

THE JOURNAL
OF
THE DEPARTMENT OF AGRICULTURE
OF PORTO RICO

VOL. VI.

JULY 1922.

No. 3.

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GUMMING DISEASE OF SUGAR CANE.

By JULIUS MATZ.

INTRODUCTION.

Gumming disease of sugar cane was noticed for the first time in Porto Rico in February 1920 in two car loads of sugar cane brought in from the neighborhood of the town of Trujillo Alto to be ground at Central Vannina, Río Piedras. Soon afterwards the distribution of the disease was ascertained by inspections of cane at the mills all over the Island, including the adjacent island of Vieques, and by inquiries from men engaged in sugar-cane cultivation. By the end of the harvest of 1920 the disease was located at the following places: Río Piedras; Guaynabo; south of the town of Trujillo Alto, between kilometers 13 and 18 along the Caguas Railway; at a point 9 kilometers from Río Piedras on the main highway going to Caguas; one gummed cane was found, at Central Juncos, in a last shipment of cane from the vicinity of Las Piedras; and another diseased specimen was seen in cane from near Morovis. This comprised the known infected locations at the end of the harvesting season of 1920. During that year the first observations on the disease in Porto Rico were recorded in a circular (1)¹ and a note in Phytopathology (2). The following is part of the text of the note:

“In February, 1920, gumming of sugar cane was identified by the writer in two car loads of cane from the Trujillo Alto district, Porto Rico. The gummy exudation, varying in color from a lemon-yellow to that of honey, at the cut ends of the cane stalk, together with the bright-red vascular bundles in cane in the more advanced stages of the disease, are symptoms that agree with the gumming

¹ Numbers in parenthesis refer to references listed at the end of this paper.

of cane of Australia as described by Cobb and studied by E. F. Smith. Cultures of gum were made on potato agar, and the bacterial colonies as well as the transfers of these to potato plugs agree with those of *Bacterium vascularum* described by the last author. Masses of the bacterium in pure culture were smeared on needle-pricked surfaces of leaves of ten healthy, young "Otaheite" canes in an isolated greenhouse. After three months from inoculation all these plants showed, when cut, typical gummy exudation from the fibro-vascular bundles.

"Immediately upon the recognition of the fact that gumming disease exists unmistakably in Porto Rico, a special survey was made of all the principal sugar-cane growing centers, and it was found that the disease is not wide-spread and that the exact locations of its occurrence are only in the Trujillo Alto district in an area of about fifteen kilometers. Specimens of the diseased cane were shown to men who have planted cane for years but all were unanimous in declaring it a new thing. One planter stated that he saw it to a very limited extent the previous year. The disease occurs in places where no new introductions of seed were made for many years past, and it was found in the oldest varieties grown on the Island, namely, "Otaheite," "Rayada," "Crystalina" and "Cavengerie" or "Colorada." The "Otaheite" is the most severely infected, while the "Cavengerie" is the least infected variety. It is very likely that the disease has been here in insignificant proportions for some time in the past, but the unusually heavy rains at the beginning of the present year have most likely aided it in taking on the form of an epidemic in one district where "Otaheite" is still generally grown. Whether the disease will subside with the advent of normal rainfall remains to be seen. The only safe way to check it is through the planting of resistant varieties. So far the disease has not been observed in the variety "Yellow Caledonia." The fact that "Rayada" is susceptible makes it rather a difficult problem here, as this variety is very largely grown all over the Island. "Cavengerie" shows decided resistance but it is not a very desirable variety here from the millers' point of view."

The following year, beginning January 1921, the disease was found to have spread to a much larger area. Cane in the vicinity of Caguas, Cidra, and Cayey were found heavily infected with gumming. From Morovis and Barros, in the interior of the Island, heavily gum-diseased canes were repeatedly received. The disease was also found at Corozal, Aibonito and Barranquitas. During that year gumming disease was found to have spread at least 25 kilometers in westwardly and southwardly directions in advance over the infected area of the previous year.

At the beginning of the third season, the 1922 harvest, the disease was located in the interior as far as Adjuntas; south and southwest it has advanced to Santa Isabel, Peñuelas, Guayanilla, and Yauco; on the north coast it has advanced from Bayamón towards Vega Baja; and at the eastern end of the Island it was found in the vicinities of Humacao, Las Piedras, Fajardo, Río Grande and Carolina. In the previously infected zones around Trujillo Alto,

Río Piedras, Bayamón and Cayey the disease became more common in a larger number of properties, and it became noticeable in the more resistant cane varieties as well.

THE OCCURRENCE OF THE DISEASE OUTSIDE OF PORTO RICO.

