
6-12 inches high	85%	52 fields
6-18 inches high	72%	23 fields
12-18 inches high	17%	24 fields
12-24 inches high	35%	11 fields
Average over 18 inches high	34%	26 fields

Kolla similis shows a decided preference for plant cane rather than ratoon cane of the same size. Its average infestation in 40 fields of ratoon cane examined was only 3 per cent, the highest infestation in any field being 20 per cent. Of the 153 fields of plant cane examined, of the same sizes and in the same localities, the average infestation was 59.4 per cent, the highest infestation in any

field being 800 per cent. That is, *Kolla similis* is twenty times as abundant in plant cane is in ratoon cane. No comparable observations were made on the spread of mosaic disease in plant and ratoon cane.

The abundance of *Kolla similis* varies directly with the rainfall. The correspondence between abundance and the amount of rainfall is so close that there can be no doubt about the relation. The small number of observations made during April, when the drought was most severe, is unfortunate, but the importance of securing a large number of records of scarcity was not recognized at the time, and even if the April records are omitted the curves correspond quite as closely.

TABLE.

The Abundance of *Kolla similis* by Months from December, 1919, to June, 1920, as Influenced by Rainfall. (Plant Cane Only.)

Month	Percentage of infestation of cane by *Kolla similis*	Mean rainfall of ten localities where most observations were made	Mean rainfall of Porto Rico
December, 1919	68%	4.40	4.83
January, 1920	104%	7.16	5.26
February	90%	6.47	7.37
March	36%	4.24	4.71
April	13%	1.38	1.10
May	67%	5.20	6.20
June, 1920	41%	3.76	Not available

The importance of water for *Kolla similis* is shown not alone statistically by the monthly records of abundance, but by field observations in *malojillo* grass. The leafhoppers do not occur at all, or only in small numbers, in dry meadows or pastures of *malojillo* grass, or on grass in a dry ditch in a cane field, even though the grass is green and thrifty, but on grass in a wet ditch, or in a wet depression in a field, or along a stream margin, or in a wet sink hole, they have invariably been found abundant. During December, January and February, large numbers of *Kolla similis* could be swept from the grass in the hill pastures, which are kept moist by almost daily rains during those months, but when they began to dry out, even though the grass remained green, very few or no leafhoppers could be found.

Most of the few exact records of the rapid spread of mosaic show that the spread occurred during periods of heavy rainfall, so that abundance of *Kolla similis* and rapid spread of mosaic, so far as the rainfall factor is concerned, are synchronous. However, in a field

of plant cane at Río Piedras, near the Caguas railroad, about kilometer 7, mostly a level upland with a small stream running through one edge, to which there was a steep slope, observed January 16, 1920, no mosaic was found (although it existed in nearby fields) and only 1 *Kolla similis*, a few *Delphax saccharivora* and a few *Sipha flava*. On February 2, no *Kolla similis* were found and few other insects. The field was not observed again until May 19, when an abundance of secondary infection of mosaic was found in the *vega* where the stream flowed, but only one case of mosaic was found in all the rest of the field. *Kolla similis* was found in the vegetation along the edge of the stream, but not on cane. Also an abundance of *Lachnosterna* (May beetle) adults had fed on the cane in the little valley. All cane outside of the valley was dry and stunted on account of the drought, which had just been broken a few days before. Whether an abundance of *Kolla similis* might have occurred on the cane in March, before the beginning of the drought, is doubtful, but it presents an instance of rapid spread of mosaic, apparently unaccompanied by an abundance of insects, and apparently occurring during, or at least observed after, a very severe and extended drought. At this same date (May 19) several other instances of recent secondary infection by mosaic were noted in small valleys, along the edges of streams, with a similar non-

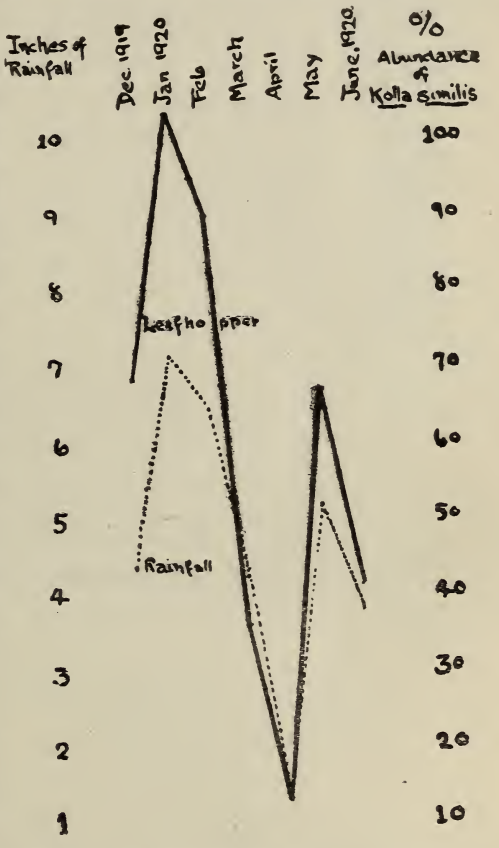

FIG. 9. — The abundance of *Kolla similis* by months form December, 1919, to June, 1920, as influenced by rainfall. (Plant cane only.)

abundance of insects at the time of observation, at Río Piedras, Trujillo Alto and Sabana Llana, but in none of these fields had previous observations been made on the abundance of insects.

Kolla similis shows only a slight preference for cane fields in the interior, rather than on the coast, but does show a decided scarcity in the fields on the steep hillsides.

TABLE.

Abundance of *Kolla similis* as Affected by the Contour of the Field. (Plant Cane Only.)

Kind of field	Percentage of abundance	Number of fields observed
Level *vega* (valley)	82%	34 fields
Level upland	74%	11 fields
Pocket	74%	5 fields
Coastal plain	65%	54 fields
Gentle hill	58%	12 fields
Coastal slope	29%	4 fields
Steep hill	26%	29 fields
Swamp	5%	4 fields

In this respect its abundance does not coincide with the more rapid spread of mosaic in the inland fields, including the steep hills. But for this exception, however, *Kolla similis* does possess all the characteristics supposed to be necessary for the transmission of mosaic disease.

