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THE HAWAIIAN PLANTERS' MONTHLY

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WEATHER AND CROP.

For this period of the year exceptionally dry weather bordering on a drought has been experienced. While very favorable for field operations and the harvesting of the 1906 crop the lack of moisture has affected young cane which has made little growth during the month. In Maui irrigating ditches were lower than for a long time past, necessitating the operation of the pumps. Windward plantations have been most affected some having to stop grinding on account of shortage of water for fluming cane to their mills.

On most plantations harvesting and grinding have progressed rapidly.

SUGAR PRICES, MONTH ENDING FEB. 15, 1906.

	Centrifugals.	Beets.
January 15	3.67c	8s 3d
January 22	3.625c	8s 3d
January 29	3.505c	8s 1½d
February 5	3.42c	7s 10½d
February 12	3.36c	8s 0¾d

Czarnikow, Macdougall & Co., under date of February 2, report as follows:

"The downward tendency exhibited by the market since the middle of January has continued throughout the past week. After a few transactions in Cuban sugars at 2⅛c. c. and f., a decline of 3-16c. from the highest price in January, it has become difficult to find buyers even at that price. Our principal refiners are well supplied for this month's requirements and, as they expect greater selling pressure from Cuba as the crop advances, they have withdrawn from the market. In consequence of this, offers at 2⅛c. of comparatively large quantities of Cubas for shipment this and next month remain unplaced.

So far, there has been no sign of willingness on the part of Cuban producers to accept lower prices, but if stocks accumulate, planters will have to part with some of their sugars even at the present disparity between this market and that of Europe, where the price of beets represents a landed cost here equal to 2.31c. c. f. for Cubas.

Added to the unsatisfactory condition of this market we have similar conditions in the European markets, which, after closing last week at 8s 2¼d. for February, have declined by slow stages until today the official quotations are 7s. 11¼d. for this month and 8s. 1¾d. for March, with May at 8s. 2¼d. and August at 8s. 4½d. It was hoped that the beet market would not go below 8s. for prompt sugars, but the enormous visible supplies in Europe, aggregating 3,874,000 tons—the largest ever known—weigh heavily on that market, especially as all the reports thus far received indicate a belief that European sowings this spring will be only slightly reduced.

This week's decline will, naturally, tend to check sowings, but so far there are no signs that the reduction will be greater than the 8 per cent. for all Europe, estimated by Mr. F. O. Licht. A reduction of 8 per cent. is equivalent to a reduction in production of about 560,000 tons, assuming that the European yield would be as good as it was in the past season. Such an unusually high yield can hardly be expected, but even should next season's yield be 12 per cent. less, and the combined reductions of acreage and yield be 20 per cent., the crop of 1906-7 would reach fully 5,500,000 tons. The past season's exceptionally large acreage and yield gave a crop of 6,930,000 tons, as compared with 4,712,976 in the poor season of 1904-5 and 5,881,330 tons in the season of 1903-4, when sowings were 6 per cent. less than in 1905-6.

A more radical reduction in beet sowings than is at present in prospect is required to adjust supply to demand and bring about a recovery in prices.

SUGAR CROPS OF THE WORLD.

FROM WILLETT & GRAY'S WEEKLY STATISTICAL.

These figures include local consumption of home produc.ion wherever known.
Willett & Gray's estimates of cane sugar crops, February 1, 1906.

	Crop begins.	1905-06	1904-05	1903-04
United States—Louisiana	September	300,000	335,000	215,000
Texas	September	12,000	15,000	19,800
Porto Rico	January	210,000	145,000	130,000
Hawaiian Islands	November	370,000	380,576	328,103
Cuba, *crop*	December	1,300,000	1,163,258	1,040,228
British West Indies—Trinidad, *exports*	January	35,000	28,000	44,058
Barbados, *exports*	January	40,000	41,600	58,081
Jamaica, *crop*	January	18,000	16,000	14,255
Antigua and St. Kitts	January	19,000	19,000	19,000
French West Indies—Martinique, *exports*	January	33,000	29,986	23,936
Guadeloupe	January	36,000	36,000	35,976
Danish West Indies—St. Croix	January	13,000	11,000	13,000
Haiti and San Domingo	January	50,000	47,000	47,000
Lesser Antilles, not named above	January	13,000	13,000	13,000
Mexico, *crop*	December	105,000	115,000	107,547
Central America—Guatemala, *crop*	January	8,000	8,000	7,640
San Salvador, *crop*	January	7,000	7,000	6,300
Nicaragua, *crop*	January	5,000	4,500	4,235
Costa Rica, *crop*	January	3,000	3,500	3,275
South America—Demerara, *exports*	October & May	115,000	101,278	113,282
Surinam, *crop*	October	13,000	13,000	13,000
Venezuela	October	3,000	3,000	3,000
Peru, *crop*	October	150,000	150,000	147,000
Argentine Republic, *crop*	June	125,000	126,550	142,895
Brazil, *crop*	October	275,000	195,000	197,000
Total in America	....	3,258,000	3,007,248	2,746,611

	Crop begins.	1905-06	1904-05	1903-04
Asia—British India—*Exports*	December	15,000	30,000	15,000
Siam (cons'n 30,000 tons, mostly imported)	....	....	....	....
Java, *crop*	May	993,900	1,008,900	885,561
Japan (cons'n 170,000 tons, mostly imported)	....	....	....	....
Philippine Islands, *crop*	December	135,625	106,875	84,000
China (cons'n large, mostly imported)	....	....	....	....
Total in Asia	....	1,144,525	1,145,775	984,561
Australia and Polynesia—Queensland	June	162,000	147,688	91,828
New South Wales	June	20,000	20,000	21,500
Fiji Islands, *exports*	June	50,000	56,000	50,000
Total in Australia and Polynesia	....	232,000	223,688	163,328
Africa—Egypt, crop	January	65,000	60,000	60,000
Mauritius	August	200,000	142,101	220,589
Reunion	September	30,000	30,000	41,117
Total in Africa	....	295,000	232,101	321,706
Europe—Spain	December	28,000	28,000	28,000
Total cane sugar crops (W. & G.)	....	4,957,525	4,636,812	4,244,206
Europe beet sugar crops (F. O. Licht)	September	6,930,000	4,712,976	5,881,333
United States beet sugar crops (W. & G.)	July & October	285,000	209,722	208,135
Grand total cane and beet sugar—tons	....	12,172,525	9,559,510	10,333,674
Estimated increase in the world's production	....	2,513,015	....	....

BEET SUGAR INCREASE.

EUROPE ADDS NEARLY 50 PER CENT. TO CROP.

The beet sugar crop of Europe for 1905-6 is estimated at 6,855,000 tons by a Belgian journal, La Meuse, of Liege. This shows an increase over the previous year's crop of almost 50 per cent., according to the following table forwarded by Consul McNally:

Country.	Estimated, 1906. *Tons.*	Actual, 1905. *Tons.*
France	1,050,000	633,000
Belgium	330,000	175,000
Holland	200,000	137,000
Germany	2,325,000	1,595,000
Austria-Hungary	1,480,000	889,000
Russia	1,075,000	940,000
Sweden	120,000	84,000
Denmark	65,000	48,000
Spain	90,000	98,000
Italy	85,000	75,000
Roumania	25,000	19,000
Switzerland, Servia, Bulgaria and Greece	10,000	8,000
Total	6,855,000	4,701,000

It is estimated that the excess production of the current year will be about 2,150,000 tons of raw sugar as compared with the actual production of the preceding year. This excessive increase would make the present year the greatest known in the history of the industry. While the above estimate is given as probable, the stock of the preceding year on the 1st of September was greater than on that date of the present year. This increase will influence an enhanced consumption, of which the month of October is a forerunner.

LETTER.

Editor Planters' Monthly.

The December number of this journal contains a reply by "Sugar Boiler" to the article: "On the Superintendence of Sugar Factories," written by Ph. N. for the October number.

The Planters' Monthly being read in all sugar countries, "Sugar Boiler's" statements must not be allowed to go unrefuted, lest they create a wrong conception of our local conditions.

This is the only reason for this reply, which is entirely unnecessary for those familiar with the industry of Hawaii; for the very choice of his signature, "Sugar Boiler," has betrayed the one-sidedness of his standpoint.

It is an unquestionable right of the public to criticise in foro an article brought before them; but if one feels called upon to do so, one should first of all possess the necessary moderation and intelligence.