Contemporaneous with the outbreak of gumming in Porto Rico the same disease was, and is at the present writing, existing in Australia. There exist records of the occurrence of the disease in other countries and these records are summarized by Dr. E. F. Smith in his treatise "Bacteria in Relation to Plant Diseases" published in 1914. In summarizing the geographical distribution of the disease he states as follows:

"This disease occurs in New South Wales (Cobb, Greig Smith), Queensland (Tryon, Cobb), Fiji Islands (Clark), Mauritius (Boname), Java (Went), Borneo (Kruger), New Guinea (Cobb), and Brazil (Dranert). From various statements in Spegazzini's paper on Polvillo or humid gangreen of the cane I believe this disease is also present in Argentina, Tucuman province. It is probable not in North America. No complaints have been received from the cane fields of Louisiana. Dr. Went did not find, or hear of it, in his tour of inspection in the Dutch West Indies in 1902. It has not been reported from the British West Indies nor from Porto Rico. The writer did not see it, or hear of it, in Cuba in 1904, nor was it seen in 1907 by John R. Johnston, Assistant in the Laboratory of the Plant Pathology, who spent eight months in the West Indies, visiting Cuba, Jamaica, Trinidad, Guiana, Venezuela, Barbados, and Porto Rico, and who was instructed to look for it especially. Recently a top rot of sugar cane has been reported from Cuba by Cook and Horne, but their account leaves very much to be desired. It does not occur in the Sandwich Islands (Cobb). Sereh and cane gomosis are said by Dr. E. J. Butler to be 'unknown or rare' in India (letter to our Secretary of Agriculture, April 21, 1903). It is a disease most prevalent in the Southern Hemisphere but one likely to occur wherever cane is grown. The Java top rot as described and figured by Wakker is not this disease. Possibly, however, it may have been confused with the Java heart-rot or with the pokkabong."

The earliest recorded date of the occurrence of the disease is that of 1869, when F. M. Dranert (3) reported the disease from Bahia, Brazil, and he stated that the disease existed there to an alarming extent for at least six years previous to that date.

In 1894 it was reported from Pernambuco, Brazil, that the disease was greatly diminished by the substitution of resistant cane varieties among which there is mentioned a "dark claret-colored cane with a still darker stripe, called here 'Louzier.'" This cane is probably our *caña* Colorada or Cavangerie. In the same year M. Boname reported the disease from Mauritius.

One year back, in 1893, Cobb reported the disease from Australia (New South Wales) and brought forth the idea that it is caused by a bacterium. Two years later Tryon reported on the gumming disease of sugar cane in Queensland.

In 1902 Greig-Smith published an account on the reactions of the bacterium of gummosis which he isolated from diseased cane and cultured in pure state.

In 1904 Dr. E. F. Smith published a paper on his inoculation experiments with a pure culture of *Bacterium vascularum* which he obtained from diseased cane from Australia, establishing the causative relation of this organism to gumming disease of cane and he attempted to show that acidity of the cane is a factor in immunity to this disease.

De Gomzichte van het suikerriet (the gum disease of sugar cane) of Java has been discussed in publications by J. Groenewege (4) in 1914 and again in 1916 (5). The same disease has later been studied by Miss. G. Wilbrink and the results and observations of this author were published in 1920 (6).

In the last three publications from Java the identity of the Javan gum disease with the one described from Australia is amply discussed. Groenewege maintains that the gum disease of Java is identical with the gumming of Australia. Wilbrink does not share that view and maintains that the identity of the two diseases could be established only if they were observed together in one locality. In reality there exists a marked symptom by which the two diseases are distinguished from each other, namely, the exudation of a copious yellow gummy mass which is the most characteristic symptom in the Australian and Porto Rican gumming disease and which is lacking entirely in the disease of the same name at Java. All of the investigators in Java agree that there is no exudate from affected canes. It is true, the extent of gum flow in quantity from the cut ends of the disease cane may become influenced by atmospheric conditions to a certain degree, but it is always in evidence no matter how small the quantity, under a rather wide range of climatic conditions such as at Brazil, Australia, Mauritius, Porto Rico and to say the least in the greenhouses of Washington where Dr. Smith has produced the disease, exhibiting the symptom of gummy exudation, with pure cultures of the organism isolated from cane which became diseased in Australia. It is therefore difficult to accept the view that the same organism

which produces the characteristic gum flow in several countries however much they differ from each other climatologically, should lose entirely that very pronounced character in Java. It seems that the gum disease of Java is caused by another organism.