REFERENCES:

Van Dine, D. L. "The Insects Affecting Sugar Cane in Porto Rico." Journ. Econ. Ent., Vol. 6, No. 2, 1913, p. 257. First record of *Kolla similis* on sugar cane in Porto Rico.

Smyth, E. G. "Report of the Division of Entomology," Annual Report Insular Experiment Station, Río Piedras, P. R. 1917–1918, p. 118. * * * "A green leafhopper, *Tettigonia similis* Walk., which occurs in greatest abundance on the Para grass (*Panicum barbinode*) growing in *callejones* between cane fields and to some extent on young cane, and is often encountered in districts where the disease (mosaic) is spreading."

Large Grey Sugar-Cane Leafhopper of Porto Rico. *Dræculacephala sagittifera* Uhler, det. Metcalf.

This large leafhopper has been collected on cane at many points in Porto Rico—Patillas, Guayanilla, Guánica, Córsica, Aguada, Barceloneta, Caguas—and probably occurs all over the Island. There is considerable variation in coloration, although the pattern is quite

constant. The wings vary from almost black with white veination through bluish-grey to light yellow, the scutellum is bright yellow with brown and black spots, the pronotum is mostly brown with yellow spots, the head is light yellow with a pattern of black and reddish-brown, the eyes vary from black to light yellow and the legs and ventral surface from light yellow to yellow brown.

The nymph is a uniform yellowish gray, with markings of a less grey yellow, and eyes of bluish-grey. Nymphs have been seen only on cane and this is the probable normal host of the species. While not as rare on some other leafhoppers (20 specimens having been collected in half a year) yet it is much too scarce to be considered of any importance as a cane pest.

FIG. 10.—Adult of *Draeculacephala sagittifera* Uhler. 12 × original.

Spangbergiella vulnerata Uhler.

This light-green leafhopper, the largest occurring in Porto Rico, 6.5 millimeters long by 2 millimeters wide, has been collected only three times by the author, on Vieques Island, December 20, 1919; Camuy, April 26, 1920, both times on cane, and at Point Cangrejos on *malojillo* grass. The leafhopper is found in the southern United States. The flattened head and the two diagonal reddish stripes on both head and thorax are the most obvious diagnostic characters.

REFERENCE: "The Cicadellidæ or Leaf-Hoppers of South Carolina," by Frank H. Lathrop, Bull. No. 199, South Carolina Agr. Expt. Station, pp. 50–51.

FIG. 11.—Adult of *Deltocephalus senilis* Uhler. 12 × original.

Deltocephalus senilis Uhler, det. Metcalf.

This leafhopper has been taken only twice on cane, at Garrochales and at Manatí, and is probably only an accidental visitant, but it is a common inhabitant of grasses on the coastal plain, as many have been taken at light and by sweeping *malojillo* grass at Point Cangrejos. The nymphs have not been observed.

A lighter variety, or possibly another species of *Deltocephalus*, was taken on grass at the top of the mountain divide along the road between Cayey and Guayama.

Another variety, or species, lacks the black coloration in the apical cell of the forewing. All the specimens showing this variation were taken at Point Cangrejos.

FIG. 12.—Adult of *Athysanus exitiosus* Uhler. 12 × original.

The species are characterized by the black spots and markings on the head, which are constant, and by the yellow outer margins of the forewings.

Athysanus exitiosus Uhler., det. Ball.

This large greasy yellow-and-black leaf-hopper has been collected but twice in Porto Rico, both times on cane, at Patillas, March 30, and Hatillo, April 27, 1920. The cane was very small, about 6 inches high, and the fields were on narrow coastal plains between high hills and the ocean.

This leafhopper is often a serious pest in grain fields in the southern United States.

REFERENCE: "Leafhoppers Affecting Cereals, Grasses and Forage Crops," by Herbert Osborn, U. S. Bur. Ent., Bull. No. 108, pp. 86–91.

The Four-Spotted Leafhopper. *Thamnotettix colonus* Uhler, det. Metcalf.

FIG. 13.—Adult of *Thamnotettix colonus* Uhler. 12 × original.

This leafhopper has been collected on cane at Arecibo, Barceloneta, Dorado, Palo Seco, Río Piedras and Trujillo Alto, and although it has been quite common on *malojillo* grass at Point Cangrejos, yet it occurs in greatest abundance on the pasture grasses of the hills, especially the carpet grass, *Axonopus compressus,* and most of the specimens were taken in sweeping pastures at Trujillo Alto, Caguas and Cayey. There is considerable color variation, the usual coloration being light or dark-grey wings with white veination, the rest of the body more or less bright yellow and light brown, but the two small and two large black spots on the vertex are constant and diagnostic.

The nymphs have not been identified, but they probably occur on the same host grasses as the adults.

Erythronura comes Say., det. Metcalf.

This brilliant little yellow-and-brown leafhopper, with silvery spots in the brown blotches, is sometimes very abundant on cane growing in weedy sandy fields. The nymphs are all yellow with indistinct olive-green markings on the thorax, five rows of brown hairs on the abdomen, black claws and light-green eyes. The nymphs will be found feeding on *Wedelia trilobata,* which is a common weed in some cane fields, and the adults will be found most abundant on this host, indicating that its occurrence on cane is accidental.

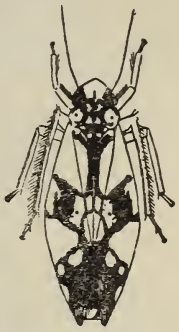

FIG. 14. — Adult of *Erythronura comes* Say. 12 × original.

Scaphoideus faciatus Osborn, det. Ball.

One adult of this beautifully mottled grey leafhopper was taken on cane at Bayanóm, May 28, 1920, and two collected at light at Point Cangrejos on the same date. It had never been collected before, nor has it been seen since.

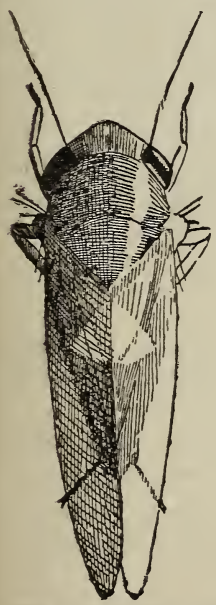

FIG. 15.—Adult of the Green *Chlorotettix* n. sp. Met. 12 × original.