When I say: "...... that the manager, with a chiefly agricultural training, and on account of the high importance of this part of the sugar industry, cannot possibly devote sufficient time to the manufacture proper," it is utterly incomprehensible to me how "Sugar Boiler" can accuse me of trying to tell your readers that the manager is not competent, can never become so and is just good enough as a head luna. Those who have read my articles knew very well that this was never meant or said, and therefore "Sugar Boiler's" intimation must have an ill flavor to managers. Ph. N. has quite a different opinion about the importance of the manager's work, but to go into lengthy details about this question would be love's labor lost, since the 3 pages of my first article are too much for "Sugar Boiler," who nevertheless does not disdain to claim 2 pages for himself.

My "critic" says: "...... but were he (the chemist) himself responsible, he would be reporting his own work and it is only reasonable to suppose that no man is likely to put on record that which may be of an inferior order." Well, well, Mr. Sugar Boiler, Ph. N. has a better opinion of a self-respecting man. Do you realize what calumny you are throwing at the existing mill superintendents whose reports, if their originators were of the moral disposition suspected by you, would actually need watching?

I will forgive "Sugar Boiler" his vanity shown in citing the parable of the rich man and poor Lazare for the very absurdity of it.

If "Sugar Boiler" had not formed an opinion of his own on the meaning of the term "amateur chemist" by including Ph. N.

in that "common herd," he might be referred to the 1904 report "On Manufacture of the H. S. P. A."

And if "Sugar Boiler" would read my article over again he would perhaps notice that the same was based on a broader foundation than Hawaii only, where, as Hamakers rightly says, the chemist has thus far never had elbow-room.

The present state of the sugar industry bears witness to what the technical sciences have done for it; "Sugar Boiler's" ridiculous challenge has been answered long ago in every scientific treatise on sugar.

"Sugar Boiler" does not cast a very pleasant reflection on the knowledge of those twelve chemists he has been working with, if he thinks a man with ordinary intelligence can become a chemist in at least six months. If this is his honest opinion he should seriously think of undergoing a treatment for short-sightedness.

It is unnecessary for me to rebuke "Sugar Boiler's" meaningless attack on the technical (?) engineer, as coming from an unqualified and highly biased quarter.

For my part I close the discussion, giving "Sugar Boiler" the well-meant advice: *Ne sutor ultra crepidam!*

Honokaa.

PH. NICKLAS.

SUGAR IN CUBA.

We are in receipt of Bulletin Number 2 (July, 1905) of the Estacion Central Agronomica of Cuba on Sugar Cane by F. S. Earle, and a few extracts therefrom will be of interest to the planters of Hawaii:

SUGAR CANE SOILS.

Practically all of the heavily forested lands in Cuba will produce good crops of sugar cane when first cleared for cultivation. The methods of preparing and planting new lands are much the same in all cases, but when replanting becomes necessary the different classes of soils require somewhat different treatment in order to yield the best results. The sugar cane soils of Cuba may be roughly divided into three groups, as follows: 1st, the red lands; 2nd, black lands with a white calcareous sub-soil; and 3rd, black lands with a yellow or brown clay subsoil.

The red lands:—These are found mainly in Havana and Matanzas Provinces, but they occur also in eastern Pinar del Rio and in certain areas near the coast in the three eastern provinces. This red soil has very peculiar properties. It is very sticky when wet and is heavy and difficult to cultivate, and yet it allows water to pass through it as readily as through the lightest sand.

Within a few hours after a heavy shower, if the sun shines the surface will begin to dry and it will be possible to run plows and cultivators. There is no subsoil, as the red surface soil extends down practically unchanged to the bed rock, which is always a cavernous limestone pierced with numerous subterranean passages which provide a perfect natural under-drainage. There are very few streams or rivers in the red lands, as the rain water sinks so readily into the soil and is carried off by these underground passages, finally finding a vent in great springs, many of which come out in the bottom of the sea forming the spots of fresh water which are known to occur along certain parts of the Cuban coast. The remarkable natural drainage makes these soils easy to cultivate during the rainy season, but for the same reason they become too dry for most crops during the winter, except where artificially watered. Irrigation on a large scale will always be difficult on these lands, on account of the lack of available streams, and because so much water will soak away in the canals and ditches that a large head will be required in order to cover a comparatively small area.

Taking everything into consideration, these lands are probably the most satisfactory on the island for sugar production. With good management and with favorable seasons the best black lands will yield somewhat heavier crops; and it is claimed by some that the cane from black lands is slightly richer in sucrose; but the crop on the red lands is always certain, never being injured by excessive rains, and it is always possible to give sufficiently frequent tillage to keep down the weeds. The cultivation is cheaper also, as no expensive drainage ditches are needed, and no ridging up of the rows is required, level culture being best for these lands. The red soil is well supplied with the mineral elements of fertility and, on account of its depth, it stands successive cropping for many years. No soils respond better to the use of fertilizers, and none can be built up more quickly by the growth of leguminous crops for green manuring.

Black soils with a white calcareous subsoil:—These occupy large areas in the hill regions in the northern and central parts of Havana and Matanzas Provinces. Similar soils occur also in the eastern provinces, usually where the country is more or less rolling. When first cleared, such lands are very fertile, but their hilly character subjects them to constant loss from washing during heavy rains. Their durability depends on the original thickness of the top soil, and on the steepness of the hills and the consequent degree of loss from washing. These soils are fairly permeable to water, but not nearly as much so as the red soils. On account of their more retentive character they cannot be cultivated so quickly after rains, nor, on the other hand, do they suffer so quickly from drought during the dry season. Ditching is seldom necessary except sometimes on the lower portions;

the uneven surface usually affords drainage and it can be aided by slightly ridging up the rows during cultivation. On the steeper and more broken of these lands, much of the loss from washing could be avoided by terracing or by running the rows in irregular circles following the contour lines, as is done so universally in cotton fields on the broken hill lands of the southern United States. These irregular, crooked rows seem unsightly and awkward to those who are not accustomed to them, but when properly laid out they are very effective in preventing loss from washing.

Black lands with impervious clay subsoil:—The black lands that are underlaid with a stiff impervious clay present some of the most difficult problems to the sugar planter. They are naturally very fertile, and, when conditions are favorable, they yield maximum crops. But most of these lands are quite level, and the subsoil holds the rainfall, so that the cane often suffers from lack of drainage. In wet seasons, too, it is difficult or often impossible to give sufficiently frequent cultivations to keep down the weeds. These troubles are not so obvious when the land is new, as the immense numbers of decaying roots leave the soil more or less open and porous, so that the surface water passes away more readily. With age the soil settles together and becomes more compact and impermeable. All old lands of this class will be greatly improved by establishing a carefully planned system of drainage ditches and keeping them always well cleaned. Ridging up in cultivation so as to leave deep water furrows between the rows will also be very advantageous.

PREPARATION OF THE SOIL.

In the history of a cane field there are three rather well defined periods during which the methods of preparing the soil and of tillage must necessarily vary widely. When the virgin forest is first cut down, no other preparation of the land is needed for planting cane than the burning of the fallen timber, and no subsequent cultivation will be required other than the cutting down of bushes and occasional weeds. The growing of cane on new lands or "tumbas" is well understood in Cuba and always gives satisfactory results. Such fields, when properly planted and cared for, will continue to yield profitable crops for from ten to twenty years or more according to the richness and character of the soil. * * * * * *

SYSTEMS OF CULTIVATION.

The results of many trials made in many different countries and under widely varying conditions make it seem absolutely certain that the largest crops will be harvested the first year other cane growing countries an abundant first crop is the chief object sought since the fields are plowed up and replanted every from cane in rows as close as five feet or even less. In nearly all two or at most every three or four years. Under these circumstances there can be no question but the prevailing practice in those countries is the wisest one. Here in Cuba, however, owing to our favorable soil and climate, it has been possible to keep the fields in a productive condition for a much longer period. Eight or ten and often as many as fifteen and twenty crops or even more are taken from a field before it is replanted. * * *

The existing system:—While there is considerable difference in the methods adopted by different planters, the prevailing system seems to be to plant in hills about three feet apart and to give a distance of four and a half to five feet between the rows. When the soil is properly prepared and sufficient cultivation is given, the yield at the first cutting is usually quite satisfactory, but, judging from experience in other countries, it would be still heavier if the hills were closer together in the row. After the first season no attempt is made at tillage. The trash is allowed to lie where it falls, or, if very heavy, it is opened a little over the hills and the ground is cleared by the hoe of such grass and weeds as come up through the heavy mulch. Such was the original richness and productiveness of our best Cuban lands that even with this treatment, or rather, lack of treatment, they have continued to produce profitable crops for a great number of years. As they become more hard and compact with age and the available elements of plant nutrition begin to fail, even the best of them in time show signs of exhaustion, and require replanting more and more frequently. At last they are abandoned or used only for pasturage. Almost every old mill on the island is surrounded by thousands of acres of this kind that are lying practically idle, while cane to supply the mill is brought longer and longer distances. * * * * * *

The Zayas System:—During the past few years a new system of planting cane has been ably advocated by that eminently patriotic citizen and learned physician, the venerable Dr. Francisco Zayas. As I gather from his writings and from personal conversation, the principal points for which he contends are as follows: 1st. The failure of the present system lies in the lack of cultivation for the old plantings and the inadequate tillage of the new ones. 2nd. Planting and cultivation by hand is too expensive; it is necessary to utilize implements drawn by animals (oxen or mules). 3rd. The proper and vigorous development of the cane plant depends not only upon the proper soil conditions, but upon the amount of air and sunshine it receives, since all green plants are dependent upon light for growth. 4th. Stirring the soil and exposing it to the action of the sun and air promotes nitrification and also tends to render the insoluble plant food in the soil soluble and available for plant growth. 5th. Good cane soils contain enough mineral plant food for the continued production of good crops almost indefinitely, provided it be made available by proper tillage and by supplying humus. 6th. Humus is best supplied by the use of stable manure.