It would be incorrect to suppose that the gum flow in diseased cane is not a primary or direct symptom of the disease but is due to other organisms which may follow the initial entrance of *B. vascularum*, because in the first place cultures of small drops of the gum itself have, in many instances, produced uncontaminated growth of *B. vascularum* unassociated by any other organism, and secondly, pure cultures of *B. vascularum* on a 2 per cent glucose, 5 per cent peptone, almost neutral agar medium are exactly like the gum, exuded from diseased cane, in color, consistency and copiousness. It is evident, therefore, that the gummy exudation is a natural character of *B. vascularum* and is present whether the organism lives in the sugar cane or in an artificial food medium in the laboratory. This same phenomenon should occur in Java, provided *B. vascularum* is the organism associated with gum disease there. It should be stated here that in using the word "gum" in connection with this disease it does not imply a true gum but only in the sense of a sticky substance, because in reality it is not more than a yellowish zooglia mass of bacteria each individual bacterium possessing a gelatinous and sticky outer covering. One becomes readily convinced of it when a drop of newly exuded gum of a freshly cut cane is examined under the microscope, then an ordinary mass of bacteria is seen and nothing else. If the exudate is somewhat dry on account of exposure to dry air the individual bacteria are less distinct as they do not readily separate themselves after they are cemented together through drying and in this condition it may resemble a gum. In free-hand sections of cane affected with gumming the individual bacteria are easily detected in some of the vessels of the fibers. (Fig. A.) There occurs, sometimes, on account of injury, a homogenous gum-like substance, variously colored, in the vessels of sugar-cane fibers, but this substance does not contain normally any detectable masses of bacteria.

Regarding the relation of Sereh disease to gumming it is quite clear that not only is our gumming distinct from Sereh, but also the Javan gum disease has nothing in common with Sereh according to the later investigation of Wilbrink.

ECONOMIC CONSIDERATIONS.

Gumming of sugar cane is a serious disease in view of the fact that it produces decay of the growing points of young as well as mature canes, naturally where young canes are attacked they stop growing and ultimately die. The disease prevents the development

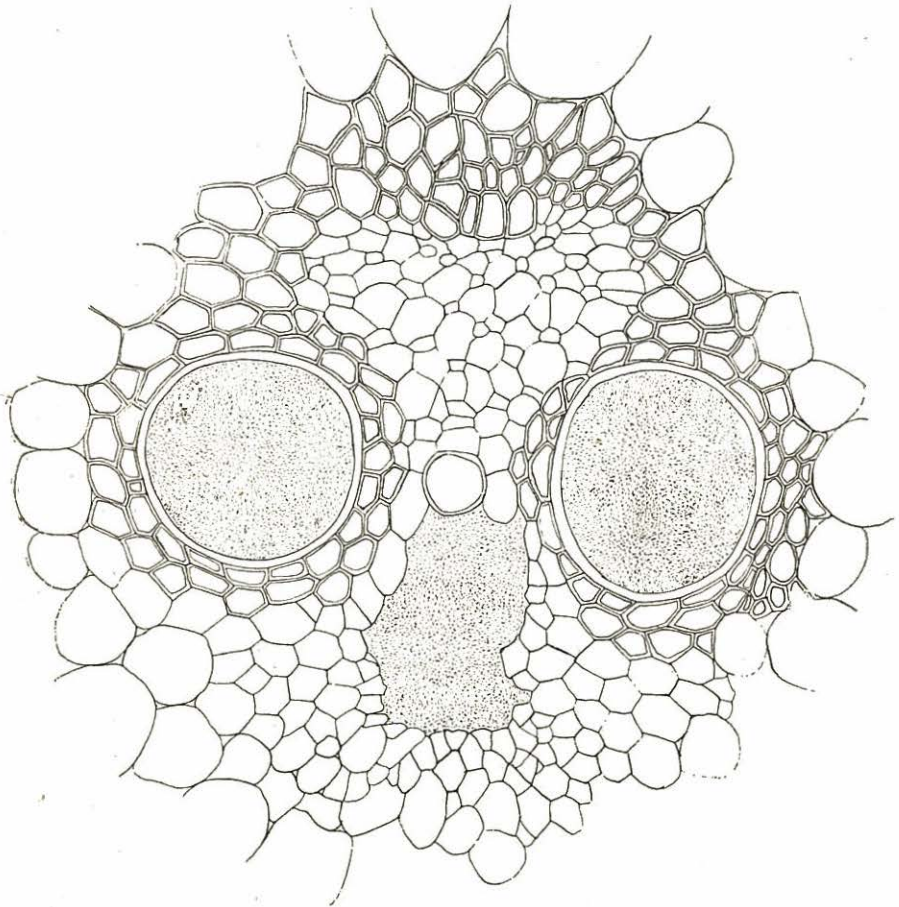


FIG. A.—Cross section of a fiber of sugar cane affected with gumming disease, showing the masses of bacteria in the vessels.

