1902

Cane borer (Diatroea saccharalis): report of investigations

William Carter Stubbs

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BULLETIN
OF THE
AGRICULTURAL EXPERIMENT STATION
WM. C. STUBBS, Ph. D., Director and State Chemist.

CANE BORER
(Diatroea Saccharalis.)
Report of investigations by W. C. STUBBS, Director, H. A. MORGAN, Entomologist

ISSUED BY THE LOUISIANA STATE BOARD OF AGRICULTURE AND IMMIGRATION,
J. G. LEE, COMMISSIONER.

Baton Rouge, La.
Printed at the Truth Book and Job Office.
1902.
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Louisiana State University and A. & M. College,
Office of Experiment Stations,
Baton Rouge, La., April, 1902.

Hon. J. G. Lee, Commissioner of Agriculture and Immigration,
Baton Rouge, Louisiana:

Dear Sir: The accompanying manuscript recites the results of
the work performed by the Experiment Stations in their effort to
relieve the sugar planters of this State from the injury annually
inflicted upon the cane crop by the sugar cane borer (Diatraea sac-
charalis). By following the remedies given by Prof. H. A. Morgan,
deducible from his patient investigations, it is believed that the
borer can be reduced to harmless numbers, if not entirely exterminated. I respectfully ask that this be published as Bulletin No. 69.

Respectfully submitted,
WM. C. STUBBS, Director.
In 1890, the cane of the Sugar Experiment Station was badly injured by the borer. A partial study of the habits and life history of this insect was then made and the results published in Bulletin No. 9. It was then intended to continue these studies and obtain accurate data as to its hibernation and the ways and methods by which it renews infection in the spring, but the heroic measures adopted by the station for its eradication so successfully accomplished the purpose that these studies were necessarily postponed. Prior to 1890, no general alarm had awakened the planters of the State to the necessity of taking precautions against the spread of this insect, notwithstanding it had occasionally produced serious injury in various localities of the cane belt.

The visitation of 1890, and the subsequent publication of Bulletin No. 9, failed, however, to attract universal attention, since little or no injury was done to the splendid crop of 1891. Only when the crop of 1900 was being passed through the mill was it discovered in certain sections of the State, that the borer was present in damaging quantities. In Ascension, Assumption and portions of Iberville parishes, the injury was revealed in the decreased yield, both in the field and in the sugar house. So great, in many instances, were these losses that a general alarm was given and everybody began to inspect closely his cane. Hon. Henry McCall, of Evan Hall Plantation, thus expresses his losses:

"We had a good stand of cane, both plant and rattoons. Stalks were fairly long, but owing to a wet summer and want of cultivation, they were unusually slim, and consequently tonnage proved disappointingly light (from twenty to twenty-five per cent. short). Light tonnage was almost universal over the whole sugar belt, but where the borer was not present, it did not fall off more than ten to fifteen per cent., and therefore, we can safely conclude that the loss was from ten to fifteen per cent. by virtue of the presence of the borer. It was difficult to find a cane that had not been more or less bored, sometimes in as many as a dozen places, rendering it pretty hollow and dry.

"Our seed cane was also badly damaged, reducing the spring plant area as much as fifty per cent., i.e., we would have had enough seed under ordinary conditions to have planted twice as much ground."
“Our neighbors complained bitterly of the same losses, and I do not think that I have over-estimated the ravages inflicted on the community by the borer.”

Messrs. E. & J. Koch, of Belle Alliance Plantation, have kindly furnished the following estimate of their losses during these years of borer infliction:

**COMPARISON OF RESULTS OF BELLE ALLIANCE FACTORY, BORER YEARS WITH NON-BORER YEARS.**

<table>
<thead>
<tr>
<th>SEASONS</th>
<th>Tonnage Plant.</th>
<th>JUICE COMPOSITION</th>
<th>Av. Sugar Per Ton.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Brix.</td>
<td>Sucrose</td>
</tr>
<tr>
<td><strong>1887-1897...</strong></td>
<td>23.39</td>
<td>15.00</td>
<td>11.78</td>
</tr>
<tr>
<td><strong>1898-1900...</strong></td>
<td>18.41</td>
<td>14.01</td>
<td>10.28</td>
</tr>
</tbody>
</table>

*General average 11 years, no borer.  
**General average 8 years of borer.

“During the seasons 1898-1900 carbonitation process was used, which was proven to have increased yield of sugar from 6 to 7 per cent.

“Hence, if old method of working had been carried on in sugarhouse, yield would have been reduced by the above percentage, and would have been in the neighborhood of 120 to 122 pounds per ton.

“Thus there is a falling off of 4.98 tons per acre, and about 25 pounds sugar per ton. Estimating cane to be worth $3.60 per ton agricultural losses have been $54,252, based upon 3,227 acres, (actual figures for three years) at 18.41 instead of 23.39 tons.

“Assuming that sugar has been worth .0435 cents per pound, (average price for three years) number of pounds of sugar worked up would be a loss of 25 pounds per ton on 75,479 tons, at .0435 cents, equal to $82,083.

“Referring to above figures a total agricultural and factory loss of $136,335 has been sustained.

“These figures are based on plant cane alone, no stubble taken in consideration, as the number of acres of stubble from outsiders has proven a very variable and unreliable quantity, owing to the many changes made in the amount of same which is put down for seed.”

So great was the alarm created by this destruction of cane that at the December (1900) meeting of the Louisiana Sugar Planters’ Association, a resolution was passed asking the Experiment Station to make at once a thorough investigation of this insect, determine its life history in Louisiana, and if possible, to suggest methods for its suppression.
In compliance with this resolution, the Director, aided by Prof. H. A. Morgan, Entomologist, began a series of experiments, looking to an intelligent comprehension of the life of the insect, its methods, and places of hibernation, its emergence in the spring, and the sources of food supply before the cane was large enough to serve it. Gaining this knowledge, it was believed that vulnerable points in its life history would be discovered, upon which successful assaults for its destruction might be made.

To aid in the work, a printed circular, asking numerous pertinent questions, was sent to each planter in the State with the request that he answer fully every question, basing his replies upon his own observation and experience.

At the January meeting of the Planters' Association, the Director made a preliminary report, based upon a compilation of all the replies from planters and upon information obtained from previous study and experience. This paper was published in the Louisiana Planter, January 12, 1901, and is reproduced below in full:

In obedience to a request of this association, made at its last meeting, a circular was immediately prepared and mailed to 500 sugar planters of this State, asking definite information in regard to the cane borer and the damage to the sugar crop of 1900.

Before presenting this circular, with the replies, it would be well to state that the cane borer, Diatraea (Chilo) saccharalis, has been known for nearly two hundred years. It was first mentioned by Sir Hans Sloane as "a worm eating the sugar cane in Jamaica." It is widely extended over the West Indies and tropical America. It is found also in India, Java, Mauritius, Hawaii and other Pacific islands. It has been carefully studied in Java and West Indies. In the former country there are four distinct forms of borers, the least hurtful to the cane being the one under discussion. There are

The White Borer—Scirpophaga intacta—which attacks the tops of the cane and destroys them, causing the eyes to shoot out, with great loss both of growth and sugar. This borer is as yet confined to Java, Borneo, Bangka, Singapore, English India and Celebes.

The Gray Borer—Grapholitha schistacea—enters the young cane at the ground and kills the young bud. It seldom attacks old canes. This destructive insect has but a limited range in Java and it not found elsewhere.

The Yellow Borer—Chilo infuscatellus—enters the cane near the terminal bud and follows an upward direction into the youngest leaves. This borer is common in Java, but has not been found
on other plants or on wild cane. It is sometimes confounded with

The Striped Borer—*Diatraea saccharalis*—which is the insect under discussion. This insect rarely attacks the extreme tops of the cane, and where canes of all ages are to be found, as in tropical countries, it prefers the maturer ones. It also lives upon corn and sorghums and, if we are to believe several of our correspondents, on sweet potatoes. (?)

Leaving to my colleague, Prof. Morgan, the treatment in detail of the habits and history of this insect, I will only state in passing that the life of the cane borer falls into four periods: (1) The egg (2) the caterpillar or worm (3) the pupa or chrysalis (4) the moth.

The length of each stage of the life of this borer is given by several investigators, and varies with the country in which the investigations were made. Mr. H. Maxwell Lefroy, entomologist to the Imperial Department of Agriculture for the West Indies, has recently given the following:

<table>
<thead>
<tr>
<th>Stage</th>
<th>Duration</th>
<th>Find</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg</td>
<td>6 days</td>
<td>found on leaf</td>
</tr>
<tr>
<td>Caterpillar</td>
<td>35 days</td>
<td>found in cane</td>
</tr>
<tr>
<td>Chrysalis</td>
<td>7 days</td>
<td>found in cane</td>
</tr>
<tr>
<td>Moth</td>
<td>2 days</td>
<td>found flying</td>
</tr>
</tbody>
</table>

of 48 days for its complete existence.