The correctness of the first four of these propositions can be doubted by no one. The fifth will be accepted by some investigators but will be questioned by others. Soils vary so widely in their qualities that it is often unsafe to make broad generalizations. Some classes of soils are quickly exhausted of their mineral plant food by continued cropping, while others retain their fertility for long periods without manuring. Cane soils certainly belong to the latter class, but the question of whether or not the application of chemical fertilizers will prove profitable on a given soil can usually be proven only by an actual trial. In regard to the sixth proposition, there can be no doubt of the value of stable manure for restoring fertility. The only questions will be as to its availability in sufficient quantity and its cost as compared with the other methods for obtaining practically the same results.

The system which Dr. Zayas bases upon the above propositions consists in planting in hills at a much greater distance apart than has ever been suggested before, and in giving continued tillage throughout the year. The distance which he recommends has usually been 9 by 12 feet (3 por 4 varas), though some plantings have been made at 9 by 9 feet and some at 9 by 15 feet. He counsels the use of stable manure but of no chemical fertilizers. Another feature of his system consists in the careful saving of all canes that are not mature enough for cutting. To accomplish this he advises cutting with special chisel-shaped tool, instead of the cane knife or machete now in common use. * *

INSECTS AND DISEASES.

So far Cuba has been fortunate in escaping serious injury from any of these pests. A number of insects and diseases are known which, if accidentally introduced here, might work incalculable injury to this important crop. Importation of canes from other countries should be strictly prohibited by law except when subjected to the most rigid inspection and fumigation. The unfortunate experience of Hawaii with the imported Australian leaf hopper shows the great danger of such importations where the most thorough precautions are not taken.

The cane borer, a mealy bug, and a leaf-eating larva related to the cut-worms have been observed so far, and are being studied by the Department of Vegetable Pathology. No recommendations can be made regarding them at the present time.

EXPERIMENT STATION RECORD.

The Experiment Station Record for January, 1906, contains digests of Bulletins issued by the Department of Agriculture of the West Indies on Manurial Experiment with Sugar Cane in the Leeward Islands, 1903-4, and Seedling and other Canes in the Leeward Islands, 1903-4, as follows:

Manurial experiments with sugar cane in the Leeward Islands, 1903-4, F. Watts, et al. (Imp. Dept. Agr. West Indies, Pamphlet 36, 1905,).—Former results in this series of experiments have been previously reported (E. S. R., 16, pp. 44, 45).

This season the 36 different tests were repeated 10 times with plant canes and 8 times with ratoon canes. As in former years, the fertilizers were applied in varying quantities and different combinations. The guano, potash, and phosphate series did not give remunerative returns. The best results were obtained from the use of either sulphate of ammonia or nitrate of soda alone. The largest gain, which amounted to $8.78 per acre, was obtained from the use of 60 lbs. of nitrogen as nitrate of soda. Nitrogen in the form of sulphate of ammonia stood second, with a financial gain of $7.11 per acre.

It was further shown that the application of nitrogen all at one time gave better results than when it was divided and applied at 2 different times. The results pointed out in general that 20 tons of barnyard manure per acre without commercial fertilizers is adequate for plant canes and that ratoon canes, in addition to good tillage, require a dressing of from 2.5 to 3.5 cwt. of nitrates of soda or 2 to 3 cwt. of sulphate of ammonia per acre.

Seedling and other canes in the Leeward Islands, 1903-4, F. Watts, et al. (Imp. Dept. Agr. West Indies, Pamphlet 33, 1905,).—A summary is given of tests with plant and ratoon canes in Antigua and St. Kitt's and of experiments in the chemical selection of sugar canes, the raising of new seedlings, and in the treatment of plant tops and cuttings with germicides before planting. Ordinary cultivation was given in all tests with canes to make the results comparable with common practice.

In the plant-cane test in Antigua, Sealy Seedling ranked first in the production of sucrose in the juice with 9,914 lbs. per acre. Canes B. 156, B. 306, B. 208, and D. 95, mentioned in the decreasing order of sucrose production, ranked next to Sealy Seedling. These same varieties also stand among the first 7 in the average results for 3 years. Sealy Seedling and B. 306 ranked high in the ratoon test.

B. 393 and B. 208 stood first among the plant canes tested in St. Kitt's. White Transparent, Mont Blanc, and B. 306 appeared to be most drought-resistant, while the results with B. 208 indicated the need of a greater rainfall. In the ratoon test for the year D. 115, B. 306, and B. 208 led in the production of sucrose in the juice, and these same varieties retained the lead in the average results for 3 years, with B. 306 ranking first and D. 115 second.

As a result of using cuttings either high or low in sugar content, there was a gain of about 10 per cent. in sucrose in the cane from the high sugar cuttings over those from the low sugar cuttings. Treatment with Bordeaux mixture tended to preserve cane cuttings while in the soil and increased the number of plants grown from cuttings by 62 per cent. Tarring the ends of the cuttings gave an increase in the number of plants grown of only 34 per cent.

LEAF-HOPPER BULLETIN.

Bulletin Number 1, Part 9, of the Division of Entomology of the Experiment Station of the Hawaiian Sugar Planters' Association on Leap-Hoppers and their Natural Enemies, with copious illustrations, by G. W. Kirkaldy, has just been published. The bulletin is very technical, but the general introduction thereof is very interesting even to those who are not entomologists. Mr. Kirkaldy says:

"The Hemiptera, or Rhynchota, are readily distinguished from all other orders of insects by the structure of the mouth, which consists of a grooved sheath, usually in the form of an elongate proboscis, in which lie enclosed four setae; in some respects the Order is perhaps the most isolated of all true insects, and is certainly in many more, one of the most interesting.

As Dr. Sharp has very truly said, "there is probably no order of insects that is so directly connected with the welfare of the human race as the Hemiptera; indeed, if anything were to exterminate the enemies of Hemiptera, we ourselves should probably be starved in the course of a few months."

It is not alone the exhaustion consequent upon the rapid draining of the plant's juices by the Hemipteron's almost microscopic mouth-setae, that is so deleterious; it is the addition of the horde of fungus spores which often subsequently attack the wounded surface, and quickly multiplying, penetrate into the tissues of the plant, causing decay and death.

Here should be noted a common error among entomologists who are not specialists in Hemiptera. The probocis-like rostrum (*labium*) probably *never* penetrates the tissues, neither vegetable nor animal, unless these be already lacerated by the setae; it is simply a sheath to protect the delicate piercing organs, and more or less of a fulcrum to steady their operations.

Such injurious Hemiptera as the Chinchbug (*Blissus leucopterus*), the Bed-bug (*Clinocoris lectularius*), the Cotton Stainer (*Dysdercus sutureltus*), the Coffee-blight (*Helopeltis antonii*), the Plantlice (*Aphidae*), the White flies (*Alcyrodidae*) and the Mealy bugs and Scales (*Coccidae*), are household names and to these must be added the Sugar-cane Leaf-hopper (*Perkinsiella saccharicida*).

Six hundred million dollars would be an exceedingly conservative estimate of the values of the damage occasioned all over the world each year by the depredations of the Hemiptera, taking everything into consideration.

And one cause of this devastation is the extraordinary rapidity of increase, which were it not for restraining parasites and predators, would in a year or two leave not a single green leaf on the earth. Osborn estimates that in North America, one-fourth, if not one-half, of all the grass growing annually is destroyed by leaf-hoppers.