of the second-generation canes in the ratoons, and the presence of the gum causes difficulty in the elaboration of sugar at the mill—it interferes with cristalization in the vacuum pans or tachos. If gumming disease attacked with equal severity all varieties of cane, the sugar-cane industry would be destroyed in a few years. For-

tunately there are cane varieties that are not affected by it and some only in a slight degree. The most susceptible varieties are at the present time the least cultivated ones in Porto Rico, except in one locality around Guayanilla where the susceptible Otaheite cane is still predominant. The most commonly grown canes here in Porto Rico are the varieties *Cristalina* and *Rayada*, and these exhibit a certain degree of resistance to the disease, yet they are quite commonly found diseased in the infected zones, especially if they are planted together with infected Otaheite canes. The apparent resistance of certain cane varieties to this disease is not thoroughly understood, it may be an inherent quality such as the reaction of the cell contents to the invading organism, structural differences which may obstruct its entrance, or the absence or scarcity of carrying agents which may frequent in their visits some varieties more than others, but whichever factor is responsible for the greater resistance of, for instance, *Yellow Caledonia* to the disease at the present time, nevertheless it is possible for a change to take place in the requirements for the development and the adaptability of the bacterium and thus enabling it to attack hitherto resistant canes. As long as there exists a source of infection any cane variety might lose its resistance and adapt itself to the parasite.

Besides the immediate destruction of the tops of growing cane which results in the death of younger canes and a reduction in tonnage, gumming causes a rapid decay of canes after they are harvested. In this way mature canes may lose a large proportion of their sucrose if they are to remain in the piles or in the loading cars for several days before being ground.

It is impossible to give an estimate of the loss caused by the disease because it would be necessary first to determine the quantity of Otaheite canes present in the fields, since this cane is the one that suffers more materially of this disease. In the largest number of fields where this disease occurs there exists a mixture of varieties, in various proportions, usually *Cavangerie*, *Caledonia*, *Cristalina*, *Rayada*, and Otaheite with its close relative the *Calancana*. The last two varieties are the most susceptible ones to gumming; next follow *Cristalina* and *Rayada*, then *Cavangerie* is only slightly infected and *Caledonia* is practically immune so far. The amount of loss in any plantation, due to gumming, would depend therefore primarily on the nature of the predominating variety planted.

Some growers have expressed the view that gumming disease is less severe in ratoon than in plant cane. This is true at first glance

because the infected early sprouts die soon on account of the disease, that leaves the stool apparently free from the disease, though with fewer canes, for a time at least; but the bacteria have since

found their way into the older shoots, and before long some of them will show symptoms of the disease and dead tops, and thus the stools become thinned out, and lastly when the crop is harvested those few apparently full-grown and mature stalks will show the gummy exudation from their fibers when cut.

In one ratoon field the disease actually eliminated itself with the disappearance of the few stools of infected Otaheite in amongst the resistant Cavanerie and Yellow Caledonia.

THE SYMPTOMS OF THE DISEASE.

The principal symptom of the disease is the yellow gummy exudation from the cut ends of affected cane, and it is so striking that few can fail to become aware of its presence. (Fig. 1.) The exudate varies somewhat in color and abundance. At times it is grayish yellow and somewhat watery but more often it is lemon yellow and thickly gummy. In almost every case, and especially where the disease was present in any marked quantity of the harvested cane, the mill men recognized the disease by this symptom before

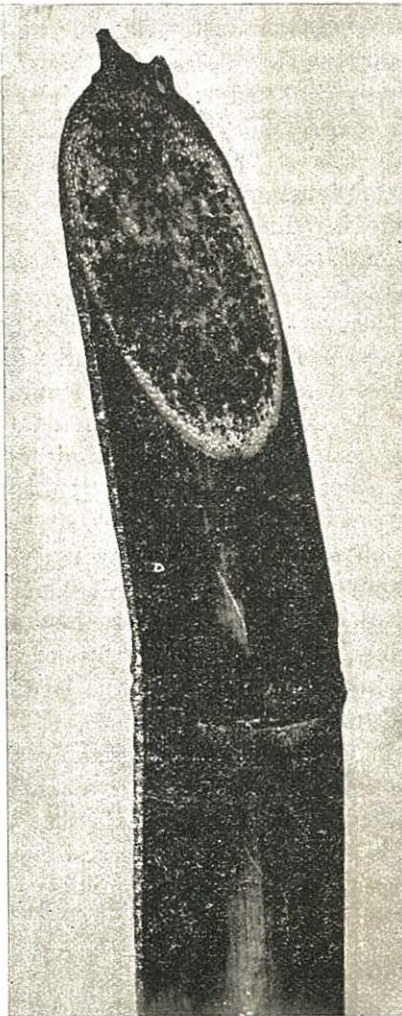


FIG. 1.—Gumming of sugar cane, gum drops exuding from cut surface of cane.

their attention was called to it. This helped to ascertain the distribution of the disease.