Kruger finds in Java the following:

<table>
<thead>
<tr>
<th>Stage</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg</td>
<td>8 days</td>
</tr>
<tr>
<td>Caterpillar</td>
<td>20 to 30 days</td>
</tr>
<tr>
<td>Chrysalis</td>
<td>10 to 20 days</td>
</tr>
<tr>
<td>Moth</td>
<td>5 to 12 days</td>
</tr>
</tbody>
</table>

Miss Ormerod, and Prof. Comstock in this country, have studied this insect on corn, and give the time to hatch the egg at nine days, of the worm stage thirty days, of the pupa stage, 14 to 15 days, and of the moth (according to Prof. Morgan) 4 to 6 days.

This much of the life history of the borer is given in order to show the difficulty of fighting this insect in Louisiana. Several of our correspondents, among them Mr. Jas. Koch, of Belle Alliance, a close and intelligent observer, asserts positively that the worms have been found both in the windrowed and planted canes, three months or more after harvest. If this be true, and there is every reason to believe it, then the period of its existence as a caterpillar is greatly extended in Louisiana, and perhaps accounts for its ability to survive our winters.

In 1890-1891 the canes upon the Sugar Experiment Station were seriously injured by the attacks of this borer. There were
growing upon the station at that time a large number of varieties of cane, and it was curious to observe how intelligently the moth selected the softer canes upon which to deposit their eggs. The harder varieties were scarcely touched, while the soft kinds were literally destroyed.

At that time an investigation into the habits, life history and remedies for this borer was begun. Suffering heavily both in tonnage and sugar content, our first efforts were devoted to its extermination. This was quickly accomplished by planting only in the fall, using cane, stripped as for the mill, for seed, and by burning completely the trash, accomplished by previously raking it up carefully with hand rakes.

A parasite, in the form of a black beetle—Chauliognathus marginatus—became also abundant and greatly aided us in the work of extermination. The year 1892 found the station practically clean of borers, and it has remained so ever since. The results of these investigations, prepared by Prof. Morgan, were published by the station in Bulletin No. 9, second series, and a request was made therein for the assistance of the planters "in a more extended investigation." This eradication of the borer depriving Prof. Morgan of the opportunity of further investigation on the station and together with the absence of application for assistance from the planter, suspended the systematic study of this insect. For the first time since 1891 has the borer become so troublesome as to demand a continuation of the investigations. This has already begun, and in a few years more definite information than we to-night possess, may confidently be expected.

With these preliminary remarks let us review the replies to the circular. The following is the circular sent out:

SUGAR EXPERIMENT STATION,
AUDUBON PARK.

New Orleans, La., December 17, 1900.

Dear Sir: In response to a resolution passed by the Louisiana Sugar Planters' Association, the following questions, relative to the Cane Borer, are sent you. Will you kindly enter your replies in the vacant spaces and return this sheet in the enclosed envelope, at as early a date as possible, not later than January 5. These replies will be tabulated for a report to the association at the January meeting.

Yours very truly,
WM. C. STUBBS, Director.

QUESTIONS.

1. Has your cane been affected by the borer the past season?
If so, can you express the damage in percentage of the crop made?

2. How long have you been troubled with the borer? Can you tell when and how it was introduced?

3. Have the attacks been heaviest upon “plant,” first stubble or second stubble?

4. Has the fall planted cane been less subjected to attack than that planted in the spring?

5. Has the use of commercial fertilizers had a tendency to increase the borer? If so, state character of fertilizer used?

6. Is the cane borer more abundant after a mild, or a severe winter?

7. Have wet seasons been propitious towards multiplication of the borer?

8. Does your experience justify the opinion that succession cane is more liable to attacks of the borer than cane following corn and peas?

9. Do Johnson grass, Guinea corn or sorghum (all furnishing food for the borer) grow on your plantation, either cultivated or in waste places?

10. Borer free canes are sometimes required by central factories. Could they not be selected by the planters for seed?

11. Give observations upon habits of borer. Its earliest appearance in the spring. Where moth lays its eggs. Parts of the stalk preferred. Does it seek the more succulent top in the fall? Have you other food plants for this insect?

REMEDIES.

12. Have you found a practical remedy for the borer? If so, please give it.

13. Have you tried fall planting (only), as a preventive?

14. Do you burn your trash? If so, at what time? and is the burning complete or partial?

15. Have you noticed any parasites of the borer?

16. Have you noticed any birds hunting or destroying it?

17. Please give any facts observed, not indicated by above questions?

Name
Plantation
Post Office
Parish

Five hundred of these were sent to the planters of the State. A large number have been returned. Every sugar parish in the State has been heard from, except St. Bernard. The following par-
ashes have no borers, and if we are to judge from the replies of our correspondents, are not acquainted with the destructive insect, viz.: Pointe Coupee, Rapides and St. Landry. One correspondent out of six in Iberia, notes the presence of the borer, but reports no damage. The others report negatively. St. Martin, through its largest planter, Hon. J. B. Levert, reports no complaints from worms, the cane not being appreciably affected. Vermilion, from its largest estate, "Rose Hill," reports "practically none."

East Baton Rouge is practically free from the borer, save "very few" upon that portion of the plantation of Hon. N. S. Dougherty, which adjoins the Baton Rouge Central Factory. These, he thinks, were imported with the canes bought by the factory. The latter also reports an increase of borers in the canes bought this year.

St. John and St. Charles report "very few," one correspondent from the latter parish says "home cane free from borer"—"purchased cane from new lands damaged fifty per cent."

Mr. Andrew Cayard, our only correspondent from Lafayette, reports one per cent. damage from borers.

Mr. S. L. Pearce, Jr., Home plantation, Evergreen, Avoyelles Parish, reports two cuts of fifteen acres each damaged, one one-half, the other one-third. The rest of the parish seems to be free of the borers.

Staunton and Aurora plantations, of Orleans Parish, have not had the borer since 1888.

"Southside," "Willswood" and "Avondale" plantations, of Jefferson Parish, have few or no borers.

All of our correspondents in St. James report "very little," "scarcely perceptible" damage from borers. Mr. E. Cherbonnier, from Helvetia plantation, says "borers more the exception in 1900," having been present for the last nine or ten years.

In Terrebonne, Mr. J. M. McBride "observed a few" but not enough to note. The other correspondents report clean plantations.

Of the large number of replies from St. Mary, only Capt. L. S. Clarke and Col. G. C. Zenor from the eastern end of the parish report borers and they have wrought "inmaterial damage." St. Mary is virtually free of the borer.

In West Baton Rouge, Mr. A. T. Bird reports damage 10 per cent. Messrs. Emile Landry, W. L. Barnard and A. Rivault report very few with inappreciable damage. The rest of the parish seems to be clear of borers.

In the parish of Plaquemine, Mr. E. L. Lothrop reports "fewer than for a number of years."
Gov. H. C. Warmoth, of Magnolia, estimates his damage at 25
per cent. of his crop; while “Stella,” “Belair,” “St. Clair” and “Live
Oak” are all without borers.

The situation in Iberville is badly mixed and hence the replies
are given in detail:

<table>
<thead>
<tr>
<th>NAME</th>
<th>PLANTATION</th>
<th>POSTOFFICE</th>
<th>INJURY</th>
</tr>
</thead>
<tbody>
<tr>
<td>L. L. Martin</td>
<td>Bayou Paul</td>
<td>Iberville</td>
<td>None</td>
</tr>
<tr>
<td>M. L. Randolph</td>
<td>Blythewood</td>
<td>Bayou Goulia</td>
<td>“Few;” “can’t say”</td>
</tr>
<tr>
<td>W. J. Behan</td>
<td>Alhambra</td>
<td>White Castle</td>
<td>Trifling less than</td>
</tr>
<tr>
<td></td>
<td>Wester</td>
<td></td>
<td>past four years</td>
</tr>
<tr>
<td>Nelson LeBlanc</td>
<td>Euphroline</td>
<td>White Castle</td>
<td>10 per cent</td>
</tr>
<tr>
<td>Minville &amp; Robert</td>
<td>Iron</td>
<td>Plaquemine</td>
<td>3 to 5 per cent</td>
</tr>
<tr>
<td>J. T. Guyton</td>
<td>Oaks</td>
<td>Bayou Goulia</td>
<td>Considerable</td>
</tr>
<tr>
<td>Mrs. Jas. S. Tuttle</td>
<td>Laurel Ridge</td>
<td>White Castle</td>
<td>Ten per cent</td>
</tr>
<tr>
<td>Jas. A. Ware</td>
<td>Belle Grove</td>
<td>White Castle</td>
<td>Ten per cent</td>
</tr>
<tr>
<td>Geo. M. Murrell P. CoTallyho</td>
<td>Bayou Goulia</td>
<td>10 to 15 per cent</td>
<td></td>
</tr>
<tr>
<td>Geo. M. Murrell P. CoGlensmore</td>
<td>Bayou Goulia</td>
<td>10 to 15 per cent</td>
<td></td>
</tr>
<tr>
<td>LeBlanc &amp; Danos</td>
<td>Milly</td>
<td>Plaquemine</td>
<td>10 to 15 per cent</td>
</tr>
</tbody>
</table>