The calculations of Reaumur and Huxley regarding the increase of parthenogenetic Aphidae are classic; Reaumur one month, while Huxley supposed that the tenth brood alone of a single Aphid—*if all the members survived*—would contain more ponderable substance than half a million of stout men. Buckton, however, shows that this is much underestimated and calculates that at the expiration of *300 days*, the progeny of one Aphid (each Aphid producing 20 only) would be the 15th. power of 210, which is the almost inconceivable number of 17,000,000,000,000,000,000,000,000,000,000! and this, I believe, is really considerably underestimated.

In comparison with these stupendous figures, the generation of the cane leaf-hopper sinks into insignificance, but taken by itself is sufficiently serious.

It is very difficult to base calculations on this extraordinarily variable insect in respect of the number of eggs deposited, and the length of time taken for their metamorphoses, but supposing each hopper to lay only 50 eggs, (the sexes to be about equal) and there to be but 6 broods in the year, then the undisturbed progeny of one impregnated female would amount in one year to very little less than 500,000,000.

As an offset to this, there are but few beneficial Hemiptera. The predaceous Reduviidae often attack our friends and foes indiscriminately; for example it seems a matter of indifference to *Zelus peregrinus* whether it seizes the destructive *Perkinsiella* or the friendly *Coccinella*. Certain Coccidae exude merchantable wax and others provide formerly important dyes, while certain waterbugs furnish food for game and cage-birds or even to some races of man, but the total value is insignificant."

GUMMING OF THE SUGAR CANE.

(With Original Illustration in the Text.)

By N. A. Cobb.

[*Continued from January Number.*]

PART IV. OCCURRENCE. SPREADING OF THE DISEASE.

It seems probable that the disease is likely to be found wherever cane is grown, but that it is only under certain conditions that it is likely to cause a large amount of damage. It has been observed in Australia, where it was first investigated by the writer, in Mauritius, in tropical America, and in Hawaii according to verbal reports made to the writer, and according to letters from apparently good authorities. Thus far I have not myself seen a case of Gumming in Hawaiian cane.

Up to the present time observation appears to make it clear that the gumming disease is more likely to occur where the rainfall is abundant, and where the drainage is poor, especially where there is an impervious subsoil within a few feet of the surface. The one condition of drainage has a most important bearing on the prevalence of the disease.

HOW THE DISEASE SPREADS.

Reporting on this disease as it occurred on the Clarence River in New South Wales the author wrote in 1893 as follows, and sees no reason to in any way alter the conclusions arrived at at that date.

It seems evident that gumming is not a disease that is spread to any great extent through the air, as is so often the case with diseases of fungus and microbe origin. This is shown by an array of facts that cannot for a moment be overlooked. Some stalks in a stool may be badly gummed and others in the same stool be fairly healthy; part of a crop may be gummed, and the

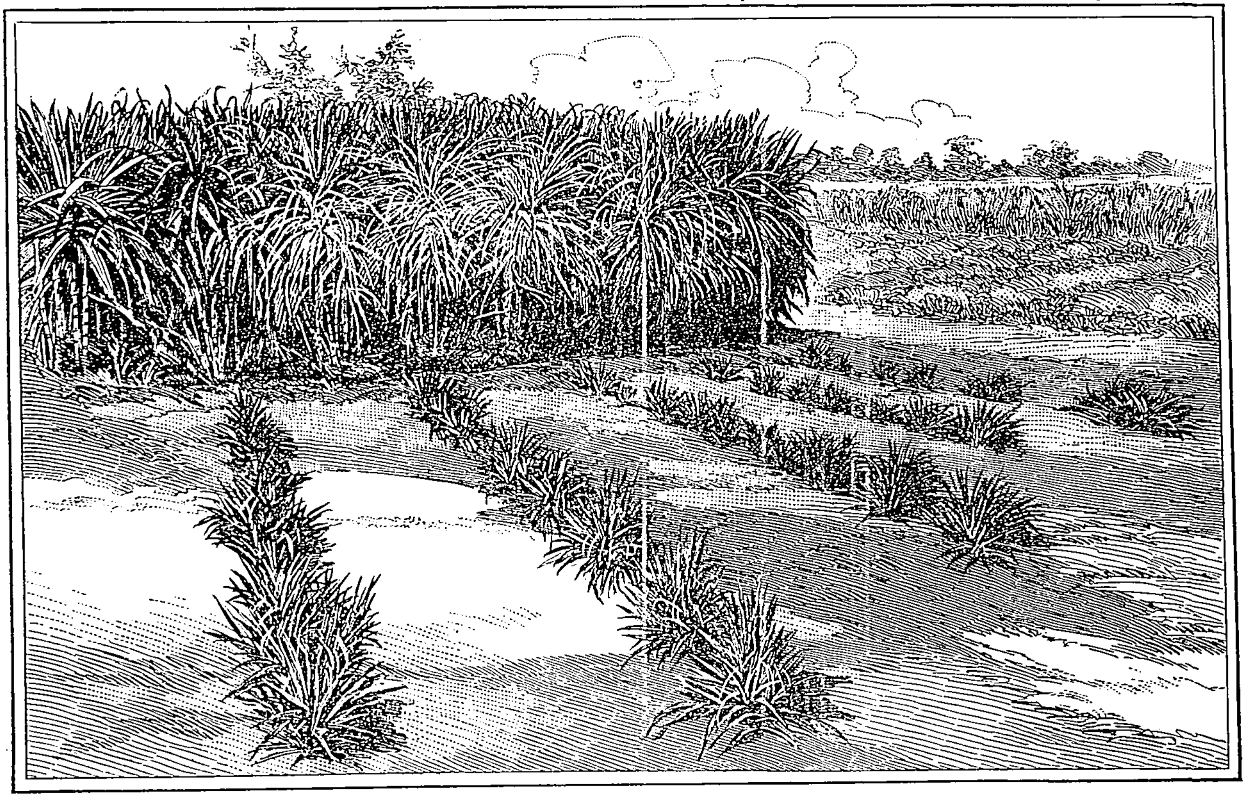

FIG. 11. Cane planted from sound and diseased cuttings. The plants in the foreground are from diseased cuttings; those in the background from healthy cuttings. The plants are all of the same age. —Drawn from a photograph.

rest remain in good condition; one field may be badly gummed, and an adjacent field perfectly healthy; the upper Clarence is comparatively free from gumming, while the lower Clarence has suffered severely for several years. All these facts are incompatible with the idea that the disease is very infectious. If healthy plants easily caught the disease by receiving the germs of it from elsewhere, borne on the wind, such a case as a healthy crop alongside a badly diseased one of the same variety would be almost an impossibility.

On the other hand, the above facts are in harmony with the idea that the disease originates with the seed,—the sets. When a disease is propagated in this manner, we expect that a crop from infected seed will be infected, or, if part of the seeds are good and part bad, some of the crop will be likewise good and the rest diseased. It is even the case that where a disease, as, for instance, smut in wheat, originates from the seed, some stalks of a plant may be much less diseased than others; thus, there may be ears bearing grain on the same wheat plant with ears whose grain is completely destroyed by smut.

But there is no necessity to rely on these analogies drawn from other crops. I was able to discover three cases on the lower Clarence in which the crops were almost a total failure on account of gumming, and where the planters, now that they know the nature and injuriousness of gumming, can recollect that the sets were badly gummed. They noticed the gum in the sets, which, when bad, is indeed very conspicuous, but not then knowing its nature, went ahead and put in the sets notwithstanding. These three cases are those of intelligent farmers, to converse with whom was to be convinced that they were quite right in their observations. In another case a farmer purposely took sets from diseased plants in order to see whether they would reproduce the disease. The disease was reproduced. I had an opportunity to examine the resulting plants, and can certify to the result.

On the other hand, on farms where the crops have been badly gummed, and in consequence almost a total failure, the introduction of sets from a district where the disease was not known to be prevalent has been followed by fairly healthy crops.

I am able to supplement these facts by others no less convincing. By carefully following up the branches of the diseased fibres at the node of the cane stalk I was able to *trace them into* *the bud,* and to *show the presence in the bud* of the *Bacterium vascularum.* From a number of examinations, I am convinced that this is generally the case, so that in planting badly gummed sets, i. e., sets out of which gum can be seen oozing, the farmer is actually *setting out diseased plants,* the bud of course being actually the new cane plant.