The Six-Spotted Leafhopper. *Cicadula 6-notata* Fall.

This leafhopper was collected on cane at Patillas, March 30, and at Garrochales, April 9, 1920—a total of 3 specimens. The record on cane in Porto Rico is of importance because of the wide-spread distribution of this leafhopper in the United States and Europe, and the damage which occasional outbreaks cause.

REFERENCE: "Leafhoppers Affecting Cereals, Grasses and Forage Crops," by Herbert Osborn. Bull. No. 108, U. S. Bur. Ent., pp. 97–100.

The Large Green Leafhopper. *Chlorotettix* n. sp., Metcalf.

This large green leafhopper with transparent wings is found on cane all over Porto Rico, specimens having been collected at Patillas, Guayanilla, Yauco, Guánica, Coloso, Arecibo, Garrochales, Caguas and Río Piedras, and noted on cane at many other places. It also occurs at Point Cangrejos, where it comes to light, a few individuals being noted nearly every night from December to July, and probably occurring in moderate abundance throughout the year. It

never occurs in abundance on cane, seldom more than an occasional individual being seen, but as it feeds in the same place as *Kolla similis* on the central whorl of leaves and occurs with it, its color being very nearly the same, it is quite possible that its abundance, compared with the commoner *Kolla,* has been underestimated. The nymph is all green with darker green eyes.

The Large Yellow Leafhopper. *Chlorotettix* n. sp., Metcalf.

This leafhopper is readily distinguished from the preceding by its yellow color, darker eyes, brown legs and the brown spots on the wings, while the former has a light-green body, darker green eyes and transparent greenish wings. The size is the same, 5–6 millimeters long. The yellow leafhopper has been taken on cane only once, at Guánica, December 10, 1919, all the other specimens being collected at light at Point Cangrejos during December, January and February.

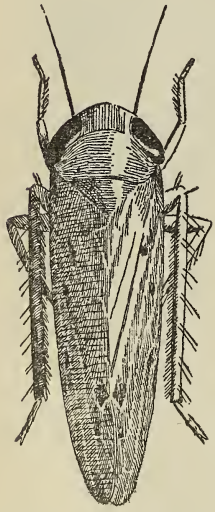

FIG. 16.—Adult of the Yellow *Chlorotettix* n. sp., Met. 12 × original.

The nymph is light green, with two median, interrupted by sutures, parallel, brown stripes on the back, which become rows of spots on the abdomen, smaller and less distinct caudally. Only one nymph has been collected, on cane at Patillas, but sufficient to indicate that cane is a normal breeding host plant.

The Little Green Leafhopper. *Balclutha osborni* Van Duzee, det. Metcalf.

This insignificant little pale-green leafhopper has been found on cane in abundance at several places—Guánica, Coloso, Bayaney, Vega Alta and Río Piedras—and been taken on *malojillo* grass at Point Cangrejos, Morovis, Corozal and Trujillo Alto, so that from this wide range of localities as to elevation and rainfall, it may be inferred that it occurs all over the Island. The adult is pale green with darker eyes, with transparent green wings.

The nymph is very small and pale green. It has been found both on cane and *malojillo* grass, and both are normal hosts.

This leafhopper occurs at times in extraordinary abundance, especially on *malojillo* grass, and at other times a field of *malojillo* grass may be swept without collecting a single specimen.

Empoasca mali Le Baron.

This little green leafhopper has been found on cane where beans are growing between the rows, and will be found in abundance on the beans. In Porto Rico it is a pest of considerable importance on vegetables, but its occurrence on cane is accidental. It is a pest of a variety of economic plants in the United States and has a wide distribution.

REFERENCE: "Insects Attacking Vegetables in Porto Rico," by R. T. Cotton, Jour. Dept. Agr. P. R. Vol. II, October, 1918, p. 276.

Family Aphididæ.

The Yellow Sugar-Cane Aphis. *Sipha flava* Forbes.

The yellow aphis of sugar cane, *Sipha flava*, is one of the most noticeable of the common sugar-cane insects of Porto Rico. It will be found in almost every field of young cane on some plants, but only once (Río Grande, Feb. 24, 1920) has a field been found where every plant was infested. The aphids live on the undersides of the older leaves, and it is only in the exceptional case of a very heavy infestation on a plant that they will be found overflowing onto the uppersides of the leaves near the base and on the collar of the leaf-sheath. They do not live on the central whorl of leaves. A mass of minute red and yellow spots on the leaves, which mark the presence of a colony of yellow aphis, coalesces to turn the whole infested part of the leaf a brilliant yellow, orange and red. This coloring of the leaf is permanent until it withers and turns brown, and is an unfailing indication of the presence of yellow aphis, or of its having been present, if the colony has been destroyed by the black-and-yellow spider, *Theridula triangulata* Keyserling, det. Shoemaker, or Syrphis fly larvæ, *Baccha clavata*, det. Metcalf, or predaceous Coccinellid beetles or their larvæ.

The adults of the yellow aphis can fly and are carried considerable distances by the wind. The younger stages crawl about, and especially when the leaf they are on is overcrowded, or beginning to wither, they migrate to another greener one higher up, or crawl off the plant in search of another. The aphids are also attended by numerous ants. A black ant was observed in the fields at Río Grande, which had apparently injured a Syrphid fly larva (*Baccha clavata*), in its efforts to make it let go of an aphid on which it was preparing to feed. The ant succeeded in rescuing the aphis from the Syrphid larva, pulling it away, and ran far off with it. Possibly the

ants carry aphids which are not immediately menaced by predators, to other plants.

The yellow aphis possesses the characteristics of (1) abundance, (2) rapid dispersion and (3) piercing-sucking mouthparts, but it does not live on the youngest leaves and it has never been found in the central whorl. The characteristic red and yellow spotting of the leaves, which absolutely indicates its presence or having been present, has been absent in the vast majority of cases of secondary infection of mosaic observed in the fields, and from this fact alone it must be eliminated from consideration as being responsible for any considerable amount of mosaic transmission.

REFERENCE: "Aphids or Plant Lice Attacking Sugar Cane in Porto Rico," by Thos. H. Jones, Bull. No. 11, Bd. Comm. Agr. P. R.