Iberville P. & M. Co. Cora Ann ... White Castle ... 15 per cent
O. D. Billon ........... Upper Etter ... Bayou Goulia ... 20 per cent

Assumption parish has even more varied conditions:

<table>
<thead>
<tr>
<th>NAME</th>
<th>PLANTATION</th>
<th>POSTOFFICE</th>
<th>INJURY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naquin &amp; Roussel</td>
<td>Sansnom</td>
<td>Labadieville</td>
<td>None in the neighbor-</td>
</tr>
<tr>
<td>E. P. Munson</td>
<td>Glenwood</td>
<td>Napoleonville</td>
<td>Slight</td>
</tr>
<tr>
<td>G. St. M. Malarcher</td>
<td>Supple</td>
<td>Belle Rose</td>
<td>Slight; borers less-</td>
</tr>
<tr>
<td>Oakley Planting Co.</td>
<td>Oakley</td>
<td>Avoca</td>
<td>Can’t express dam-</td>
</tr>
<tr>
<td>R. C. Martin, Jr.</td>
<td>Albemarle</td>
<td>Albemarle</td>
<td>Considerable extent</td>
</tr>
<tr>
<td>W. W. Pugh</td>
<td>Woodlawn</td>
<td>Birdie</td>
<td>Seriously; ½ ton</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>less to each load of</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>cane</td>
</tr>
<tr>
<td>D. Himel</td>
<td>St. Martin</td>
<td>Labadieville</td>
<td>10 per cent</td>
</tr>
<tr>
<td>E. F. Painchaud</td>
<td>Etienza</td>
<td>Belle Rose</td>
<td>25 per cent</td>
</tr>
<tr>
<td>Alice F. D:laune</td>
<td>St. Thomas</td>
<td>Albemarle</td>
<td>Hard to tell</td>
</tr>
<tr>
<td>C. C. Clifton</td>
<td>Olive Branch</td>
<td>Paincourtville</td>
<td>25 per cent</td>
</tr>
<tr>
<td>Robert Maurin</td>
<td>Ville du Bois</td>
<td>Belle Alliance</td>
<td>Over 25 per cent</td>
</tr>
<tr>
<td>E. &amp; J. Kock</td>
<td>Belle Alliance</td>
<td>Belle Alliance</td>
<td>25 per cent</td>
</tr>
<tr>
<td>E. &amp; J. Kock</td>
<td>Scattery</td>
<td>Belle Alliance</td>
<td>Sugar 30 per cent</td>
</tr>
<tr>
<td>E. &amp; J. Kock</td>
<td>Front Place</td>
<td>Belle Alliance</td>
<td>Sugar 30 per cent</td>
</tr>
<tr>
<td>Henry Munson</td>
<td>Enola</td>
<td>Napoleonville</td>
<td>25 per cent</td>
</tr>
</tbody>
</table>

The following are the reports from Ascension:

<table>
<thead>
<tr>
<th>NAME</th>
<th>PLANTATION</th>
<th>POSTOFFICE</th>
<th>INJURY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miles P. &amp; M. Co.</td>
<td>Burnside</td>
<td></td>
<td>But little more than</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>usual</td>
</tr>
<tr>
<td>Ernest H. Barton</td>
<td>St. Emma</td>
<td>Barton</td>
<td>Can’t be positive</td>
</tr>
<tr>
<td>W. E. Morgan</td>
<td>Rearwood</td>
<td>Belle Helene</td>
<td>“Great many borers”</td>
</tr>
</tbody>
</table>
A review of the above will show that, with the exception of Gov. Warmoth's plantation in Plaquemine, and Mr. A. T. Bird's Stella plantation in West Baton Rouge, the ravages of the borer are confined to the parishes of Assumption, Ascension and Iberville. In the last two, the injuries were greatest on the right bank of the Mississippi.

From the reports before us the area of the infected district may be circumscribed as follows: On the right bank of the Mississippi from Cofield on the south to Plaquemine on the north. On left bank, from Burnside to New River, or the bend opposite Donaldsonville. It extends down the Bayou Lafourche almost to the limits of Lafourche parish.

**HOW WAS THE BORER INTRODUCED?**

The question how and when it was introduced is not definitely settled.

Mr. Robert Maurin, of Ville du Bois, plantation Belle Alliance Postoffice, Assumption parish, states that "in 1856, after the destruction of the cane in mats and stubbles by cold, Hon. Miles Taylor, congressman of the district, got the government to import cane from South America. I received one box, and on opening found the borer in it, and burnt the box and cane. Others planted them, and then it (the borer) began to spread slowly."

It may be in order to give a brief account of this importation, which had so disastrous a termination. In 1856 Congress appropriated $10,000 for the purpose of obtaining cuttings of sugar cane of such varieties best suited to the climate of the Southern States. The Commissioner of Patents was authorized to superintend the expedition, and the Secretary of the Navy was directed to furnish the ships. One expedition was sent to the Straits Settlement, and brought back the Salangore variety, which was so badly rotted on arrival that no results were obtained. The other expedition went to South America on U. S. Brig Release, under Captain Sims, with Mr. Thomas Glover, the entomologist, to make proper selection of
the canes. He was instructed to secure cuttings near the River Demerara, in British Guiana, and from the high lands, near Caracas, in Venezuela. He was specially enjoined to bring back the special variety of cane, known as Labba, in Demerara, and the Japanese purple canes from Caracas. Specific instructions were given Mr. Glover as to the selection and packing of the canes. The expedition returned to New Orleans early in 1857. Mr. J. Holt, Commissioner of Patents, in his official report, alludes to these canes as “growing nicely,” and “if they should prove sufficiently hardy to withstand the climate of the regions where they are intended to grow, it is believed that they will amply compensate in the end for the trouble of introducing them.”

Per contra, a writer in De Bow’s review, May 1857, arraigns severely the parties engaged in the introduction of these canes, while in the New Orleans Delta the condemnation of the management of the expedition was wholesome and sweeping. “The boxes were filled with miserable chaffy stuff, completely spoiled.” “Why make planters pay freight for West India pebbles?” “A plain, unpretending overseer from the State would have saved the government much expense and have done something more profitable for the planters than help extract the few dimes from their pockets (in the shape of freight on trash) which they saved from the wreck of the last crop, to say nothing of the preceding ones.”

De Bow's Review, in another place, has a letter from one of the largest planters, in which “he handles the officials without gloves.” The letter says: “There was never such a failure. What a misfortune that Uncle Sam did not send a practical planter.” “Not a sound bud from the stalks either in the hold or on deck.”

The evidence here given is contradictory, but I have yet to meet the first planter that has any recollection of any canes grown from the imported cuttings.

Can it be possible that this importation brought the borer for the first time into this State? The evidence of our old friend seems to be direct and positive. Our friend says the Hon. Miles Taylor was instrumental in getting this appropriation for the importation of new canes. In a speech in Congress, delivered in 1857, Mr. Taylor says: “This appropriation in consequence of which some of the declared enemies of the sugar culture have taken advantage to decry that culture as a forced one and altogether precarious in its results was, I will not say a Buncombe affair, but it was one which was occasioned by newspaper representation coming from the inexperienced; grew out of a desire to concentrate public sen-
tement, and was in my view, of doubtful expediency, and was more than doubtful in principle. I say it was of doubtful expediency, because the cane which has been cultivated for many years in Louisiana, in my opinion, is better fitted for the production of certain and large crops of sugar than any which will be likely to be introduced."

The reports of some of the correspondents are rather at variance with Mr. Maurin's. Mr. A. T. Bird, of Stella plantation, West Baton Rouge Parish, says: "I have known of the existence of the cane borer in Louisiana for sixty odd years." Mr. D. Himel says: "In 1857 they destroyed, with the late freeze, which occurred in April, one-half of the best crop I have ever planted. The worms came after the freeze."

Mr. W. B. Chamberlain, of Camp plantation, West Baton Rouge Parish, says: "I have been told that by selecting borer-free canes was the way followed by the planters in eradicating the borer after the heavy attack of 1857." He further says that the borer was introduced in 1857, in cane coming from the West Indies.

Col. W. W. Pugh, of Assumption Parish, the Nestor of sugar planters, says: "About fifty years ago a sugar maker who had worked on the Perret plantation in St. Charles Parish, told me that one year the borer was so numerous and destructive that they seriously injured the product of sugar, and they found some difficulty in making it. There may have been some exaggeration in his statements, but it shows that these insects existed at that date and diminished the product."