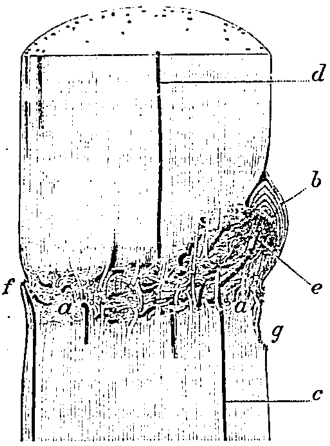

FIG. 12. Longitudinal section through the eye of a diseased cane stalk, nearly natural size. The diseased fibres are shown in darker color. It will be seen that they predominate at the node of the cane, i. e., the place on the stalk where the leaf-sheath arises. a, a, is the node, and it will be noticed that the fibres of the cane are here closely interwoven, forming a very compact and woody tissue; b, longitudinal section through tne centre of a bud or eye; e, e, a diseased fibre coming from the internode below and passing into the bud b; the bud, b, would be doomed to produce a diseased shoot; d, a diseased fibre in the upper internode· f. scar formed by the removal of trash. It will be noted that at this scar a fibre has become diseased, and the disease has ~ro~ressed downward into the internode below. The premature or careless removal of trash is responsible for many such diseased fibres.

PART V. CHEMICAL AND PHYSICAL PROPERTIES OF THE GUM.

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*Vasculin and Its Properties. Chemical Tests.

Vasculin, the substance formed by the growth of the *Bacterium vascularum* as it occurs in sugar-cane, is a yellowish, non-crystallisable, viscid substance, having an almost imperceptable acid reaction. The taste is that of a slightly soured solution of gum arabic. A short time after oozing out from the ends of cut cane by solution it converts ten times its weight of water into a fluid of the consistency of mucilage as used for adhesion purposes. Though soluble in water it is insoluble in alcohol. The addition of absolute alcohol to the raw substance converts it into a hard mass, but this is only owing to the abstraction of water; on placing the hardened mass in water it soon resumes its former consistency and appearance.

PRECIPITATION OF THE WATERY SOLUTION.

The following tests were made with watery solutions of the exudation from gummed cane. Great care was taken to procure only the growth due to the bacillus. Of course the solution tested contained an abundance of microbes, as it was found im-

*As this term is non-committal in any chemical sense, it is here retained as originally coined by the writer.

possible with the means at hand to filter them out; but there is no evidence that this fact would interfere with the reactions.

The solution was precipitated by lime water; the precipitate re-dissolved on the addition of hydrochloric acid. The solution was similarly precipitated by the hydrates of barium, strontium, potassium, and sodium, but was not precipitated by ammonium hydrate. In the case of barium, strontium, sodium, and potassium the precipitates were re-dissolved on the addition of hydrochloric acid.

Vasculin is therefore precipitated by the non-volatile alkalies but not by the volatile alkali.

Watery solution of vasculin was precipitated by lead acetate and ferric chloride, but was not precipitated by ferrous sulphate, barium chloride, or silver nitrate.

ACTION ON POLARIZED LIGHT.

The action of vasculin on polarized light was tested as follows: 628 milligrams of the air-dried gum was dissolved in ten cubic centimetres of water. It was necessary to make this quantity of solution up to 600 cubic centimetres before it became clear enough to test in the polariscope. This dilute solution was declared by Messrs. Moline and Samson to have no effect on polarized light. The same percentage by weight of cane-sugar in the solution would have given a reading of 2°. The half-length tube was used, so that this reduces to 1°, which was the lowest possible reading or limit of accuracy of the polariscope. It will thus be seen that the test was not satisfactory. The result, however, distinctly favored the conclusion that the vasculin solution had little or no effect on polarized light.

MEDICINAL PROPERTIES OF VASCULIN.

Among the most important of all the properties of any substance are its effects on the human body. I took at one dose about 100 cubic centimetres of a thick solution of the crude gum, equivalent to about 10 grams of the air-dried gum. The taste was somewhat nauseating. There followed no change of temperature, disturbance of the pulse, or other effect on the system that I could observe. We may conclude from this that vasculin has no striking medicinal properties, and that the microbe of gumming is probably harmless to human beings, when taken internally.

ACTION OF BACTERIUM VASCULARUM ON SOLUTIONS OF SUGAR.

The effect of the microbe of gumming on aqueous solutions of sugar was one that it was of prime importance to investigate.

Any reduction in the amount of sugar caused by its growth would be of consequence not only to the sugar manufacturer, but to the brewer, and those who use sugar for other industrial purposes. The microbes occur in all the products of the sugar mill, and even a slight fermentation due to its presence might be the cause of great loss, and the same might be true in the brewery using sugar derived from a mill crushing gummed cane. I according procured good samples of the gum, and having air-dried it, placed weighed quantities of it in solution with weighed quantities of pure cane sugar as follows:

On Saturday, 29th July, at 10 p. m., 457 milligrams of the air-dried gum were placed with one gramme of pure cane-sugar in 10 cubic centimetres of water, this quantity being used as approaching the percentage of sugar in cane juice. Precautions were taken against dust and accidental contaminations. On Tuesday, 1st August, at 11 a. m., the whole was tested for sugar. There was no reduction in the amount of cane-sugar. A check was kept in the shape of 1 gramme of sugar dissolved in 10 cubic centimetres of water. This also remained unchanged.

This experiment was repeated with even greater precautions, but with the same result. There was no reduction of the amount of sugar due to the presence of the microbe.

THE AMOUNT OF SUGAR IN GUMMED CANE.

In selecting the specimens for the following comparative analyses I took great pains. I secured seven badly-gummed canes and seven canes nearly, but not entirely, free from gum, both lots from the same crop. Every precaution was taken to have the two lots as nearly alike as possible, except in the matter of gum. In this latter respect the one lot contained much gum and the other only traces. It was found necessary, in order to match the gummed specimens in ripeness and color, to use for the second lot cane that appeared over-ripe. There were no canes in the crop that were entirely free from gum. The canes of the two lots were matched in pairs, one of each pair being gummed and the other, practically speaking, not. Of a pair, each specimen had the same length and number of joints and they were of the same diameter, and were taken from the same part of the cane, and neither was allowed to show traces of any other disease than gumming. In a word, every precaution that could be thought of was taken to have the samples vary in but one respect, namely, the presence of gum. The analytical results were obtained by digesting the chopped up cane in the usual manner, and were as follows:

Analyses of very slightly and badly gummed cane for comparison.

	Very slightly gummed.	Badly gummed.
Per cent of cane sugar....	12.50	10.50
Per cent of fruit sugar....	.82	.88
Per cent of other organic matter and soluble ash..	1.91	2.36
Per cent of total solids....	15.23	13.74
Quotient of purity........	82.1	76.4

Some of the same chips were pressed by hand, and the juice thus expressed was tested for sugar, with the following results:

	Very slightly gummed.	Badly gummed.
Percentage of cane sugar..	14.90	11.50

The raw juice squeezed out by hand having stood 48 hours was tested with decinormal solution of sodium hydrate.

	Very slightly gummed.	Badly gummed.
100 cubic centimetres required of n|10 Na OH...	3.8 cubic centimetres	3.2 cubic centimetres

CONCLUSIONS DRAWN FROM THE RESULTS OF THE CHEMICAL TESTS.

These various tests to which the gum was submitted lead to several important conclusions.

First, the fact that hydrate of lime precipitates the gum from watery solution and from cane juice, shows that the present practice of precipitating the organic matters in the juice as it comes from the rollers, has the effect of getting rid of any gum that may be present in the juice from gummed cane in the feed. This is an important fact inasmuch as if this were not the case and the lime failed to precipitate the gum, the presence of so much organic matter in the juice would interfere seriously with the boiling and crystallization. Where cane is being used part of which is gummed, the amount of organic matter in the juice will certainly vary much from hour to hour and even from minute to minute, and consequently the regulation of the supply of lime to such juice needs special attention to secure the best clarification. It seems quite likely that it is a failure to give this special attention to the clarification that has given rise in some sugar mills to a most serious loss of sugar owing to lack of crystallization in the jellies. Beyond doubt juice containing much gum is more difficult to clarify. In some cases the most careful addition of lead acetate fails to completely clarify such juice. Lime has a similar limit in its clarifying action. There is good reason to believe that this lack of clarification is not due to a failure to precipitate all the vasculin, but to a failure to precipitate the microbes. In the mill these certainly go on. I have seen the *Bacterium vascularum* in every product of the mill while it was handling gummed cane. The presence of microbes in the jellies may mechanically prevent crystallization, or even by their growth cause other deleterious disturbances. The only present remedy for such a state of things is great care in the clarification. The sharper and more complete the precipitation of the organic matter is, the more microbes it will remove mechanically included in the precipitate. If the subsequent growth of the microbes is possible, which seems not to be the case judging by their action on pure sugar solutions, it may be that superheating the juice would sterilize it and so avoid the difficulty. This would be a problem for the engineer, but it is one that in the present state of our knowledge of the question it would be unwise to take up. It might be worth trial to handle gummed cane by itself, giving special attention to the clarification, or at least where there are two crushers, to feed the gummed cane to only one, and regulate a separate supply of lime to the gummy juice.