GUMMING DISEASE OF SUGAR CANE

At first it was thought that gum-diseased cane could be recognized only by the yellow gummy exudation from the cut ends of the cane, but further observation showed that the disease can be located in growing cane, before they are cut, by a peculiar appearance in the leaves. The leaves, and mostly the younger and innermost, not fully unrolled ones, show, in the early stages of the gum disease, pale green to almost pure white patches and (Fig. 2) longitudinal bands or streaks. These light-colored areas become often sprinkled with dark-red small spots or narrow and short streaks. (Fig. 3.) Such leaf symptoms can be found in young shoots or in older ones in the not quite unfolded basal parts of their inner leaves. In the outer maturer leaves long dark brown streaks may be found. (Fig. 4.) In older cane and where the disease is more advanced the inner leaves possess long, sometimes lighter and sometimes darker gray, dead, stripes usually about 1 centimeter in width. These stripes are usually found towards the middle of the leaf blade. This feature distinguishes this symptom from the ordinary drying of leaves which occurs in cane either because of white-grub injury, borers or drought. In the latter cases the edges of the leaf commence to dry first. In gum-diseased cane the dry stripes are usually in the interior of the leaf, while the edges may remain green for a long time. This phenomenon is due primarily to the partial infection of some of the fibers; naturally only the cells surrounding the infected fibers die first and result in the dead-stripe appearance in the leaf. Usually the tops of gum-

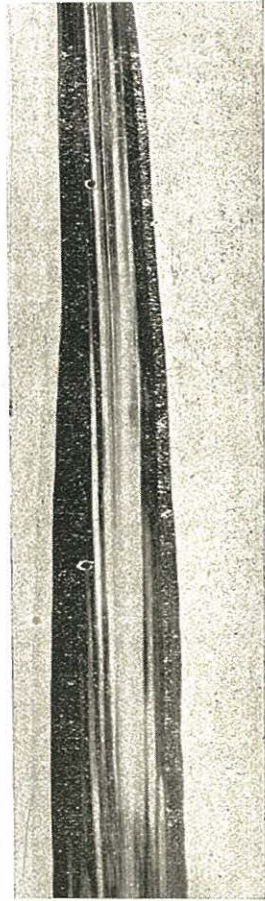


FIG. 2. — Light - green areas in first stages of gumming disease in the leaf of a young sugar-cane plant.

diseased cane showing the dry stripes will not be as widely unfolded as in healthy cane, the dead longitudinal areas or stripes in the leaves preventing the straightening out of the leaf blades, therefore the tops in gummy cane usually stand up erect and are more or less

unfolded. In the latter stages of the disease an odorless decay sets in the tissues of the growing points of the cane. At this stage the outward symptoms bear resemblance to the top-rot condition of cane

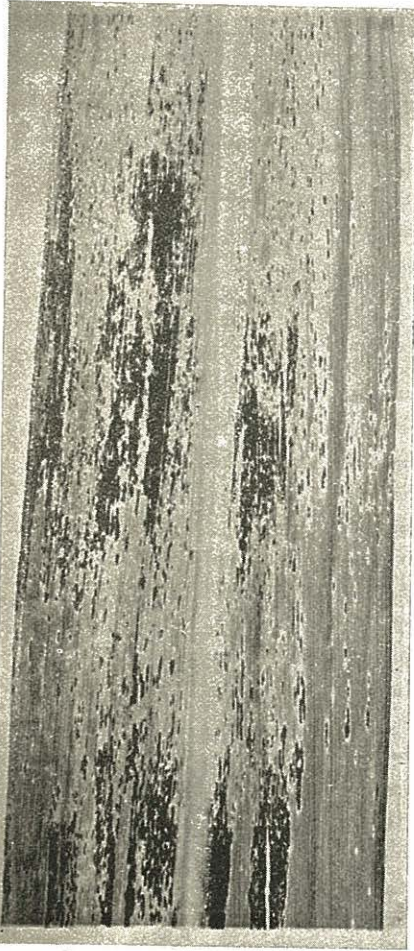


FIG. 3.—Reddish to dark-brown spots and narrow and short streaks on light-colored areas at the base of a sugar-cane leaf of a gum-diseased plant.