Mr. M. L. Randolph, of Iberville, says: "In 1866 I was told by an ante bellum overseer that the borer infested some fields in St. Charles Parish, and did a great deal of damage."

Many planters testify to the existence of the borer for the last twenty-five to thirty years.

How and when the borer was introduced is not certain, but the separate corroborating testimony of Mr. Chamberlain and Mr. Maurin would rather fix the date at 1857, and as canes in large quantities from South America were that year introduced, it is reasonable to conclude that they came from that country as asserted by Mr. Maurin, and not from the West Indies, as Mr. Chamberlain thinks. However, if Col. Pugh and Mr. Bird are accurate in their dates, it was here in quantities before that year. *

Enough is known, however, to show that it has been here for years and ever and anon occurs in such quantities as to be destruct-

* Subsequent investigations have proven that the borer was here in quantities long before the importations of cane described above.
ive to both tonnage and sugar content of canes. Something has, however, kept it in check and destroyed it when it became numerous and destructive. The remainder of the questions were designed to throw light upon the subject.

Let us examine them:

The third question, whether the attacks have been heaviest upon plant, first or second stubble, has not received concordant replies. Many assert positively that the plant cane is preferred. While scores of others are equally as positive that the stubble is first selected. A similar disagreement of replies to the fourth question is noticeable.

To the fifth question, a large majority of the replies favor the belief that fertilizers have little or no effect in increasing the borers. "Only to the extent of producing large succulent canes are fertilizers chargeable with a tendency to attract the borers."

A few of our correspondents are loud in the denunciation of the use of cottonseed meal, charging it with being the chief cause of the presence and multiplication of the borer.

One correspondent says: "The borer appears as soon as the cottonseed meal begins to decompose. If you buy some cottonseed meal and keep it moist, you can soon see the borers in the dirt."

Per contra, another asserts that, "improper fertilizers cause borers. I use only cottonseed meal, and have fewer borers than my neighbors, who use tankage and bone."

To the sixth and seventh questions, there is quite a unanimity of replies in favor of the mild winter and wet season, based, doubtless upon the conditions that prevailed during the past year.

Some few, less severely troubled this year than last, point to 1899 as a proof that borers are worse after a severe winter. Among these may be mentioned Judge Taylor Beattie, of Lafourche; Mr. William Minor, of Terrebonne; Gen. W. J. Behan, of Iberville, and Mr. G. St. Malarcher, of Assumption.

Nearly all correspondents are disposed to think a wet season propitious for rapid multiplication of the borer, though a few point to 1870 as a very dry year, no fertilizer used, and an excessive quantity of borers.

A large number of correspondents do not believe that success- sion cane is more liable to attacks of borer than cane following corn and peas. In fact, many assert that on account of increased vigor of the latter cane, it is preferred by the borer to all others. A few believe that the chief reason for the borer abiding in Louisiana, "is found in the atrocious practice of growing cane after cane
number of years, getting the land infected with it, from which it can be eradicated only by a rotation of crops.”

The ninth question has revealed the fact that nearly every planter grows sorghum for feed. Also that many have more or less of Johnson Grass and Guina corn on their plantations. No one, however, has found that these plants have assisted in perpetuating or multiplying the borer.

Very few correspondents look with favor upon the proposition to select only borer free canes for seed, a large majority considering it impracticable on account of time and expense. Several refer to this method as the one adopted to eradicate the borer in 1857.

The eleventh question has elicited many replies; some suggestive, others of little value. One planter, with large experience, states that, “when the borer begins its work, it can be seen by the leaves at the fork turning a pale yellow tint and can be observed at end of rows riding on headland.” Another, on the confines of the cotton belt, asserts that, with him, “more borers found with cane following corn and peas than that following cotton,” and he infers “the borer lives upon the corn stalk and perhaps hibernates therein.”

Several correspondents assert that the borer lives also upon sweet potatoes. However, in each case, the potato borer has been taken for the cane borer.

One observer has “found the borer in plant cane when scraping in March, in the growing cane in April, May and June. Have taken them from the young corn, placed them in a bottle and hatched out the butterfly in June.”

REMEDIES.

Remedies are numerous, particularly from those not now troubled by the borer.

One correspondent dissents from the otherwise unanimous opinion of the necessity of burning the trash for the destruction of the borers left therein. This dissenting planter condemns burning, and says: “It is God’s manure, bury all of it. It is the best manure, that and rotation.”

To emphasize the necessity of burning, Major C. Lagarde, of Lafourche, relates his experience, as follows: “I was once troubled with borers on my Leighton place for six or eight years, previous to 1889. I buried as much cane tops as I could, pulling them in the middles with hoes and covering them with four-horse plows. The crop of 1889 was one-third short, almost every cane was affected.
by the borer. In 1891 the bricklayer went under the shed to eat a cane. He cut seventy-five and every one was affected by the borer. My neighbors who had not buried, but burned their cane tops, were not affected at all. Since then I have burned the tops in December or January, in very dry weather, if possible, and I find very few canes now affected by the borer."

The time of burning is given all the way from "as soon after harvest as they will burn," up to "March," and all advise "as complete as possible."

Several correspondents assert that the continued use of acid phosphate will eradicate the borer (?) Others think that keeping one's ditch and headlands clean, with a late lay by, to prevent the growth of grass in the cane will also stop the borer, as the weeds and grass are the receptacles of the eggs of the moth (??) Good cultivation is recommended by a few. Deep plowing during cultivation is given by one as a panacea for this trouble. (?) Avoid the use of cotton seed meal, say some; others commercial fertilizers; others succession cane if you would be free from the borer.

"Land kept clear of grass, weeds and stalks, plowed early and twice before planting will not be bothered with borers," says a planter from Iberia.

A veteran planter "has found in dry years a plenty of ants that go into the borer holes and eat up the worms and leave only the skeletons." This observation is fully confirmed by other planters.

Another old and experienced planter has found that an immersion of the canes in water one foot deep will completely kill them. "I have irrigated canes that had any quantity in it and they were all killed. You can put water at any time until March without danger to cane. Have had cane ten days in water that did very well, and no borers left in it."

One planter on the Teche suggests that their exemption from the borer may be due to the extensive fall planting.

**PARASITES.**

Among those reported are the ants (already mentioned) and a species of centipede of reddish color, with thin and long body, which has been found by several correspondents in the burrows of the borer. It is not known whether this centipede destroys the borer.

Mr. J. T. Guyton, of Iberville, notes on canes much infected a small parasite, which he calls cane lice.
Several correspondents report birds eating the worms, though the names of the birds are not given.

Many report crows and blackbirds in quantities following the burning of the trash, presumably to pick up any scorched worms that may be left.

**REVIEW.**

In reviewing the numerous replies received, it is evident that nearly every correspondent was familiar with the borer, and at some time had suffered from its attacks. It is probably true that there are very few plantations where the borer does not exist at all, and why it should be kept in subjection, yea, almost obliterated, in some localities, while existing in destructive numbers elsewhere, is not clearly understood. Everybody (with but few exceptions) burns the trash, an acknowledged aid in depreciating their numbers, yet with this only known effort practised alike in every community, the borer multiplies to a destructive extent in one section and is practically subdued in another. Again, a plantation practically exempt from its ravages for years may suddenly become a theater for its most destructive efforts, and then, as quickly as it came, the borer may disappear and be seen only in very limited quantities for years to come.

It is known that the cold of our winters is a great ally, not in the severity of the cold as much as in the fact that it gives us a long period when there is nothing above the ground for the borer to feed on, and therefore no opportunity for rapid multiplication, as in late summer. But the winters and the burning of the trash are common to all and hence like conditions should everywhere exist if these were the only forces of destruction at work.

It is, therefore, reasonable to suppose that there are other agents of destruction at work, more abundant and powerful in some sections than others, which check the multiplication of this pest. In foreign countries the eggs, soon after being laid, are sometimes filled with parasites, which destroy them. There are parasites which prey upon the worm and chrysalis. Observations have found several of the latter, and closer investigation may reveal the existence of the former. The larva of the beetle and the ants are known to be parasites of the larva here. Hence every effort should be made to drain well our lands, so as to make them habitable by ants and beetles, even during our wettest seasons. These little creatures may explain the facts reported that borers were worse in new ground than in old lands in wet seasons than in dry seasons, etc. Dry land is essential for the rapid multiplication of ants,
and rainy weather, in alluvial lands, quite destructive. There may be other parasites of the egg or larva that are dominated by the weather.