I observed that the sooner gummy juice was clarified the more perfect was the result, and I believe that if the lime could be added to such juice immediately after the cane has passed the first rollers, it would be a distinct gain, apart from preventing inversion by the gain in time.

The second fact of importance brought out by these tests is the low percentage of sugar in gummed cane. Even where the crop grows sufficiently well to be marketable, the percentage of sugar is much less than it otherwise would be. Its market value is therefore, so much the less; and this loss must be *subtracted from the margin of profit,* for it costs just as much in every way to raise a crop of gummed cane, or to convert it into sugar afterwards, as to do the same for a sound crop.

The third fact of importance is that the raw sugars from mills using gummed cane may be used with impunity by brewers. They need not fear that by using it they will introduce into their vats an organism that will interfere with the fermentations, for I have shown that the *Bacterium vascularum* is not one that acts, to any deleterius extent, on sugary solutions, even where they contain starchy matter.

PART VI. REMEDIES AND PREVENTATIVES.

1. *Sets.* First in rank among the measures to be taken against gumming is care in the selection of sets. All other precautions will be in vain if gummed sets are planted. "Anything is good enough for seed,"—that has been one of the banes of farming. I fear that it has not been without its pernicious effect on cane plantations. "No sugar-boiler will take that piece there, —better cut it for plant-cane." Has the cane-planter ever been

guilty of this thought? Let him answer for himself. In some cases I fear his crops answer it but too plainly for him.

Sound sets are easily procured. Any cane-planter can easily qualify himself to select them. Let him simply familiarize himself with the appearance of healthy cane, and then use no other for plant-cane. Of course selected sets will cost more labor or more money; but both will be wisely spent, and will be returned manifold at harvest time.

To select sets free from gumming proceeds as follows:—Select a clean shady place and use a sharp knife (as sharp as a razor if possible), and cut the cane into sets. Cut the stalks into sets from the top downwards, and endeavour to cut nearer to the joint further away from the hand. I make this recommendation because the shock of cutting shatters the cane on the side away from the cutter, as can easily be seen on examining some cuttings. This shattering injures the resulting sets less if the cut is made as directed in the writer's Bulletin on the "Inspection and Disinfection of Cane-cuttings." The inspection will be much easier and more thorough if the stalk is given a half turn with the left hand after each cut; both ends of a set can then be inspected easily as both will face up at the same time. As the sets are cut they should be stacked in long piles with the cut faces upwards. After half an hour or so, or more if in the shade, the sets may be inspected and any gummed sets easily detected and picked out. The inspection will be unsatisfactory unless the cuts are clean, and it will be useless to attempt the cutting with anything but a thin specially-sharpened knife. By following this method any planter who has a fairly good crop may get sets fairly free from gum.

2. *Drainage.* Good drainage decreases the loss due to gumming as well as that due to other diseases.

3. *Burning the Trash.* When land is kept continuously under cane it is highly desirable to thoroughly burn the trash after each cutting. This destroys a vast number of germs,—not only those of gumming, but of many other diseases, as well as the eggs and grubs of destructive insects. This is a common practice is our cane districts, and to it no doubt they owe some of their freedom from disease.

4. *Land itself* contains many of the germs of disease,— that is to say, after the crop has stood on it for some length of time. Consequently, if one crop is followed by another of a different sort not subject to the same diseases, there will be less loss from disease than where land is kept continually under the same crop. Whether this rotation of crops is advisable depends on the markets that are available. In the absence of rotation, a bare fallow once in every few years does much good, both in renewing the fertility of the soil and allowing diseases to run out, especially if the fallow land is frequently stirred with harrows.

5. *Seedlings.* Where a crop is derived from cuttings from a previous crop, and not from seed, unless great care is used there is a gradual decadence in the quality of the crop; the variety runs out, as the saying is. This running out of varieties is often much more noticeable in crops like cane and potatoes than in crops derived from true seed.

Of late years considerable attention has been given to producing new varieties of cane by raising seedlings. Though the sugar-cane as it grows in Hawaii, produces, when allowed, a great quantity of seed-flowers, it appears, so far as my inquiries have extended, to produce very little fertile seed, so that considerable trouble has to be taken to produce seedlings. That it can be done has, however, been shown by Mr. C. F. Eckart, who has produced such seedlings. It is certain that varieties that have run out may be renewed or improved by raising seedlings from them. This is a line of experiment that is within the power of any cane-farmer, and one which is promising enough to be worthy of much attention.

It is difficult to tell young seedling canes from grass-seedlings. On this account I would recommend that the seeds of cane be first sown in boxes of carefully baked soil. The baking will kill all grass-seed and other seed contained in the soil, so that whatever comes up after sowing cane-seed on such soil may be set down at once as cane. The seed should be sown on the surface, or be but slightly covered, and the soil should be kept moist and shady, during germination.

6. *Improving by Selection.* While it is true that under ordinary care varieties of cane tend to run out, it is true that by extraordinary care the same varieties may not only be kept up to their standard, but improved. By systematically growing the same variety year after year, and carefully selecting only the very best for planting, a given variety may be greatly improved, and as far as we know there is no limit to the amount of this slow improvement. This should excite endeavor to use this simple method of making progress, and in fact does do so. The matter is mentioned here only because, in spite of the obviousness of the plan, it seems to be almost entirely over-looked by some cane-growers.

By selection cane can be slowly improved in almost any direction we like,—made to yield more to the acre, made richer in sugar, made hardier, made taller or shorter, softer or harder, in fact, as said, slowly improved in any way we wish.

7. *New Sorts.* There are plenty of sorts of cane grown in other countries that are unknown in Hawaii. The advisability of their introduction is beyond question, and the Hawaiian Sugar Planters' Association has done good work in importing some of these varieties under the proper restrictions. It is quite probable that the majority of the varieties introduced may prove inferior to those already grown here, but it is possible that some of them may prove superior, and this possibility should move every cane-grower to be not only willing but anxious, to give them a trial on a small scale.

8. *Nurseries.* A number of Hawaiian cane-growers have established near their houses, nurseries, in which they carry out recommendations 5, 6, and 7. The plan is highly to be commended.

9. *Selection of Disease-Resistant Sorts.* This is a subject that needs an essay by itself. I am convinced that one of the greatest improvements destined to be made in agriculture is in the line of securing pest-resisting varieties. We stand as yet but on the threshold, yet we can clearly see the alluring prospect. What we now possess in a few cases, having obtained them almost by accident, shows how on the alert we should be to discover varieties as little subject to disease as possible.

* * * *

The efficiency of the foregoing measures has stood the test of time. They were devised to meet the needs of a region where the gumming disease was such as to seriously threaten the profits of the cane industry. The light thrown on the matter by the investigations and the consequent measures taken against the disease so reduced the ravages of the pest that at the present day, thirteen years later, the disease excites no alarm, and, in many parts of the district formerly severely smitten, is now a rare occurrence. This result has been brought about largely through the inspection of the cuttings and through the introduction of new and more resistant varieties.

In one of the districts where it was formerly prevalent the manager of the mill that takes the larger part of the cane of the district informs me that the disease is now so rare that it has to be carefully searched for to be found. In another of the smitten districts statements from similar authority indicate that, while the disease is not rare, it no longer excites fear, and that the losses are comparatively trifling.

CONCLUSIONS.

1. The disease first discovered in Australia and called the Gumming of the Sugar Cane is a very distinct disease, and is caused by the microbe *Bacterium vascularum* (Cobb) Greig-Smith.

2. Though the course of the disease is somewhat slow, it is often fatal, and may be the cause of most serious losses to the sugar industry in districts where it prevails.

3. The disease is most readily recognized in marked cases by the oozing out on the ends of fresh cuts of a yellowish gum or slime in small droplets, which appear first on the ends of the fibres, but finally often run together into larger drops.

4. The disease is one more particularly connected with the vascular bundles or fibres of the cane, but may extend in some cases to the parenchymatous tissue, more particularly at the base of the arrow, there causing a kind of top-rot characterized by the presence of much slime in cavities near the top of the stalk,—cavities sometimes containing as much as a teaspoonful of gum.

5. Different varieties of cane vary remarkably in their susceptibility to the disease, some varieties being practically immune.