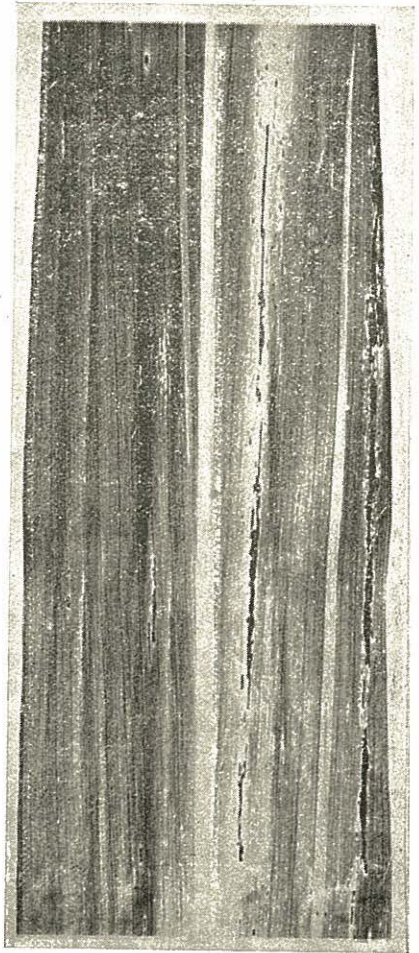


FIG. 4.—Long dark-brown streaks in outer leaf of gumming-diseased sugar-cane plant.

caused by borers and *Plasmiodiophora* disease. In the last cases the cause of top rot is due entirely to the interference with the normal functioning of the fibrovascular system. However, whether it is a bacterium as in gum

disease or a *Plasmodiophora* as in dry top rot which fills up the water-conducting vessels, or whether it is a mechanical cut made by an insect, thus breaking the connection between the roots and top of growing cane, the effect on the growing point where the new leaves issue from is the same. In gumming disease, in addition to a clogging of the fibers, there is a direct decay of the tender tissues of the top caused by this bacterium as is evidenced by the red coloration of the tissue between the fibers.

Another phenomenon found with gum disease is the red coloration of some of the fibers themselves in severely affected cane. This is not a primary symptom of gum disease, but it indicates that the phloem in some fibers, or in these which show the red color, have died. Canes which show exudation of gum from a majority of their fibers do not in many cases have a single red fiber. In many instances a severe stunting of the stalks and the presence of grayish longitudinal depressions along the internodes was quite common. In gumming top rot there may be present masses of gum between the leaf sheaths and the stalk.

In summarizing the symptoms of gum disease as it occurs in Porto Rico we must distinguish between the primary and secondary symptoms. The primary symptoms, or those which are always associated with gum disease, are the yellow gum exuding from the fibers of cut canes, the light areas sprinkled with dark-red little streaks in the younger portion of leaves, brown long streaks, and light to dark gray, more or less wide dead stripes in the older leaves, and top rot. Red fibers, and even stunting of cane may or may not occur in gum-diseased cane, depending on the severity of the infection. While the gum-flow symptoms is the easier to detect after the cane is cut, the leaf symptoms are more important, because by these it is possible to detect the disease in the field before the cane is cut, and it should be taken advantage of in controlling the disease. Wherever possible, diseased stools should be cut after the healthy stools have been harvested. This is hardly possible in severely infected fields, but it should be borne in mind that infected *machetes* can introduce the disease into healthy cane.

THE CAUSE AND BEHAVIOR OF GUMMING DISEASE.

As stated in the introduction, *Bacterium vascularum* was isolated from diseased cane and it was proved by inoculation trials that this organism is the cause of the disease in Porto Rico. However,

some difficulty was experienced in the first attempts at isolations. For a time no growth was produced in agar plates from diluted gum, but it was soon discovered that the agar medium used was of a too strongly acid reaction. When the work was repeated, using sucrose or glucose agar titrated to only + 1 or + 2 Fuller scale and sometimes leaving the agar at about neutral, copious growth of the bacterium, from diluted gum, was obtained in three or four days. In thick sowings growths was visible to the naked eye the following day.

From the sudden appearance of gumming disease here in the fields, where no new seed introductions were made for some time and in varieties which have been grown here for many years, no definite opinion could be formed as to its future possible spread, but now it is certain that it is spreading rapidly and that it is becoming a general epidemic. In attacking this problem at the Insular Experiment Station it was felt that the first thing to know is the manner by which this disease is spread. It became evident from the inoculation experiments that it could be transmitted by contact. Could the disease be transferred to healthy seed planted in previously infected soils? This was the second problem which was deemed important to solve. Gum-diseased cane pieces, the buds of which were removed, were split and these were tied to healthy seed and planted in new soil. Twenty seed of each of the varieties Caña Colorada, Yellow Caledonia, Rayada, Otaheite and P. R. 260 were used in the trial, each variety being planted in a separate row. In addition five seed of each of the above varieties were planted in the same rows but alone without infected cane. Practically all the healthy seed in this whole planting germinated and no sign of disease was noticeable in the young plants in spite of the fact that at first their buds and later their roots had been in contact with gum diseased cane pieces which were gradually decaying in the soil. They all made a good normal growth, and when the whole plot was harvested at the age of eight months, there were no trace of gumming in the stalks of any of the varieties used. The ratoons of these canes sprouted normally and no disease symptoms were noticeable in them when they were cut 10 months later. Apparently the soil is not the proper means through which infection might be carried to the roots of healthy seed. In another experiment diseased seed were planted with the view to allow those to sprout, as only about 25 per cent germinated; healthy Otaheite seed were planted in the holes of the ungerminated seed. There