The Black Aphis of Sugar Cane. *Aphis setariæ* Thos.

The black aphis lives on the young cane shoot at the base of the leaves, and colonies are covered with sheds of mud built over them by the ants, *Solenopsis geminata* Fabr. This aphis is rare and has been noted but twice in a half year of observations of cane insects in the field. Their scarcity immediately eliminates them from consideration as having any connection with mosaic.

REFERENCE: "Aphids or Plant Lice Attacking Sugar Cane in Porto Rico," by Thos. H. Jones, Bull. No. 11, Bd. Comm. Agr. P. R.

The Corn Aphis. *Aphis maidis,* Fitch.

The corn aphis has not been found on cane in Porto Rico. It can not in any way be considered responsible for the transmission of mosaic disease of sugar cane under field conditions in Porto Rico.

REFERENCE: "Insects Attacking Vegetables in Porto Rico," by R. T. Cotton, Jour. Dept. Agr. P. R., Vol. II, October, 1918, p. 291.

Family Coccidæ.

Aclerda tokionis Ckll.

Aclerda tokionis is a peculiar scale insect, an oval, flattened, brown sac, surrounded by a mass of white wax where it does not touch the cane, living between the leaf-sheath and the stalk. The adult females are about one-half inch long and are dry and break open when one strips off the leaf-sheath, but the younger stages are smaller, softer and lighter colored—pinkish grey and light brown. None were found during the present investigation, as the scale is very rare, and in 1914–16, when the author inspected nearly 50,000

stalks of full-grown cane, less than .1 per cent were found infested with this scale. It most commonly occurs on the Otaheite cane, but some have been found on the variety G. C. 888. It has been found only at Río Piedras, Guánica and Humacao.

Targionia (Aspidictus) sacchari Ckll.

Targionia sacchari is a scale living at the base of high cane stalks, most often where the leaf-sheaths are bound to the cane by the mycelium of the root-disease fungi. It has a much wider distribution on the Island than *Aclerda tokionis*, having been noted at Río Piedras, Cieba (Fajardo), Humacao, Guayama, Aguirre, Santa Isabel, Fortuna, Mayagüez, Córsica, Quebradillas, Camuy, Barceloneta, Manatí and San Vicente in 1914–16, but only .15 per cent of all stalks inspected were infested.

Pulvinaria iceryi Guern., det. H. Morrison.

Pulvinaria iceryi, synonymous with *P. elongata* Newst. described from British Guiana on cane, is a quite large, thick, fleshy scale, of which six individuals have been found on the leaves of young cane at Cayey and Trujillo Alto. Mr. Smyth reports it as quite abundant on his cane grown in the greenhouse, where possibly it is protected from some of its insect enemies.

Sugar-Cane Mealybugs. *Pseudococcus* spp.

The mealybugs on cane, as ordinarily seen, are small, oval, fat, pink sacs of flesh, wingless and with minute legs, more or less covered with a mass of white waxy, powdery and filamentous secretion, looking like a miniature pink gum-drop, one-fourth inch long or less. They live under the leaf-sheaths of cane, collecting at the point of attachment of the sheath to the stalk, the youngest being on the most rapidly growing parts of the large cane, but the fat mature females are often abundant even under the old dead leaf-sheaths. The leaf-sheath clings more closely to the stalk when there are mealybugs underneath and does not trash off readily, but furnishes a most effective protection to them. The mealybugs also live on the roots of young ratoon cane. They are transported to new cane fields in seed cane (tops), for hidden deep under several layers of closely adhering green leaf-sheaths, they can not be readily reached and destroyed by an insecticide that will not injure the seed itself. Aside from this dispersion by man, the young larvæ crawl about, nearly always traveling at least from between the hard cane stalk and dead leaf-sheath where they hatched, up to the softer, growing part of

the cane, and while crawling about are often picked up by the fire ant, *Solenopsis geminata,* which feeds on their secretions and protects them, and carried to the most favorable situations for development. Despite their transportation on seed cane by man to new cane fields, and the crawling of the young to a proper place of development on the softer parts of the cane plant, neither of these methods of travel aids greatly in dispersion to new plants, and it is only the occasional transportation by ants to another plant that mealybugs could function as a carrier of mosaic, producing new infections. They have the other necessary characteristics of universal abundance and they live in old cane, and on plant and ratoon cane, before and while sprouting, on the most rapidly growing parts of the cane plant, although not within the central whorl of leaves.

REFERENCE: "First Report of the Entomologist," by D. L. Van Dine, Bull. No. 1, Expt. Sta. P. R. S. G. Assn, Río Piedras, 1911.

LEPIDOPTERA.

The larvæ or caterpillars of the various butterflies and moths living on cane have biting mouthparts and chew out parts of the stalk or leaf on which they feed. The adult butterflies and moths have a long proboscis, through which they suck up water, dew, the juice of cut or crushed cane stalks, or nectar of flowers, but it is not adapted for piercing plant tissue and obtaining cane juice from an uninjured cane plant. Thus, the adults, which fly and are capable of rapid dispersion, could not transmit mosaic, as they have no way of obtaining the juice of an uninjured cane plant. The larvæ, which eat the cane leaves, or make tunnels in the cane stalk, can crawl about, but seldom do migrate to another plant. The possibility that any of the Lepidoptera have any relation to the spread of mosaic is slight.

Family Crambidæ.

The Sugar-Cane Moth Bearer. *Diatræa saccharalis* Fabr.

The larvæ of this Crambid moth are a very serious pest of cane in Porto Rico and have been extensively treated in numerous publications. The eggs are deposited on cane leaves, the larvæ feed on the center of the young shoots, at or beneath the surface of the ground, killing the central whorl and producing what the planters call "dead-hearts," and in older cane make tunnels in all parts of the stalk. They are very abundant, practically every stalk of cane on the south side of the Island showing the tunnels which these cater-

pillars bore, but are less abundant on the north side where the rainfall is heavier.

REFERENCES: "The Sugar-Cane Moth Stalk Borer," by Thos. H. Jones, Bull. No. 12, Bd. Comm. Agr. P. R.

SUPERFAMILY TINEINA.

Family Lyonetidæ.