Why not have an outbreak all over the State when a wet season occurs, some one may ask. I reply that worms in a given quantity are necessary at the start, to produce the large numbers required for the material injury of the cane in a favorable season. Only those localities already possessing the borer in certain quantities will therefore suffer. The other sections may suffer an increase, but the damage will be imperceptible. This is apparent in the different reports from the parishes of Ascension, Assumption and Iberville, reporting all degrees of damage from zero to thirty per cent.

Again, the power of flight in the moth is very limited, and hence the area of infection may remain local for some time. On account of this feebleness of flight, the moth, while existing in small numbers, confine their attacks to the ends of the rows and to the ditch-bank rows. When they begin to multiply, they penetrate deeper and deeper into the cane, and the moth that emerges from the pupa in the interior of the field, lays its eggs in the immediate vicinity of its birth. Sometimes they are borne by the prevailing winds to distant fields, and since our winds in summer are mainly from the South and West, one would expect the progress made by the borer would be Northward or Eastward. No such progress has been reported.

Again, when the moths are comparatively few, they select the tenderest cane upon which to deposit their eggs. Canes, therefore, which are succulent and tender from any cause, either by cultivation, by fertilization, or by inheritance (varieties), will attract the borer when in numbers sufficiently large to be disseminated over the field and sufficiently small to be allowed the privilege of selection. When existing in destructive numbers this privilege of selection is greatly abridged. Hence white cane is more subject to attack than our purple or striped, plant cane more than stubble, fertilized cane more than unfertilized, well cultivated canes more than grassy ones, green, succulent canes more than short, pithy ones, canes on sandy loams more than those on stiff black soils, the upper and tenderest parts of the stalk in preference to the lower harder portion. The eggs are believed to be laid upon the green leaves, and the young worm on hatching descends the leaf to the stalk, and after eating for some days the parenchyma of the leaves and the outer cuticle of the stalk enters the latter and begins his destructive work. Hence, in fall of the year, the borer will generally be found in the upper part of the stalk, and if he is not sent to the mill, may
be laid away in the lower portion of the top which is left in the field. Therefore, burning the tops should be thoroughly accomplished to destroy every possible borer that may be present.

In cutting cane the tops can be advantageously laid upon the tops of the rows, rather than in the middles, as now usually practiced. In this position they would prevent the immediate germination of the stubble (a most desirable consummation), would dry out quicker and could be more easily and completely burnt. With the tops thrown into the middles, it is difficult, if not impossible, to completely burn them, as they lie.

If fall planting only be made, using for seed cane stripped as you would for the mill, and planted sufficiently late to prevent germination in the fall and covered with three to four inches of dirt, the enclosed borers must remain until the cane is scraped in the spring, and the few which will then escape would be hardly enough to produce much harm during the summer. If to this be added the complete destruction by burning of all the tops and cane trash, it is hard to conceive of a way and manner in which the borer could survive the winter in quantities sufficient to be injurious during the summer. If the planter should delay the planting of such crops as corn and sorghum until April, it is more difficult to conceive of a suitable plant upon which the borer, should he escape from the fall planted canes, could deposit its eggs.

Those who have suffered from the ravages of this insect in the past year should use every effort to destroy as many borers as possible this winter, and exercise every care in preventing the multiplication of those which should escape.

Since this preliminary report was issued a thorough study of the insect has been made in the field and in the breeding cages of the laboratory, and a final report of the results of these investigations was made by Prof. H. A. Morgan to the Sugar Planter’s Association on October 10, 1901, illustrated by numerous stereopticon views. This report, much enlarged and extended, is herein given, with full illustrations.

The remedies suggested, if rigidly applied, will most assuredly reduce the number of borers with us to an inappreciably harmless quantity. No sugar country is more fortunately situated for the successful combat against sugar cane insects than Louisiana. Our winters, which sometimes bring disaster to our harvests, are at least favorable to the destruction of tropical insects, and if advantage be taken of our knowledge of the life history of this pest and
an intelligent co-operation with nature be effected by all the sugar
planters of the State, the sugar cane borer would ultimately be
exterminated in this State. The results of the patient and intelli-
gent labors of Prof. H. A. Morgan are here given, with the hope
and expectation that every planter in the State will carefully study
them and apply the remedies prescribed.

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LIFE HISTORY OF THE SUGAR CANE BORER MOTH IN
LOUISIANA.

With the sugar cane borer, as with other insect pests, remedies
are based upon a knowledge of the life-cycle and its habits. By the
life-cycle is meant the changes in development passed through by
each brood. The moth called by the planters "the fly," deposits
eggs. These eggs hatch into very small caterpillars or borers,
which grow into large borers. When these caterpillars are full-
grown they assume the pupa or chrysalis stage. There are just as
many pupa as there were borers, provided no accident overtakes
them. From the pupa moths emerge, and after mating, eggs are
deposited, and the life-cycle of another brood begins. This round
of life is continuous and complex. The number of broods per
season depends upon the food and temperature conditions.

By the habits of the borer is meant the peculiarities of (1) the
moth, its flight, places selected and manner of depositing her eggs;
(2) the borer, where and how it feeds, whether it migrates from
one stalk to another, in short, the disposition of the borer from the
time it comes from the egg until it enters the pupa stage; (3) the
pupa, as it is more or less quiescent, there are few habits peculiar
to it. The stages of the life-cycle will be next discussed, and the
habits of each stage that in any way suggests remedial measures
will be emphasized.

As the growth, reproduction, and methods of handling sugar
cane and corn (the two important food plants of the borer), are
slightly different, the life history and habits of the borer in each
will be treated separately.

IN CANE.

The Eggs—These were found deposited in bunches of varying
sizes, upon the upper and under surfaces of the leaves of the tops
of the cane. When upon the upper surface they are invariably placed
in the groove of the mid-rib, sometimes near the tip, but as often
near the middle and base. The arrangement of the eggs on the
under surface of the leaves is slightly different. The mid-rib is
selected, but as it extends beyond the general surface of the leaf, the eggs are placed on either side, and the number of rows of eggs in the bunch is usually two or three, while three and four rows are common upon the upper surface. The bunches, too, are often found at the extreme tip of the leaf when the under surface is selected where they are better protected from rain, which dissolves the glue cementing them to the leaves, and are thus not washed off during rainy seasons. It may also serve to hide them from parasitic and predatory enemies. The better protection given upon the under surface seems to have influenced the moth in selecting this position. Of the many thousands of bunches observed and counted, over seventy per cent. were found upon the lower surface. A full description of the locations and appearance of eggs is given, because in many cane growing countries the collecting of eggs is-

Fig. 1. A batch of eggs, of common arrangement and amber. Photograph taken a few hours after eggs were laid.

practised, and while this method is not commended to the planters of Louisiana, some few might adopt such a plan for the eradication of the worm, especially upon small patches of a new variety of seed cane. The eggs are difficult to find, as they are flat, shingled one over the other, and when first deposited, are not unlike light-colored portions of the leaf, or etiolated fungus spots common on all cane. The number of eggs to the bunch is not uniform. Those observed range all the way from two and three to as many as ninety-five per bunch. Six females, kept under normal conditions, deposited sev-
enty-six bunches, containing a total of 1,768 eggs, an average of 294.4 each. The egg product of single moths varies greatly, from even less than one hundred to as many as five hundred. The period of incubation varies with the temperature. A number of experiments disclosed five days as the shortest and ten days the greatest time required for the development of the larva within the egg. As the hatching time approaches, the eggs are more easily seen; orange spots appear first, and finally the black head and prothoracic shield become the prominent features until hatching occurs. The egg shells often remain upon the leaves for some time after hatching. Their semi-transparent appearance in contrast to the green of the leaf makes them more conspicuous.

The Larva or Borer.—On emerging from the egg, the borer or caterpillar is but a tiny object; and will be passed by unobserved, unless the most careful search be made among the terminal leaves of the cane. The borers at first nibble the surface of the leaves on their way to the terminal whorl, where they conceal themselves in its funnel. For several days they live gregariously in this terminal whorl. Some few restless individuals may be found now and then upon the leaves, but as a rule they are very shy and seek concealment. When about

Fig. 2 A ful' grown borer seen from above. The dark spots are more common upon borers of the spring and summer broods

one-quarter of an inch long their terminal abode becomes somewhat objectionable and the members of the colony begin to
part company. They wander down the upper part of the stalk and finding the wrapped axils of the leaves, eat their way between the leaf and the stalk, or sometimes go down the mid-rib. Gradually a burrow is made and each borer may soon be found in the excavation of his own effort. In very young cane or suckers, the burrows are often found from the terminal whorl straight down to the stalk. As a rule, each borer makes but a single excavation; this, however, may be somewhat winding and irregular, and may appear as a double effort or the work of more than one individual. Depending upon the size of the cane, one or more joints may be involved in a single burrow. After a series of four molts (casting off the skin), the full-grown larva stage is attained. The time consumed in this development depends upon the season (temperature) and the condition of the food. The experiments conducted to determine the length of the larval life covered a wide range, and it was found that larva or borers emerging from eggs during the latter part of November did not pupate until the latter half of March or the early part of April, while during July the larval period was usually not more than twenty-five to twenty-eight days. The phenomenal range of larval life is from the standpoint of the sugar planter one of the most important phases in the life-cycle of the borer, and must be thoroughly appreciated when considering a winter crusade against this pest.