was no gum disease produced in the replants of the susceptible Otaheite in this manner. However, when *Bacterium vascularum*, isolated from diseased cane, was introduced with a needle into the young leaf spindle of Otaheite and Rayada canes growing in the field the disease was reproduced with all its symptoms. That indicates that the air route is the path of transmission for this disease.

Stools of cane which contained several diseased stalks were dug up and all the stalks and shoots cut back. The stubble with their roots were transplanted amongst young healthy canes in an isolated field. It was noted that some young shoots which came up from those diseased stools showed at the very beginning the symptoms of gum disease, and what is more significant the disease was later found in the adjacent healthy stools as well. It is therefore evident that the infected ratoon left in the field constitutes a positive source of infection and that the disease can be carried over from these to the young canes of healthy stools. The possibilities are, therefore, that the disease can be transferred to growing cane by insects, by the cutting instruments and by driving rains, but by eliminating the diseased ratoons the primary source of infection is destroyed, since the soil does not form a favorable abode for the bacterium. Artificial inoculations in the roots of susceptible canes gave negative results. This can not be explained on the ground that the acidity of the soil does not favor growth in the bacterium.

A test was made with liming soils and then inoculating the soils with a pure culture of the organism, but the canes which grew in these soils did not become diseased. It is very likely that soil infection does not take place not so much on account of an acid condition but because the roots of the cane do not constitute a receptive organ for the entrance of the bacterium. From field observations and from experimental tests it was learned that the growing, tenderer tissues of the top leaves and points of the stalk are the most susceptible parts of the cane plant to the disease. Even resistant cane varieties may become infected when young, by artificial inoculation through the top leaf spindle. This was noted in the varieties B-208, D-625, and G. C. 606.

The course of the development of the disease from diseased seed begins with the sprouting buds. The bacterium which is present in the fibers of the diseased seed passes on directly into the unfolding bud, as some fibers of the seed are directly connected with those of the bud. If the bacterium has reached the interior of the bud before it started to swell, that bud will most likely not germinate.

On the other hand, if the bud is not contaminated, and swells rapidly, and the seed piece begins to decay early, the shoots from this bud may grow healthy, as the bacterium may become arrested in its growth on account of the acid condition of the seed tissues. Thus in planting diseased cane seed a considerable number of them do not germinate, some produce healthy shoots and some diseased shoots. The diseased shoots show the symptoms of gumming in their leaflets, usually the disease progresses until the shoot is stunted and killed; soon later another shoot, more advanced in growth, begins to show the disease, apparently a secondary infection, and so the younger infected shoots die in their turn but perpetuate the infection from one to another until good-sized canes are reached in which the disease is left to stay in the cane, as these do not die readily on account of the disease. The organism lives in the fibers but does not break through into the parenchyma cells of the maturing cane stalk, except in the top where it is able to enter the parenchyma cells and causes these to decay. In the same stool there may be diseased and healthy stalks. If the diseased stalks are removed the stool may remain healthy.

In the ratoons the disease is propagated to a large extent by the cutting instrument. When the canes are cut the very young shoots in the stools are also cut away. The cutting instrument which may have gum on its blade introduces it into the tender inrolled leaflets of the healthy younger shoots and these become diseased.

The infection has been observed to have been carried from one field to another through considerable distances.

VARIETAL RESISTANCE.

One of the most striking features of this disease is its preference for certain varieties of cane. This fact has been noted years ago at Pernambuco, Brazil, and though little has been spoken of it of late in reports on the disease from Australia, it is very accentuated here. Of our four or five common varieties one, Otaheite, is very susceptible and another, Yellow Caledonia, is practically immune. Experiments to test the resistance of varieties had to be done by artificially inoculating them with a pure culture of *Bacterium vascularum*. This method is not quite satisfactory since it does not represent a truly natural state of affairs, but it shows the possible susceptibility of each variety tested.