6. The disease is one that appears to be easy of control through the selection of sound sets or cuttings, and through the use of resistant varieties.

7. The disease is one that is *particularly liable to be transmitted from one country to another* through the medium of slightly diseased cuttings, as the amount of gum in such cuttings is too small to be noticed except through the agency of microscopic examination.

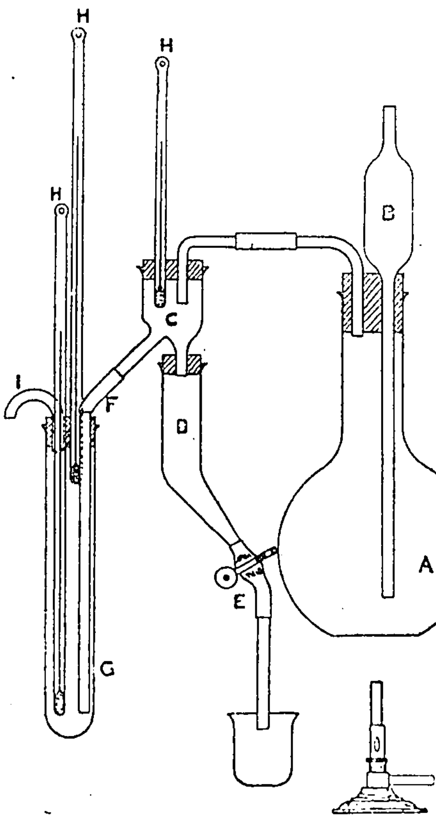
A B

FIG. 1. Two canes, from different stools, to show the effect of root disease on growth, from a photograph. These canes are of the same variety, and were taken from the same row, so that they were grown under identical conditions: they were between three and four months old. The cane on the right (B) is badly attacked by root disease, while that on the left (A) is only slightly attacked. (It was impossible to find a perfectly healthy cane for comparison.) See pages 10 and following.

THE TEMPERATURE OF SOLUTIONS HEATED BY OPEN STEAM.

BY THOS. STEEL, F.C.S., F.L.S.

The fact that it is possible to heat solutions by means of open steam to temperatures higher than that of the steam itself does not appear to be so well known as its interest and importance warrant. I have not seen any direct reference to this point in works on physical subjects, and, indeed, am only aware of two references thereto in literature. The first allusion with which I am acquainted is in Report of the British Association, 1869, Trans., 75; and 1870, Trans., 64, where Peter Spence records his accidental discovery of the phenomenon and gives results of a series of laboratory experiments on the determination of the b. pt.



of saturated solutions of various salts by blowing in steam at 100° C. Spence gives no explanation of the cause of the phenomenon but contents himself with recording the results of his experiments. The other reference to the matter occurs in a recent publication, Zeits. Ver. Deuts., Zucker-Ind., 1904, 1159, in a paper by H. Claassen on the "Boiling Point of Sugar Solutions." In this paper Claassen points the fact out clearly and gives a brief theoretical explanation.

It is my purpose in the present paper to give a description of an apparatus which I have used, with details of some illustrative experiments, and to explain the theoretical considerations governing the phenomenon under discussion.

In the accompanying illustration of the apparatus used, A is a 32 oz. flask fitted with a 100 c. c. pipette; B is a safety tube; C is a tube for removing water from the steam and allowing the temperature of the latter to be observed; D is a tube in which condensed water may gather; E is a rubber joint fitted with a spring clip, connecting to a tube leading to a small beaker placeo beneath; F is a rubber joint connecting the tube which leads the steam into the large test-tube G; H, H, H, are thermometers; and I is a tube for carrying off surplus steam. When the apparatus is in use C is wrapped round with a piece of cotton wool, while the tube G is inserted into a cylinder packed with the same insulating material. The water in the flask A is boiled, the clip at E being left open until the apparatus is warmed up and steam issues freely. As water accumulates in the tube D during the course of the experiments it may be discharged by opening the clip. On placing a solution in the tube G, and allowing the steam to pass through it, the temperature will rise steadily until a point is reached at which it will remain for a time, and then gradually fall. If the steam be allowed to escape at any moment by opening the clip at E, and the tube G be removed with its fittings in place, and heated to boiling over a lamp, the temperature reached will, as a rule, be very little higher than that which was attained by means of the steam. In many cases, by having a quantity of the powdered salt present so as to keep the solution in a saturated state, the b. pt. of a saturated solution, or a temperature very near that point, may be readily reached and maintained. Under the condition of my experiments the steam passing through the tube C has a temperature of 99.0° which rises to 99.2° or 99.3° when subjected to the hydrostatic pressure in the tube G. The steam escaping from G has a temperature of 99.0°. Some scraps of platinum foil or bits of porous clay pipe are in all cases placed in the solutions for the purpose of promoting steady boiling.

In the following table the temperatures attained by some nonsaturated solutions, when heated by steam under the above conditions, are stated, as also the temperatures at which the same solutions boil when heated over a lamp:

NON-SATURATED SOLUTIONS.

	Boiling Temperatures. With Steam.	Over Lamp.
Disodium phosphate	103.0	103.5
Sodium carbonate	104.2	104.5
Potassium nitrate	105.5	106.5
Ammonium chloride	111.5	112.5
Sodium acetate	112.5	114.0
Sodium nitrate	117.5	118.5
Potassium acetate	147.0	152.0
Calcium chloride	149.2	150.0
Ammonium nitrate	155.0	156.0
Ammonium nitrate (stronger)	163.0	164.0

It will be noticed that in all cases the temperature reached by heating over the flame is somewhat higher than that attained by means of steam. The temperatures attained by the various solutions depend, of course, on the concentrations. With a strong solution of ammonium nitrate steam at atmospheric pressure is competent to raise the temperature to 163°. In carrying out this experiment steam was passed direct into moist ammonium nitrate, and the temperature mentioned was quickly reached in spite of the fact that there is a considerable cooling effect when this salt is dissolved.

Saturated solutions, as I have before mentioned, may be tested in the same way, by having a quantity of the powdered salt present in the hot solution. In the next table are given the temperatures attained by the use of steam with saturated solutions of a number of salts, and, for comparison, the b. pt. of the same solutions as obtained by heating over the lamp and also as published in Watts' Dictionary of Chemistry, and elsewhere.

SATURATED SOLUTIONS.

	Boiling Temperatures. With Steam.	Over Lamp.	Boiling Points.*
Potassium chlorate	103.3	103.5	104.2
Zinc sulphate	103.5	103.8	104.4
Sodium carbonate	105.2	105.5	104.6
Potassium chloride	108.0	108.2	108.3
Sodium chloride	108.0	108.2	108.4
Potassium nitrate	114.0	115.0	115.9
Ammonium chloride	114.0	115.0	114.2

* The b. pt. of a saturated solution of zinc sulphate is by Griffiths and is given in Comey's Dictionary of Chemical Solubilities, p. 459, that of potassium chloride is the figure found by Legrand and quoted in Clarke's Rules, Tables and Data, p. 369; all the others are given on the authority of Legrand in Watt's Dictionary of Chemistry, vol. iii., p. 89.

As is the case with non-saturated solutions the temperatures reached by the use of steam are somewhat lower than those obtained by boiling over the lamp, while the latter figures are sometimes higher and sometimes lower than the published b. pts. for saturated solutions of the salts experimented with. In this connection it should be explained that the salts used by me were the ordinary commercial ones sold by reputable dealers for laboratory use.

When dealing with very soluble substances such as calcium chloride, the solubility of the salt prevents saturation being reached. When steam is blown into granular calcium chloride, a solution is formed having a temperature of 149.2°, while by heating over the flame this solution boils at 150°. If a saturated solution of the same salt is prepared by stirring powdered calcium chloride into the above solution kept boiling over a flame, the pasty mass formed boils at 175°. If now the tube containing the hot saturated solution be quickly placed in the lagged holder, and steam passed in, the solution does not remain at the same temperature, but steadily cools. If the steam be now turned off, the contents of the tube allowed to cool somewhat, and steam again turned on, the temperature rises to a few degrees below the point at which it stood in the first instance. With ammonium chloride, treated in the same manner, the steam merely passes through and does not form a solution, consequently the contents of the tube do not rise above the temperature of the steam itself. On adding a little water, a saturated solution is formed which becomes heated to a temperature of 114.0°, or only 0.2° less than the b. pt. for a saturated solution of this salt given in Watts' Dictionary, while on heating over the lamp it boils at 115.0°, which is 0.8° higher. A saturated solution of zinc chloride is stated in Watts' Dictionary to boil at 172°. With the apparatus described it is possible, by starting with the powdered salt into which steam is passed direct, to heat a saturated solution in which is suspended an excess of the salt, as high as 177°. Doubtless in this case the heating effect is aided by the heat of solution of the zinc chloride.