During the winter months the full-grown caterpillar has a remarkable lease on life. It can remain without food for months. Several specimens were kept in jars without food for seventy-five days and at the end of this period entered the pupa condition with the same facility as those which had been feeding and developing in other cages. While seventy-five days was the extreme limit, it is common for larva coming to maturity in February to remain inactive until March, when the warm weather forces pupation. In connection with the larval stage of the wintering or hibernating brood, nature permits of considerable elasticity in the two respects mentioned above, viz: slow development, and when fully grown, the power to remain even two and one-half months without food prior to pupation. The importance of these larval fortifications cannot be too strongly stressed in considering remedies.

Pupa—As the stage is comparatively inactive, its duration should be the most important feature to consider. As with the larva, a low temperature influences the length of pupal existence. Twenty-seven days during a continued cool spell in March and early April was the maximum period, while nine days during a warm spell
in March was the minimum time for this season of the year. During the summer months the range is from seven to ten days.

The pupal condition is invariably spent in the cane stalk. Just before a borer enters the pupa it enlarges that portion of its gallery near the rind of the stalk and slits the rind or if an exit opening has been made, takes the precaution to close the opening with the sawdust like filings just prior to pupation. The moth on emerging finds the filings or the slit easy to push aside, and thus a ready escape is made. If the pupa be irritated by an enemy or from other sources, it sometimes wiggles out of the cane and drops to the ground, and hence some persons have suspected that this stage was passed, as is the case with many insects, below the surface of the soil.

![Fig 3. The moth, or the adult and last stage of the insect.](image)

The Moth.—This is the mature or adult stage of the borer, and is commonly spoken of by the planters as "the fly." The length of life of this adult stage is variable, depending largely upon the amount of moisture in the atmosphere. As the number of eggs deposited bears some relation to the length of the adult life, a rainy season may be responsible for an increased attack of the borer. This fact, associated with the one that many enemies of the borer are less
active during extreme moist weather should be carefully considered when such conditions prevail.

As few, if any, moths emerge during the colder months of winter, it is very important to know when the moths of the wintering larva first appear, i.e., when we are to expect the first brood of spring. More than a thousand of wintering borers (larva) were collected from different plantations along the Mississippi river at different times during the winter. They were placed in cages, and the time of the appearance of the moths was carefully noted with the following result:

From March 15 to March 31, 1901, 25.9 per cent. emerged.
From April 1 to April 15, 1901, 61.2 per cent. emerged.
From April 15 to May 1st, 1901, 7.4 per cent. emerged.
And from May 1 to May 24, 1901, 5.5 per cent. emerged.

It will be seen from the above that 87 per cent. of the moths appear prior to April 15th. These results coincide with field experiments conducted contemporaneously, and may be regarded as reliable, indicating the time to expect an infection of the corn and cane growth of early spring.

Moths come from the pupa cases at night, and after expanding their wings, remain hanging to some plant, or other object, during the entire following day. The second night mating takes place and a few eggs may be deposited, and for as many as three and four nights following, eggs are deposited in bunches here and there upon plants growing over a radius of not more than twenty to thirty feet. The heavy body of the female (laden with eggs), and her specific habit of remaining quiet during the day, forbids of a very wide infection by a single moth. The moths are not shy, and unless vigorously disturbed, will not take flight during the day. They have been exchanged from one breeding cage to another upon a piece of cane leaf without ever changing position. This point is emphasized because the wide distribution of the borer in Louisiana is not due to the flight of the moth, as is the case with the spread of the cotton moth, but has resulted from exchange of seed, transporting of infected cane to distant factories, and to the promiscuous carrying of cane from place to place for eating purposes. The writer knows of plantations that are free of borers, not more than a mile away from a badly infected area, which has been more or less so for years. It often happens that all cuts of a plantation are not infected, hence it is possible to more or less confine the attacks of the borer by utilizing a knowledge of the nature of the moth, and of the real sources of infection.
As the moths are not distant flyers, and mating takes place soon after emerging, nature has provided a very regular distribution of the sexes. A careful record was kept of the sexes of all those bred, with the result that 51.4 per cent. were found to be females and 48.6 per cent. males. The greatest duration of moth life was found to be ten days, the shortest, which occurred when no moisture was kept in the cage, was two days, but even in this short time more than one hundred eggs were laid. The males are shorter lived than females, and the life of either is not so long in the hottest days of summer as in March and April.

IN CORN.

The peculiar habits of the corn plant induces some variation in the attack and habits of the borer, but in general the life-cycle
is much the same as in cane. Corn is more succulent, more rapid in development, and thus in the economy of the borer assures the development of many more specimens than if cane were the only food plant of the first two broods. From the first appearance of young cane shoots up to June the 1st or 15th, but few borers can be found on individual plants (not more than five or six, commonly only two or three), while upon corn at this season as many as fifty-six have been found upon a single stalk, while from fifteen to thirty to the stalk is of usual occurrence. It will be seen from
this how important it is to guard the corn from spring infection, which so often occurs when corn is planted upon windrowed areas.

After the tasselling of corn the whorl of terminal leaves is gone and thus freshly hatched borers, unable to find suitable hiding and feeding places, perish in great numbers. This one fact accounts for the limited attack of the borer upon corn after tasselling. “Bastard ears” and even small, normal ears are selected and offer about the only vulnerable places of attack in corn after the tassels are formed. Mature ears have been found invaded by borers, the pith of the cob in such cases marking the position of the burrow.

The effect of the borer upon young corn differs slightly from that of cane. In either case the attack is made first upon the terminal part of the stalk and is a most serious check to the growth of young cane and corn. In corn the borers riddle the terminal leaves in a manner resembling very much that of the boll worm, and unless careful observation be made upon the characteristics of the two species, and the effect upon the plants, untold confusion may arise. As these points are of value in the culling of borer-infested corn, some of the details are mentioned. Plants infested by either the very young borers or by the boll worms, show the surfaces of the leaves slightly nibbled, and lower down characteristic rows of small holes in a line across the leaves. These holes mark the work of the worms before the whorl of leaves is unraveled by growth. When such markings obtain, the plants should be examined, and it will be observed that no large borers are ever found in the terminal leaves, while large boll worms are common in such situations. Holes in the stalks of corn serve to distinguish the work of the borers from the boll worm, and if the stalk be bored, the entire plant is cut out instead of only the top when the boll worms are discovered.

As the number of moths appearing in the spring is limited, when compared with the myriads of late summer, but few corn plants are infested by these spring moths, and the practice of culling infected corn in early May, may save a crop of corn, to say nothing of the cane adjacent to infected corn fields. From the above data it may be safely concluded that the corn plant is responsible in a large measure for the increase of the sugar cane borer moth in Louisiana, and the custom of planting corn on areas or plots previously occupied by windrowed cane is the very greatest means of infecting corn. Since the development of the attack of the borer on corn, planters recall that the vigorous attack of the borer on cane has invariably lessened when the operations of the
plantation forced less acreage of the corn crop, or where the growing of corn was abandoned for a year or more.

THE SPREAD OF THE BORER.

In this connection the present plantation operations will be discussed in their relation to the hibernation and perpetuation of the borer.

Cane culture may be classified for the convenience of this discussion under the following heads: Fall plant, windrowed cane and spring plant, cane cut for the mill, cane shoots and suckers.

FALL PLANT.

At the time of fall planting there are two broods of borers upon the cane. The old brood in the stalk and the young brood upon the leaves or in the tops, in the egg or young larval condition. By the removal of most of the tops the young brood is thrown out with the trash and either perishes or a few of them may come to maturity in the tops. Burying the cane, as is done, beneath several inches of earth, it is very plain that the borer’s damage is limited to what has been done to the cane before planting and to the amount of food required to bring the borers to a full larval growth. As the moths cannot escape from cane buried even one-half inch, no spread of the borer may be expected from fall planted cane, unless the brood in the tops find food in them (the tops) sufficient to produce maturity. This is seldom the case, but as a safeguard all tops cut from fall planted cane should be burned as soon as possible after cutting.

WINDROWED CANE AND SPRING PLANT.

In this connection is meant cane windrowed for spring planting. There is no operation on a plantation that offers so many opportunities to the spread of the borer and to actual loss as windrowing. It is strongly recommended that the area devoted to spring planting be reduced as much as is possible, and the fall planting area be increased upon plantations grossly infested with the borer.