The first experiment on susceptibility of varieties was made by inoculating a number of young canes of B-208, D-625, Rayada, and

Otaheite. The expanded portions of the whorls of leaves at the top were cut off and *Bacterium vascularum* masses were smeared on the cut edges of the remainder of the whorls, that is, on the lower more or less inrolled portions of the leaves in the cane top, and these were covered with paper bags to prevent too rapid drying out. At the end of four weeks the typical red-brown spotting and streaking and drying of the top leaves were noted in the varieties Rayada and Otaheite, in B-208 the disease symptoms developed to a lesser degree and in D-625 the symptoms were faintest. Decay set in in the tops of the infected Rayada and Otaheite stalks and they finally died while B-208 remained stunted and D-625 seemed to have recovered.

During the year 1920 a larger variety test was made at the Insular Experiment Station to find which of our best canes are resistant to the disease. The results thus far are very encouraging because many of our good canes are resistant to artificial inoculation.

The following is a list of the cane varieties which were tried out and their reactions to the disease as noted at the end of the first crop:

GROUP I.

STRONGLY SUSCEPTIBLE.

Calancana	Rayada	B-376	P. R.-491
Otaheite	Cristalina	P. R.-358	P. R.-487

GROUP II.

SLIGHTLY SUSCEPTIBLE.

P. R.-260	B-3405	P. R.-207	P. R.-328
Colorada	Sealy Seedling		

GROUP III.

SUSCEPTIBLE IN YOUNG STAGE ONLY.

B-208	D-625	G. C.-606	
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GROUP IV.

RESISTANT OR IMMUNE.

Uba	D-109	B. H.-10(12)	P. R.-417
D-448	B-109	P. R.-333	P. R.-334
Yellow Caledonia	P. R.-308	P. R.-229.	P. R.-370
B-3412	P. R.-209	P. R.-292.	P. R.-272
D-117	P. R.-202	P. R.-318	B-1809
B-6292	P. R.-230	P. R.-309	
D-433	B-347	P. R.-219	

CONCLUSION.

The disease is easily transmitted by any conductor or carrier such as cutting instruments, biting insects, etc., into the growing portions of the leaves and young stalks of susceptible canes. The soil, however, is not the place through which infection can take place. Healthy seed may be planted in the same holes from where diseased canes were pulled out. In this respect it is similar to the "Matizado" or mosaic disease. Of the common canes the Caña Blanca (Otaheite, Burbon, Lahaina) and Calancana are the most susceptible canes we know, and as regards gum disease these are in the same relations to the other sugar canes as the rat is to men in the case of bubonic plague. It is quite certain that gumming disease was not present at Guayanilla before this year but it got in there because most of their fields are planted to Otaheite. This cane is grown in the interior to some extent and the disease has simply followed this cane, wherever it happened to be. At the Insular Experiment Station this same cane, in amongst a large number of other varieties, was found infected.

Ever since 1920 we have insisted on the extirpation of the disease and the avoiding of the use of Otaheite cane as seed. In the Trujillo district D-109 has been planted with success. Very drastic measures will have to be taken on the south coast to eliminate Otaheite plantings and destruction of the ratoons of some to prevent the disease from getting into the Cristalina and Rayada varieties, which are susceptible to the disease. In our experiments Rayada and Cristalina have shown to be susceptible to the disease, but in looking over cars of cut cane from infected zones it became evident that the last two varieties possess resistant properties, and it is because of their being planted together with the highly susceptible Otaheite that they contract the disease from it.

When gumming disease was first found here just two years ago, we at once advised the planting of healthy seeds and varieties which are resistant to it, but we found later on that the greatest source of infection is the diseased ratoon which is left in the field, therefore the diseased stubble must be removed in order to prevent the perpetuation of the disease in the old infected areas. But it would be impossible to detect diseased from healthy stubble, especially in fields where there is not more than 2 or 3 per cent infection if there were no means by which to recognize the diseased cane before their being cut. For this the leaf symptoms should be looked

for at the time of harvesting cane, and such stools as show the disease in the leaves should be left uncut. This practice will serve a double purpose; first, it will thus leave diseased stools marked to be removed afterwards, and secondly, it will avoid to a large degree the possibility of carrying the disease from infected to healthy stools by the cutting instrument.

During the first seasons only a few scattered samples of gummy Rayada, Cristalina, and more rarely Cavangerie or Colorada were seen. All of the outbreaks of the disease were first in Caña Blanca and in the recent cases of Coamo and Santa Isabel the new infection could be traced directly to infected Caña Blanca seed which were brought there from infected zones. It is therefore evident this cane is not only deemed to become totally infected but that it also acts as a carrier of the disease to the more resistant Rayada and Cristalina. On the other hand, the red cane (Cavangerie) and Caledonia should be propagated on a larger scale, at least for the present, as these varieties on account of their resistance will tend to check the march of the disease. Another red cane known as "D-109" has shown so far a remarkable resistance to the disease and it is advisable to procure seed of this kind and replace the white Otaheite in the hill lands.

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