The Porto Rican Sugar-Cane Bud Moth. *Opogona* sp.

The larva of *Opogona* sp. is a small grey-brown caterpillar with a black head, which eats the eyes of cane and makes superficial tunnels in the rind of the cane stalk near the nodes, and in the inside of the leaf-sheaths, when burowing between the stalk and leaf-sheaths. During 1914–16, in examining a large number of fullygrown stalks of cane, in all parts of the Island, it was found to have made tunnels or eaten into the eyes on 1.2 per cent of all stalks examined. It occurs all over the Island of Porto Rico and has been found on all the common varieties of cane—Otaheite, Rayada, Crystalina, Cavengirie and Yellow Caledonia—and on some of the seeding varieties—B-3412, B-4596, B-109, B-3696, B-3922, D-117, GC-486 and Seely Seedling—showing no particular preference for any one. It can not be considered a pest of very great importance as it does not burrow far enough into the rind of the cane to cause an appreciable loss of juice, and the eyes chewed into are usually far enough down on the stalk that they go to the mill to be ground and are not on the seed-top It is also so scarce that it would not be noted unless large number of stalks are inspected.

Family Coleophoridæ.

The Sugar-Cane Case Bearer. *Coleophora* sp., det. Busck.

A large number of case-bearer larvæ and pupæ were noted on cane plants 12–24 inches high, May 13, 1920, in a field on a shelf below the turn in the San Juan–Arecibo *carretera,* emerging from the Espinosa hills into the Toa valley. No indications of their feeding on the cane were observed, but they did not occur on any of the weeds in the field, and it must be concluded that cane was the host, as there were no cane plants in the field that did not have one or two on their leaves and some had as many as eight on a single shoot. A few specimens had previously been found on cane, farther down the valley at Toa Baja and Dorado, from which parasites emerged, determined by Mr. Gahan as *Microplectrum* sp.

Family Noctuidæ.

The Southern Grass Worm. *Laphygma frugiperda* S. & A.

The larvæ of this Noctuid moth feed on *malojillo* grass, corn and other grasses, as well as on cane, and sometimes when not held in check by numerous parasites and predators, occur in such abundance as to destroy a planting of young corn, and to literally cover the ground in a *malojillo* pasture. On cane they feed on the central whorl of tender leaves of the young shoots, but are seldom found in large cane. Larvæ have been noted in considerable abundance in young plant cane at Sabana Grande, December 11; Arecibo and Manatí, January 14; Caguas, January 14; Río Piedras, January 17; Patillas and Yabucoa, March 30; Garrochales, April 9; Manatí, June 7; Córsica, June 16; and at Ciales, June 29. The larvæ feed in the proper place on cane so that they might transmit mosaic, but cane showing recent mosaic infection has never been noted with *Laphygma* injury.

REFERENCES:

"Some Notes on *Laphygma frugiperda* S. & A. in Porto Rico," by Thos H. Jones, Jour. Econ Ent., Vol. 6, No. 2, p. 235, April, 1913.

"Insects Affecting Vegetable Crops in Porto Rico," by Thos. H. Jones, Bull. U. S. Dept. Agr. No. 192, p. 7.

The Sugar-Cane Looper Cutworm. *Mocis (Remigia) repanda* Fabr.

The larvæ of this Noctuid moth feed on the older leaves of all sizes of cane. Only a few larvæ were noted during the half year, and only one occurrence in abundance, at Manatí, January 1, 1920. It is usually heavily parasitized by Tachinid flies when an outbreak occurs, and the externally parasitic larvæ of *Euplectrus* sp. have been noted (Morovis, June 29). The larva is longitudinally striped with light and very light yellow-grey, with black and white spots at some of the sutures in the middle of the body, which show only when the larva is bent, or crawling, but when at rest, it is most effectively protected by its coloration, which is the same as that of recently dead, dry cane leaves. It pupates in a cocoon spun in a rolled leaf, or leaf-sheath and transforms to an inconspicuous bluish-gray moth.

The Sugar-Cane Skippers. *Prenes nero* Fabr. *Prenes ares* Feld.

The larvæ of the skipper butterflies have a characteristic small neck with a large head and a tapering body. The larvæ of four or five species feed on the leaves of young cane, mostly at night, and spend the day hidden in a shelter formed by folding or rolling the leaf. They are seldom abundant, usually only a few being found

in a cane field. At Manatí, January 1, 1920, the larvæ of both *Prenes nero* and *P. ares* were found in such abundance that, with the aid of the larvæ *Mocis repanda,* they had almost entirely defoliated a considerable area of young plant cane, 12–18 inches high. Aside from this record, 18 larvæ of *P. nero* and 3 of *P. ares* have been noted during the half year, and one larva of *Atrytone vittelius* Fabr. all from the north side of the Island or the hills on the north side.

The larva of *P. nero* is entirely a yellowish grey-green, yellower and a trifle greener than that of *ares.* The larvæ of *ares* has a chocolate-brown head with two lateral stripes in front and a black spot with yellow sides on the cheeks, and a black collar on the posterior portion of the first segment. The rest of the body is a light chalky grey-green.

The chrysalis of *nero* is a light opalescent green, with white, wavy, thread-like lines showing through dorsally, and with a sharp point on the head. It is suspended in a silken girdle in a curled cane leaf, with a silken band at top and bottom holding the leaf together. When the butterfly is about to emerge, the eyes turn pink a day or two before the wings begin to show dark through the chrysalis skin.

The chrysalis of *ares* is yellowish grey, but slightly opalescent, with brown hairs on the head. The larva spins quite a cocoon before pupation, using several leaves. The chrysalis has the mouth parts free from the body in a long tube from the end of the wings nearly to the end of the body. The eyes and back of the head turn dark long before the adult is ready to emerge.

The adults are thick-bodied, brown butterflies with light-yellow spots on the forewings. The largest of these spots is roughly triangular on the wing of *P. nero,* and more nearly rectangular on the wing of *P. ares.* The underside of the wings of *nero* are very slightly lighter than above, but those of *ares* are variagated with a large irregular yellow area and an irregular grey band on the forewing and three irregular gray bands on the hind wing.