Windrowed cane, like the fall plant, contains two broods at the time of cutting. As none of the leaves are removed, the young brood upon the leaves and tops of the stalks are buried with the cane. The older brood, which are usually nearly full-grown caterpillars or borers, do little further harm, and as most of them die in the stalks before the cane is removed for planting in the
spring, they are not to be regarded with the same gravity as the
younger brood. The open condition of the tops of windrowed cane
permits of plenty of ventilation, and opportunity for active work
of the young brood, and frequently it has been observed that cane
put in the windrow in fairly good condition, comes out in the
spring so seriously damaged that twice the quantity of seed is
required to plant the spring acreage.

The borers put down with windrowed cane are less exposed to
disease and enemies of all kinds and hence the vast majority are
cence of injury to the eyes of cane has warranted many planters to
denominate the borer in windrowed cane as the "eye worm." Some
permitted to riddle the cane and reach maturity. The predomi-
even believe the eye worm a distinct species, while others who have
followed more than an emphasized attack of the borer closely, know it to be nothing
more than an emphasized attack of the borer due to the number pre-
served by windrowing. After the young brood leaves the tops they
scatter down the stalks and enter the cane at the eyes or just above
and below the nodes or joints. Too frequently, the eyes are killed
and oftener the joints are so girdled (see fig. — — ) that in remov-
ing the cane in the spring it breaks into pieces of greater or less
length which produces extreme waste and encourages the spread of
the borer in the spring, as many of these fragments of cane are left
above ground upon the windrowed area where the moth easily es-
capes to deposit eggs upon corn or succession cane, which invariably
follows. Just here it is suggested that this land be not planted in
cane or corn, but that cow peas be used instead. Not only is there
danger from these pieces of cane upon the area from which the cane
is taken, but the droppings from the wagons and cars may be
left scattered about on the land devoted to spring plant. Every
piece of this spring plant cane should be regarded with active sus-
picion, since almost without exception each contains one or more
borers. The windrowed land should be carefully gone over and
systematically cleaned of all fragments of cane; no piece should be
allowed to fall from the carts or cars in transit, and every stalk
or piece should be covered upon the planted cuts.

Figs. 6 and 7, show the average danger from the
above sources, and should serve as a warning against such con-
ditions. The windrowed area and the spring plant area are not
so large on the average plantation of Louisiana, that the expense of
carefully removing and burying or destroying the fragments of cane
would be excessive. The practice of permitting people to glean the
windrowed areas is to be recommended, for such persons plant every
fragment collected and place the borers in such cane beyond the
possibility of resurrection as a moth.

CAKE SHOOTS AND SUCKERS.

From the stubble of cane cut early, whether for the fall plant;
the windrow or for the mill, shoots spring up in the fall. For the
sake of convenience we shall call the green part above ground the
shoot and the large white subterranean stalk of this shoot, the suck-
see figers.) 8-9). In late cut cane the sucker seldom forms, but
the shoot may appear if the weather continues warm. Fall appearing
moths deposit eggs upon the leaves of the shoot and the young bor-
ers find them very desirable food. Should an early frost occur,
cutting down the shoots before the suckers appear, there is not so
much danger from this source but should suckers form they are sel-
dom affected by frost (being well below the surface of the ground)
and the borers migrate from the wilted and frostbitten shoot to the
sucker below where usually sufficient food is present to mature one

Fig. 7. A Field and turn-row, showing cane and pieces of can's left above ground after
spring planting. Nearly every piece of cane shown in this illustration contained one or more
borers and should be regarded a dangerous source of infection.
Fig. 8. A piece of stubble of cane cut early in November. Upon the shoot to the right the eggs of the moth are deposited and in this shoot the young borers live until frost, when they go down to the sucker or the base of the shoot. See fig. 5.

and even more borers during the rather suspended activities of the borers in winter. This source of infection has not been suspected by many planters, but it is a very important one, as the shaving of stubble in early spring is an advantage to the borers, for sufficient dirt is removed to make the exit of the moth very much easier than if no dirt had been removed. Some times the suckers and borers are cut off and thrown to the middle of the row by the stubble shavers. This, too, makes more certain the escape of the moth, for these pieces invariably escape covering before the moth emerges.

As the suckers contain numerous eyes which develop the cane stalks of the following season, it is evident any injury to these
suckers is a positive injury to the stand of stubble cane. It is difficult to estimate how much loss obtained in this way, as the attack of the borer upon suckers has not previously been suspected, but it is safe to conclude from the observations made in the field and laboratory the last two seasons, that the borer in attacking the suckers of early cut cane materially reduces the stand of stubble cane the following year.

The area of early cut cane is usually not extensive and hence

![Fig 9 A piece of stubble hearing upon its right a sucker upon which many eyes exist. This sucker bears the shoot, and being from two to five inches below the surface of the ground is seldom injured by the frost of a Louisiana winter. In this sucker many borers hibernate, and they destroy many eyes. The stubble stand of the following season is injured.](image)

...the operation of preventing the attack of the borer on shoots and suckers should not be arduous or expensive. Some planters pile the cane trash upon the stubble in such a way as to shade the stubble and prevent sprouting, and at the same time dry the trash much sooner; for piled in this way ventilation is better and drying much
more rapid. A few planters shave the stubble in the fall and cover the shaved stubble with earth. This prevents sprouting, but can only be done on exceedingly well drained land of a loamy nature. The plan of cutting the suckers off with knives or with stubble shavers before frost, catches the young borer in the shoots in which they perish when separated from the parent plant. This must be done at a period late enough to catch all the eggs of the late appearing moths, and early enough to prevent frost from injuring the shoots, thus forcing the borers below where the shoot is severed from the suckers. In windrowed cane there will be no trash to cover stubble, and as this area is not usually preserved for stubble, little attention is paid to the shoots and suckers, and hence if succession cane or corn is to follow, the danger becomes doubly emphasized. If such tracts be put in cow peas the danger is reduced to a minimum.

**CANE CUT FOR THE MILL.**

The only danger from cane cut for the mill is in the cane tops left in the field, and in the waste in the form of pieces and whole stalks which fall from the carts and cars, or that in the cane trash pile near the carriers.

Cane tops have long been looked upon as a vigorous source of borer infection; in fact, the remedies previously advocated for the checking of the borer in this State have dealt almost exclusively with the destruction of the cane tops. Planters whose cane has not been damaged by borers have burned the tops to facilitate spring cultivation. This single practice has done much to prevent a more general attack upon the cane crop of the State.

The burning of cane tops that have been carefully piled upon the stubble to dry is not difficult during ordinary seasons. As a rule, most tops may be destroyed by burning, but frequently when the tops are in prime condition for firing, the work in the sugar house is in full blast and the tops remain unburned until after the grinding, when the season is not usually so favorable. In seasons of prevalence of borers the tops should be burned when dry under all circumstances, and the fragments of unburned tops raked to the center and covered by the first offbarring of early spring. As was urged under the discussion of windrowed cane, any piece of stalk sufficiently large to contain a borer should be covered by earth before March to prevent the escape of the moths. In the covering of cane trash in the spring special attention should be paid to the trash lying between the last rows of each cut and the ditch bank. As a rule, not sufficient room is available for complete covering of all the trash. To avoid this common
source of infection, no tops should be placed between the last row and the ditch bank, but if such should exist, all the trash that remains after burning should be raked over to the adjoining row or rows where ample room obtains for the complete burial.

It sometimes occurs that planters anxious to add humus or vegetable matter to their soils, scatter the accumulated trash from the mill during the grinding season, over certain cuts in close proximity to the sugar house. As this trash contains pieces, and even whole stalks, of cane which are infested with borers, the danger of placing this material upon the land in the spring must be accentuated. All
such trash must be burned or buried to prevent escape of moths in the spring and the re-infection of cane adjoining it.

Fig. 11. Tops as they appear in March with the leaves off. The dark places around the joints show the favorite entering place of the borers, and in the case of windrowed cane the borers damage greatly the eyes of the cane by gridling the stalks in this way. In some sections of the state the borer in windrowed cane is called the "eye worm"

THE BURYING OF BORERS UNDER EARTH.

As many of the remedies emphasize the burying of cane containing borers, it may be important to cite some of the experiments which prove the efficacy of this recommendation.

One hundred stalks of cane containing borers were placed under different varieties of soil, from buckshot to sand, as well as
different depths, from six inches to one-half inch. The results showed that in buckshot soil, well packed by rains, borers died in great numbers, due to exclusion of air. The same results were gotten from placing cane in hermetically sealed jars. Also by immersing the soil planted with borer infected cane under water. In the coarser grained soils fewer deaths occurred; many of the larva reached the pupa condition in March and April, but were unable to emerge as moths even from one-half inch of loose soil. Thinking the vitality of the borers had been somewhat lessened by the covering process, active pupa reared under normal conditions, were buried under different depths of soil, and in not a single instance could or did a moth emerge from the soil cover of half an inch or more. The moths lived a few hours under one-half inch cover, but deeper, few moths ever escaped even from the pupa case. It may be seen from the results of these experiments that here a very weak and vulnerable point exists in the economy of the borer, and every opportunity should be taken during the winter months to put under soil every piece of cane not planted or destroyed by fire.