The theoretical explanation of the results of the experiments above described is comparatively simple. When water is heated the pressure exerted by its vapour increases until, on the attainment of b. pt., it equals that of the atmosphere. The boiling point of any solution under ordinary atmospheric conditions, is that temperature at which its vapour pressure is equal to the pressure of the atmosphere. The effect of the solution in water of any substance such as a salt, is to reduce the vapour pressure of the liquid and hence to raise the temperature to which it must be heated before it will boil. It thus comes about that saline solutions have b. pts. higher than that of water. Now when steam at the boiling point of water is passed into a saline solution, the vapour pressure of the steam being equal to that of the atmosphere, but greater than that of the solution, the steam condenses in the solution and continues to do so as long as the latter has a lower vapour pressure, or in other words, so long as the solution is not at boiling point. When this point is reached the steam merely blows through the liquid, a sufficient quantity condensing to replace the heat lost by radiation, etc. It is to the liberation of the latent heat of the steam on condensation, that is due the heating effect which we have been considering. When we reflect how great is the amount of this latent heat (some 537 calories for each cubic centimeter of water condensed from steam) we can readily understand why such striking thermal effects are produced.

The fact of condensation taking place causes dilution of the solution with consequent reduction of b. pt., unless a supply of the solid salt is maintained so as to keep the solution constantly saturated.

Taking into consideration all the facts, in my opinion the temperature to which a solution is heated by steam is a truer measure of its b. pt. than that obtained by the application of direct heat. It is well known that the temperature of boiling water varies within quite considerable limits according to the nature of the vessel in which it is contained, and the b. pt. of liquids other than solutions of solids, is always determined from the temperature of the vapour. It is equally well known that saline solutions are very readily superheated when boiled over a flame, and it is highly probable that the b. pt. determined in this way will tend to be too high.

When alcohol of sp. gr. 0.816 is placed in the tube and steam injected, condensation takes place until the liquid becomes heated to boiling, and when this point is reached the liquid has a temperature of 79.1°, that of the escaping vapour being 78.1°. This difference is due to the fact that the vapour is richer in alcohol than the liquid, and accordingly, having a higher vapour pressure, comes away at a lower temperature. The fact that the water vapour escaping from a boiling saline solution has the same temperature as that from boiling water, is due to the same cause.

While experimenting on heating saline solutions with steam, it is interesting to observe the effect on the thermometer placed in the vapour space of the boiling-tube, when, through splashing, its bulb becomes covered with the saline solution. When a saturated solution of a moderately soluble salt is under observation and a portion of the liquid carrying particles of the solid salt splashes on to the thermometer bulb, the temperature at once rises to and remains at the same point as the boiling liquid itself. The film of saturated solution on the bulb, being enveloped in steam at 99°, behaves precisely like the mass of solution and maintains the thermometer at the b. pt. of the solution. Sodium chloride shows this extremely well.

The condensation of water from the atmosphere on particles of substances like sugar or salt, when the air is laden with moisture, is due to the same cause, the difference in vapour pressure of the film of solution adhering to the salt, and that of the moisture in the atmosphere, transference of water vapour always taking place in the direction of least vapour pressure. This was originally termed "invaporation" by Graham, who experimented with saline solutions in air saturated with water vapour, and determined the rate of condensation in the solutions. ("Edinburgh Jour. of Science," 16, 1828, 249. Report British Association, 1886, 207.)

In the course of some of my earlier experiments I used a vessel of boiling water in which to place the tube containing the solution under observation, but I quickly found that, far from being as efficient as the cotton wool lagging subsequently used, the boiling water actually cooled the tube.

A knowledge of this property of steam whereby solutions are heated to temperatures considerably above that of the steam itself, may be of practical importance in chemical industries where saline solutions require heating to temperatures greater than 100°. Again, in some cases, as for instance, in the course of operations in the manipulation of sugar and other organic substances, considerable over-heating may readily occur through the mistaken idea that the temperature of the steam used determines the limit of heating possible.

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Sugar Plantations, Cane Growers and Sugar Mills.

ISLAND AND NAME.		MANAGER.	POST OFFICE.
OAHU.			
Apokaa Sugar Co.	*	G. F. Renton	Ewa
Ewa Plantation Co.	*	G. F. Renton	Ewa
Waianae Co.	***	Fred Meyer	Waianae
Waialua Agricultural Co.	*	W. W. Goodale	Waialua
Kahuku Plantation Co.	x*	Andrew Adams	Kahuku
Waimanalo Sugar Co.	**	G. Chalmers.	Waimanalo
Oahu Sugar Co.	x	E. K. Bull	Waipahu
Honolulu Plantation Co.	**	J. A. Low	Aiea
Laie Plantation	x*	S. E. Wooley	Laie
MAUI.			
Olowalu Co.	**	Geo. Gibb	Lahaina
Pioneer Mill Co.	x	L. Barkhausen	Lahaina
Wailuku Sugar Co.	**x	C. B. Wells	Wailuku
Hawaiian Commercial & Sug. Co.	x*	H. P. Baldwin	Puunene
Maui Agricultural Co		H. A. Baldwin	Paia
Kipahulu Sugar Co.	x	A. Gross	Kipahulu
Kihei Plantation Co.	x*	James Scott	Kihei
HAWAII.			
Paauhau Sugar Plantation Co.	**	Jas. Gibb	Hamakua
Hamakua Mill Co.	*x	A. Lidgate	Paauilo
Kukaiau Plantation	x	J. M. Horner	Kukaiau
Kukaiau Mill Co.	*x	E. Madden	Paauilo
Ookala Sugar Co.	**x	W. G. Walker	Ookala
Laupahoehoe Sugar Co.	*x	C. McLennan	Papaaloa
Hakalau Plantation	**	J. M. Ross	Hakalau
Honomu Sugar Co.	**x	Wm. Pullar	Honomu
Pepeekeo Sugar Co.	**x	Jas. Webster	Pepeekeo
Onomea Sugar Co.	**x	J. T. Moir	Hilo
Hilo Sugar Co.	**	J. A. Scott	Hilo
Hawaii Mill Co.	x	W. H. Campbell	Hilo
Waiakea Mill Co.	*x	C. C. Kennedy	Hilo
Hawaiian Agricultural Co.	**x	Wm. G. Ogg	Pahala
Hutchinson Sugar Plantation Co.	**	Carl Wolters	Naalehu
Union Mill Co.	*x	H. H. Renton	Kohala
Kohala Sugar Co.	*	E. E. Olding	Kohala
Pacific Sugar Mill	x**	D. Forbes	Kukuihaele
Honokaa Sugar Co.	x**	K. S. Gjerdrum	Honokaa
Olaa Sugar Co.	xx	J. Watt	Olaa
Puna Sugar Co.			Kapoho
Halawa Plantation	x*x	T. S. Kay	Kohala
Hawi Mill & Plantation	‡‡	John Hind	Kohala
Puako Plantation	‡‡	W. L. Vredenburg.	S. Kohala
Niulii Sugar Mill and Plantation	*x	Robt Hall,	Kohala
Puakea Plantation	*x	H. R. Bryant	Kohala
KAUAI.			
Kilauea Sugar Plantation Co.	**	A. Moore	Kilauea
Gay & Robinson	x*x	Gay & Robinson	Makaweli
Makee Sugar Co.		G. H. Fairchild	Kealia
Grove Farm Plantation	x	Ed. Broadbent	Lihue
Lihue Plantation Co.	x	F. Weber	Lihue
Koloa Sugar Co.	x	P. McLane	Koloa
McBryde Sugar Co.	*x	W. Stodart	Eleele
Hawaiian Sugar Co.	x*	B. D. Baldwin	Makaweli
Waimea Sugar Mill Co.	*	J. Fassoth	Waimea
Kekaha Sugar Co.	x	H. P. Faye	Kekaha

KEY.	HONOLULU AGENTS.	
*	Castle & Cooke	(5)
**	W. G. Irwin & Co.	(8)
***	J. M. Dowsett	(1)
x	H. Hackfeld & Co.	(9)
*x	T. H. Davies & Co.	(8)
**x	C. Brewer & Co.	(6)
x*	Alexander & Baldwin	(6)
x**	F. A. Schaefer & Co.	(2)
x*x	H. Waterhouse Trust Co.	(2)
‡‡	Hind, Rolph & Co.	(2)
xx	Bishop & Co	(1)