The larvæ of *P. nero* are parasitized by an Apanteles, to which Mr. C. F. W. Muesbeck has given the name of *Apanteles prenidis* n. sp., and those of *P. ares* by *Apanteles disputabilis* Ashm., det. Muesbeck.

REFERENCES:

"Report of the Entomologist," by D. L. Van Dine, Third Ann. Rept. Expt. Sta., S. G. Assn. (1912–13), pp. 34 and 40.

"A Revision of the N. A. species of the Ichneumon-flies belonging to the genus *Apantales,*" by C. F. W. Muesebeck. No. 2349 from Proc. U. S. Nat. Mus., Vol. 58, pp. 483–576.

Other Sugar-Cane Hesperids.

At Point Cangrejos, on February 14, 1920, it was found that on potted cane plants the eggs of a skipper had been deposited. There were one or two eggs on a plant, near the end of the leaf. Viewed from above the eggs were round, opalescent creamy and without sculpture, with a faint brown spot in the interior, but from the side they appeared flattened. February 15th a pinkish yellow crab spider was seen eating one of the eggs. By the 19th one of the eggs showed a brown horseshoe-shaped mark in its depths and on the 20th the larva had hatched and formed a shelter near the base of the leaf. It had a black head and a yellowish-green body, and did not eat till 9 p. m. On the 22nd it changed its shelter on the plant to the end of a leaf where it had spun three bands of silk between the eggs. It was greener, with a black head, a black ring on the first segment and four large black hairs on the terminal segment and four smaller ones. On March 12th, when it was about 1 inch long, its head was yellow with brown markings, its body opalescent grey-green, with two noticeable yellow spots on the twelfth segment dorsal and very short black hairs on the thirteenth segment. On March 31st it was found pupated in a cocoon in the central whorl of leaves. The chrysalis was light yellow, fully enclosed by a silken cocoon. The adult emerged April 19th and was identified by Carl Heinrich as *Choranthus ?*, possibly *C. ammonia* Plotz. Its wings are bright reddish brown with the distal margin of the forewing and the coastal margin of the hind wing black. The underside of the wings is bright reddish brown with a large triangular black area on the forewings near the base.

Although the larvæ of this skipper have not been found on cane in the field, and possibly normally they feed on the marsh grasses and sedges growing near the Point, that it successfully passed the larval period on cane shows that it might become of importance as a pest of cane.

Mr. Smyth reports another skipper, *Atrytone vittelius* Fabr., the larvæ of which feed on cane, as commoner than *P. nero,* but only one larva has been collected by the writer, at Cayey. It has a black head and a black ring on its neck, the rest of the body being dark green. The wings of the adult are bright chrome yellow, margined with brown above.

The larvæ of *Perichares corydon* Fabr. have also been found feeding on cane leaves.

DIPTERA.

Calobata lasciva F., det. Aldrich.

This odd, long-legged fly is common in cane fields, having been noted as especially abundant at San Sebastián, December 12; Río

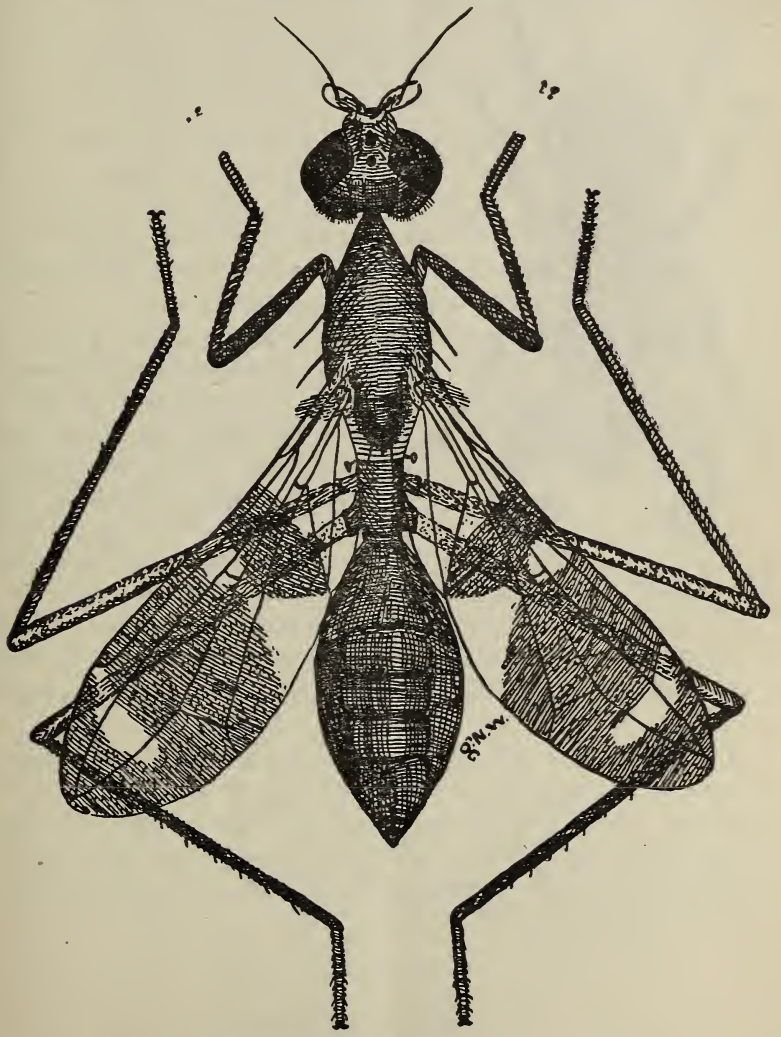

FIG. 17.—Adult of *Calobata lasciva* F. 12 × original.

Piedras, February 12; Toa Alta, May 13, and as the most abundant insect in the cane fields at 6 a. m. at Guayanilla, June 15. It has been bred from old cane stalks, in which the maggots lived.

Euxesta thomæ L. W., det. Aldrich.

This blue-black fly with black-banded wings occurs in all cane fields in Porto Rico, and is especially abundant about cane cars of loaded cane, or at loading stations, feeding on the cane juice. The larvæ probably breed in decaying plant tissue—*Diatræa*. dead-hearts—etc. The adults have been seen in greater abundance on fresh human feces (Morovis, June 29th) than they have been noted on live cane plants or even cut or crushed cane, and it may be that their omnipresence in cane fields is merely accidental.