REMEDIES

Many of the remedial measures to be adopted in the suppression of the sugar cane borer have been discussed under the sources of borer infection, but a recapitulation is here made, together with remedies not embraced in foregoing discussion.

Fall planting should be more generally practiced until the borer is either eradicated, or its attack reduced to a minimum.

The windrowed areas should be systematically gleaned after removal of cane for spring planting, and all pieces of cane destroyed by fire or carefully buried. No cane should be allowed to drop from the carts or cars in transit, and all cane on the spring planted areas should be buried deep enough to prevent the escape of the moths.

Corn or succession cane should not be planted on windrowed ground until all borers are eradicated. In fact, to avoid the greatest danger no corn should be grown on cuts previously devoted to cane in which borers existed. After realizing the attack of the borer on corn, many planters will abandon the cultivation of corn until the plantation is freed from borers.

The growth of shoots and suckers from the stubble of early cut cane should be prevented by covering the stubble with the tops, or the stubble should be shaved in the fall and covered with earth. Wherever these shoots and suckers appear they should be cut down
to the ground before frost, in order to catch the young borers in the
tops of the shoots. The borers will not leave the shoots, but perish
as their food disappears, by withering and decay.

All trash (cane tops) should, when cut, be so arranged upon the
cane rows as to hasten drying, and whenever dry should be fired.
Delay often compels the burning of tops under unfavorable condi-
tions, and large percentages of the stalks and tops remain unde-
stroyed, thus giving the borers in them ample food to reach matu-
ricity. The fragments of tops remaining after firing should be pulled
to the centre of the row and buried by off-barring before the first of
March, thus preventing the escape of moths, the majority of which
(of the hibernating brood) emerge from March 15th to April 15th.
Not permitting any trash to remain unburned or unburied, being
careful to pick up all stalks lying along the road, turn rows and car
tracks, the removal of all trash from the cars and from around the
mill will, with clean field culture, reduce the attack of the borer
beyond appreciable injury, if not eradicate this pest from the plan-
tations of the State.

Borer infested cane brought to a refinery located in a borer free
section, has undoubtedly been the medium of infection in some sec-
tions. As the manufacturer is equally interested in the production
of sound cane, all trash in cars and around refineries should be care-
fully destroyed.

In introducing new varieties of cane, care should be exercised
to select borer-free stalks. In case this is impossible, fall planting
of all new importations should be adopted.

The permitting of employees to carry infected cane from one
place to another should be discouraged. It has been found that in
towns where sugar cane is offered for sale, that borer infected pieces
are frequently thrown out in the back yards, where the following
spring the moths escape and deposit eggs upon sweet corn. The attack
of the sugar cane borer on sweet corn planted in isolated gardens,
has in several instances been traced to the purchase by some member
of the family, of borer infected cane of the previous fall.

THE CUTTING OUT OF DEAD HEARTS.

The attack of the first spring brood is more or less limited on
both corn and cane, and it is possible to greatly reduce the attack
of later broods by cutting out the infested stalks of corn and cane.
In corn the riddled condition of the leaves is an indication that
some caterpillar is at work. If it be the borer, the stalks will be
found burrowed. In such cases they should be removed with a strong knife, placed in a sack and afterward destroyed. That the culling of corn is practical, was well demonstrated last season on Mr. N. S. Dougherty’s plantation. During May the corn fields were carefully gone over and all infected stalks removed. Two cullings completely cleaned the corn fields of borers. The removal of infected corn stalks is impracticable after the first brood has completed its round of life and the moths have deposited eggs for another brood, as the infection is usually so widespread at this time that the majority of the crop is involved. Limited tracts of corn badly infested with the borer in close proximity to cane, should be completely destroyed to protect the cane crop from succeeding broods. However, if corn be not planted on windrowed areas, and careful culling is practiced during the life of the first brood, there will be no need of destroying the corn crop to save the cane.

As a rule planters have found it easier to cull cane than corn, on account of the presence of what is known as “dead hearts” of borer infested cane. Early in June the affected cane begins to show dead heart, and the practice of sending hands, supplied with strong knives and sacks, through the fields to remove affected stalks has proven eminently successful. Messrs. E. & J. Koch, of Belle Alliance plantation, were the first to institute a campaign of this kind. They found the operation so inexpensive and satisfactory, that many of their neighbors followed suit. On Belle Alliance, the cane fields were gone over twice in June and one strip of one hundred acres was culled a third time. In all, something like two thousand acres were culled at an expense of $170.00.

The Ascension correspondent has the following to say in the Louisiana Planter and Sugar Manufacturer, in issue of September 14, 1901, relative to culling cane:

"A great deal has been done toward the destruction of the borer. * * * * * A good many cane and corn crops have been culled; cars, tramways, roads, ditch banks, etc., have been cleared of trash, which has been burned, all these things being conducive to the extirpating of the pest.

"The work accomplished at Palo Alto under the direction of the veteran manager, H. C. Wilson, may be taken as an example to demonstrate the probable results achieved. Mr. Wilson had 420 acres of cane culled in the early spring, filling 120 oat sacks with borer infested stalks. Averaging these at 333 to the sack, would give 41,292 and as each borer moth may be counted upon to deposit at least 300 eggs, the number of eggs destroyed (of a single
brood) on this one plantation alone, can be estimated at 12,387,600. Anyone fond of mathematical demonstration can continue the calculation; meanwhile, the championship for killing borers is claimed for Ascension."

It has been found best to cull cane more than once. In going over the crop the first time some plants infected may not show the dead heart, and the second, and even the third, is strongly recommended in order to catch all missed in previous cullings.

NATURAL ENEMIES OF THE BORER.

Up to the present time we have not found any practical means of artificially increasing the natural enemies of the sugar cane borer (i.e. those found indigenous to the State). For this reason we do not regard it advisable in this discussion to do more than mention a few of the more important forms which were observed to feed upon the borer in one or more stages of its existence.

All of the natural enemies are predatory in their habits except the single fungus which lived and developed parasitically upon the borer caterpillars.

In Bulletin No. 9., Second Series of the Louisiana State Experiment Station, mention is made of a small black larva which entered the burrows and fed vigorously upon the borers. At the time that this bulletin was issued this enemy of the borer was thought to be the larva of a Lampyrid beetle (Chauliognathus Pennsylvanicus) but recent observations have shown it to be the larva of Chauliognathus marginatus, a beetle much more common in sugar cane and corn plantations of Louisiana. Chauliognathus Pennsylvanicus does occur in Middle and Northern Louisiana, but is much less abundant.

Upon every plantation visited the larva and adults of Chauliognathus marginatus were found. In the larval condition this insect is shy and if upon the stalk when disturbed, drops to the ground and instantly hides at the roots of the plant.

Many planters have observed this insect at work upon the borer and appreciate its presence in the State.

From many plantations we have received specimens of the larva of another beetle which has been found feeding upon borers in suckers and in windrowed cane. This insect is a "wire worm," the larval stage of a common "click" or "snapping" beetle (Drasterius elegans.) In cages the "wire worms" ate, on an average, two borers apiece per day, and gave every evidence of being a decided enemy to the sugar cane borer.
These larva are well distributed throughout the State and have no doubt been of much assistance in preventing even greater losses from the ravages of the borer.

Two species of ants were found to attack the eggs and moths of the borer. We are unable at present to give any exact data as to the value of these species in the control of this pest.

Upon the Sugar Experiment Station, Mr. Robt. Glenk found, January 1901, a few borers covered with a white fungus. Experiments were made with this disease to prove its infecting power, with very satisfactory results. Experiments are now in progress testing the value of artificial inoculation with pure cultures of this disease, the results of which will be given in full to the planters of the State at some future time.

No true parasite of the eggs or the caterpillars of the sugar cane borer moth were found during the entire period of the investigation. In the West Indies egg parasites occur, and from reports, are doing a great deal to keep in check the ravages of the borer. An attempt will be made to liberate some of these egg parasites in Louisiana and to encourage their propagation in the borer-infested plantations of the State.

Associated with injured and decaying cane are maggots of some small flies. Mention is here made of these for the reason that they have often been confused with small borers, or thought to be borer parasites. Some planters seeing these maggots abundant in the fertilizer spread upon the cane fields, have accredited cotton seed meal and other fertilizers with the spread of the borer upon these plantations. Commercial fertilizers are in no way responsible for the spread of the borer, for its only food in Louisiana has been found to be sugar cane, corn, Johnson grass, Guinea corn, sorghum (sweet and nonsweet), and possibly two other large grasses.