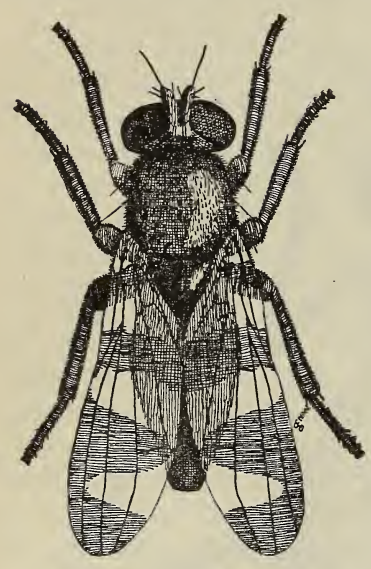

FIG. 18.—Adult of *Euxesta thomæ* L. W. 12 × original.

Acuira insecta L. W., *Ensina humilis* L. W., *Euaresta melanogastra* L. W., and *Urelia solaris* L. W. are other flies which are occasionally found in cane fields. The first two are most abundant in the hills of the north and west coast, most of the collections being made at Corozal, Morovis, Ciales, Caguas, Trujillo Alto, San Sebastián, Lares and Aguada. The third is rather rare and the last is more abundant near the coast, more specimens being swept from *malojillo* grass at Point Cangrejos than found on cane.

Hippelates texanus Malloch and *H. pusio* Loew., det. Aldrich, are very small black flies—"mimis"—which were very abundant on cane at Guánica, December 10, 1919, and what is probably these flies have been often noted in great abundance in cane fields at many other places in the dryer parts of Porto Rico. The larvæ are probably scavengers, according to Dr. Aldrich.

COLEOPTERA.

Family Scarabæidæ.

White Grubs and May Beetles (gusanos blancos y caculos). *Lachnosterna* spp.

White grubs are present all over the Island of Porto Rico, not only in cane fields, but in citrus groves, pastures, etc., but attain their greatest abundance in the cane fields near Guánica. The life

cycle of *Lachnosterna* requires a year for its completion, but there are two separate generations, spring and autumn, when the beetles are abundant, and a few beetles will be found at almost any time of year. The grubs feed on the roots of cane and other plants, but do not travel far underground, and could scarcely transfer a disease farther than from one plant to its nearest neighbor. The adults are strong flyers and may fly several hundred yards. They feed on young cane leaves and the leaves of many other plants, and at times occur in sufficient abundance to cause considerable injury. Their excrement, like a little daub of olive-green oil paint squeezed out of a tube, is often found on cane leaves where they have been feeding, where it can be washed by the rain into the central whorl of the cane. If the disease can be transmitted through the excrement by contact at the proper point for infection, all the other conditions necessary for transmission are fulfilled by the *Lachnosterna* beetles.

The *Lachnosterna* of Porto Rico have been extensively treated in the paper by E. G. Smyth, Journal of the Department of Agriculture of Porto Rico, Vol. 1, 1917, Nos. 2 and 3, "The White Grubs Injuring the Sugar Cane in Porto Rico."

Ligyrus tumulosus Burm.

Out of about 50,000 stalks of cane examined in 1914–16, 46, or nearly 1 per cent, had holes eaten into them at the base by the adults of *Ligyrus tumulosus,* and in a few cases several of the adults were found burrowing still farther into the stalk. These injuries occurred in cane at Vega Baja, Barceloneta and Camuy on the north coast Yabucoa and Humacao on the east and Guayanilla on the south. The grubs of this beetle are white grubs which feed on decaying vegetable matter in the soil, especially dead cane roots, but do not feed on live roots. The grubs can be easily distinguished from those of *Lachnosterna* spp. as they can straighten out their bodies and crawl easily with their ventral surface down flat, but the grubs of *Lachnosterna* spp. can not straighten out entirely and the caudal portion of their body is always somewhat bent down, cephalo-ventral, so that they can not crawl on a flat surface. At Guánica, the grubs of *Ligyrus* have been noted crawling about on the surface of the ground after a heavy rainfall that had soaked the soil, but this was observed but once and is quite unusual. The last (third) instar grubs of *Ligyrus* look much like the second-instar grubs of the much

larger Rhinoceros beetles, *Strategus titanus* and *quadrifoveatus,* and cannot easily be distinguished, except that the latter feed on dead wood or cane seed, but will not thrive so well on the cachaza, manure and dead cane roots that are preferred by the *Ligyrus* grubs. The grubs are parasitized by the wasp *Campsomeris dorsata* Fabr., which is very abundant in sandy areas.

The beetles are moderate-sized, robust, convex, hairy, dark-brown beetles which produce a characteristic squeak by means of small stridulating organs on the inner surface of the elytra near the outer hind margin.

REFERENCE: Smyth, E. G. "Report of the South-Coast Laboratory," 4th Rept. Bd. Comm. Agr. of P. R. 1914–15, p. 47; summary of life cycle.

Family Cucujidæ.

The Yellow Cane Leaf-Sheath Beetle. *Telephanus pallidus* Chevr., det. Schwarz. (*Telephanus pallidulus* Chevr. Leng and Mutchler, "Cleoptera of the West Indies," p. 415.)

Larvæ and adults of this beetle have been found between the leaf-sheaths of high cane. The larvæ are whitish, semi-transparent, when full grown not more than one-half inch long, and feed on the inside of the older leaf-sheaths while they are still green. By the time the larvæ are mature the leaf-sheath is brown and easily pulled off. The beentles are more abundant under the brown dry leaf-sheaths, where one finds them resting two by two, with their anal extremities together, but facing in the opposite direction. Adults have also been found on dry banana leaves, and after the end of the grinding season, when there is no high cane, they have been found on the leaves of young cane (Añasco, June 16). They are usually but not always abundant in high cane, but they are the one insect most often found under leaf-sheaths that can be readily stripped from the cane. As many as 12–15 are often found on a single stalk. The feeding habits of the adults, which can move from cane to cane, are not known, although apparently they feed on dead plant tisue, and the larvæ, which feed on live green tissue, are restricted to the plant where the eggs were deposited.

FIG. 19.—Adult of *Telephanus pallidulus* Chevr. 12 × original.

Family Chrysomelidæ.

The Tobacco Flea Beetles. *Epitrix cucumeris* Harris (small black). *Epitrix parvula* Fabr. (small brown). *Systena basalis* J. Duval (large black.)

The tobacco flea beetles may not feed on cane either as larvæ or adults, but they are so often found on cane, even when there is no tobacco planted with or near the cane, or other solanaceous host plant near, that their presence should be recorded. The following records of occurrence out of a total of 193 observations, shows their comparative abundance:

Epitrix cucumeris Harris: one, Aguadilla, December 12.

Epitrix parvala Fabr.: some, Caguas, January 14; abundant, Garrochales, April 9; abundant, Morovis, June 29.

Systena basalis J. Duvall: abundant, Aguada, December 11; one, Aguadilla, December 12; abundant, San Sebastián, December 12; some, Caguas, January 14–24; some, Bayamón, May 17; some, Aguada, June 17.

All of these records are of cane fields in the hills, except the one at Garrochales, which was in the coastal plain. One or two specimens of other flea beetles have been taken on cane, but they have never been abundant, as were the two common tobacco pests.

REFFRENCE: "Report on Tobacco and Vegetable Insects," by R. T. Cotton, 5th Report Bd. Comm. Agr. P. R. 1915–16. pp. 86–99.

The Green Beetle. *Diabrotica graminea* Baly.

The green beetle is often found in cane fields, especially on the north side of the Island, and occasionally is very abundant, although it is doubtful if cane is a preferred host.

REFFRENCE: Same as above, pp. 96–98.

Family Coccinellidæ.

The Coccinellid beetles are not cane pests, but are predaceous on aphids or other small weak insects, and especially on cane on the yellow aphis, *Sipha flava.* Six Coccinellids are common in Porto Rican cane fields, *Megilla innotata* Vauls., *Cycloneda sanguinea* Linn., *Scymus loewii,* Muls., *Scymnus roseicollis* Muls., *Hyperaspis connectens* Thumb., and *Hyperaspis apicalis* Weise., all determined by Mr. Schwarz. The first two and the last are probably most common.

REFERENCE: Jones, Thos. H., "Aphides or Plant Lice Attacking Sugar Cane in Porto Rico." Bull. No. 11, Bd. Comm. Agr. P. R., pp. 12–14.

Family Curculionidæ.

The Weevil Root-Borer. *Diaprepes spengleri* Linn.

Both grubs and adults of *Diaprepes spengleri* feed on many kinds of plants besides cane. The grubs live in a single stool of cane, but the beetles, although dispersing widely by flight, comparatively seldom feed on cane leaves, although they are often found resting on them. Eggs are deposited between two leaves of cane or other plants, which are glued together. The young grubs, on hatching, fall to the ground and burrow into it in search of live roots on which to feed. The insect is abundant in Porto Rico and the adults are more or less abundant at all seasons of the year.

REFERENCES:

Pierce, W. Dwight, "Some Sugar-Cane Root-Boring Weevils of the West Indies," Jour. Agr. Research, U. S. Dept. Agr., Vol. IV, No. 3, pp. 255–264.

Jones, Thos. H., "The Sugar-Cane Weevil Root-Borer, *Diaprepes spengleri* Linn." Bull. 14, Bd. Comm. Agr. P. R.

Family Cossonidæ (formerly Calandridæ).

The West Indian Cane-Stalk Weevil Borer. *Metamasius hemipterus* Linne.

The larvæ, pupæ and adults of this large weevil will often be found in dead cane stalks, cane stalks that have been chewed by rats or otherwise severely injured, or in dead seed cane that has not dried up. In the 50,000 cane stalks examined in 1914–16, two were found in which apparently the eggs of *Metamasius hemipterus* had been deposited in the tunnels of *Diatræa saccharalis,* at Fortuna, March 9, 1915, and at Río Piedras, November 22, 1914, as these were no rat or other injuries on the cane stalks. The eggs are never deposited in healthy, uninjured cane, but the larvæ burrow out from the injured part into the healthy cane and considerably increase the damage caused by the rats.

Family Ipidæ (formerly Scolytidæ).

The Shot-Hole Borer. *Xyleborus* sp.

This little beetle is found only in rotten cane stalks, where all stages of the life history are spent.

PUBLICATIONS OF THE YEAR (1920–21).

(Published or in Press.)

Circular No. 26.—Antrax, por J. Bagué.

Circular No. 27.—Restricciones Legales al Comercio de Plantas en Puerto Rico, por L. A. Catoni y M. A. Crespo.

Circular No. 28.—The Cultivation of Citrus Fruits in Porto Rico, by F. S. Earle.

Circular No. 29.—La Morriña Negra, por J. Bagué.

Circular No. 30.—El Mejoramiento de Nuestras Siembras por la Selección, por E. E. Barker.

Circular No. 31.—La Renovación del Terreno por Medio de Siembras Intermediarias de Plantas Leguminosas, por E. E. Barker.

Circular No. 32.—La Enfermedad de la Raíz en el Café, por J. Matz.

Circular No. 33.—Varios Trabajos, (Presentados en la Reunión de Productores y Profesionales Azucareros celebrada en Río Piedras el 17 de noviembre de 1920).

Circular No. 34.—La Vaquita o "Piche" de la Batata, por J. D. More.

Circular No. 35.—La Bronquitis Verminosa o Tos del Becerro, por J. Bagué.

Circular No. 36—La Pepita del Cerdo, por J. Bagué.

Bulletin No. 24.—Citrus and Pineapple Fruit Rots, by J. Matz.

Boletín No. 25.—Cultivo del Banano en Puerto Rico, por P. González.

Boletín No. 26.—Abonos, por R. Vilá Mayo.

Bulletin No. 27.—Plant Inspection and Quarantine Report (1919–20), by L. A. Catoni.

The Journal of the Department of Agriculture, Vol. IV, No. 3.—An Annotated List of Sugar-Cane Varieties, by F. S. Earle.

The Journal of the Department of Agriculture, Vol. IV, No. 4.—Changes Wrought in the Grapefruit in the Process of Maturation, by F. A. López Domínguez.

Annual Report of the Insular Experiment Station of the Department of Agriculture and Labor for the Year 1919–1920.

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