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The Crop of 1904. The tonnage of this crop is now estimated at 384,050 short tons. The estimate of 395,000 tons given last month has been shown to be an error. While it is possible that final returns will show this estimate is too high, it is likely that this tonnage will be attained; a number of the smaller plantations have ceased grinding, and the season is so far advanced on other plantations that the tonnage can be more accurately estimated than has heretofore been the case.

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Mole Cricket. We publish in this issue a Bulletin of the Porto Rican Experiment Station on the "Changa" or Mole Cricket. The mole cricket has been known here for many years and has done some damage to the cane. At Ewa, Mr. Renton calls attention to the fact that the mole cricket destroyed an acre or more of cane of last years' crop, which, of course, on such a large plantation amounts to but very little; and Mr. Ahrens at Oahu also calls attention to the depredations of this pest.

It is for the purpose of enabling planters and others to become familiar with the habits and characteristics of the insect that the bulletin is now published. While the damage thus far done by the cricket is very slight compared with the losses resulting from the leaf-hopper, in view of the injury which is annually done to the crops at Porto Rico by the cricket, and in view of our experience with the leaf-hopper which has been with us for years, but only within the last few years epidemic, no time should be lost in devising ways and means to rid the plantations of the mole cricket.

In Porto Rico the Changa is considered one of the greatest obstacles in the way of successful agriculture; it seems especially fond of cane and rice and the damage done amounts to over one hundred thousand dollars per annum.

Disease Resisting Canes. A great deal is being done in other sugar-growing countries to obtain improved varieties of canes which will be as nearly immune to disease as possible, and which will also yield a fair percentage of sugar. We know of no special experiments along such lines being carried on here; but it is well known that in some localities the Yellow Caledonia resists the attacks of leaf-hopper and the fungus diseases which follow, to a far greater extent than Lahaina. And now, that we seem to be passing through an epoch of cane diseases, fungus and otherwise, and of invasions of injurious insects, it is of importance to ascertain those varieties of cane which have the greatest disease resistant power, and if practical to substitute such varieties for the weaker canes. Some of the canes now largely planted, Lahaina for instance, are rich in sucrose, but easily succumb to the attacks of the leaf-hopper and other pests and diseases, and it is a question whether, notwithstanding the higher yield obtained from such canes, it would not be well to discard these for a cane less rich, but hardier and disease resistant.

In many cases it is found that it is not so much the leaf-hopper which causes the death or decay of the canes as it is the diseases which fasten to the cane after the attacks of the hopper. For instance, the rind disease gets a start from the puncture of the hopper in the stalk of the cane. Mr. Perkins has enumerated a number of diseases now epidemic here, which he says owe their recent rapid spread to the abundance of leaf-hopper; such diseases have been known to the country for a number of years but have never before been epidemic. He calls attention to the following: Cane spume, so-called by Dr. Cobb of Australia; the pine-apple disease, the rind disease, root disease, top-rot and various forms of fungus disease.

To a very great extent we depend upon the entomologists to discover and import parasitic insects which will destroy the leaf-hopper and the mole-cricket, aphis and such pests, but there would certainly be no harm in endeavoring to obtain hardier and disease resistant varieties of cane which if not entirely immune from the attack of some of the various bugs will at least aid the entomologist in his work.

In the West Indies they have a great many cane diseases, some of which we are not afflicted with; and for many years experiments have been carried on with disease-resistant varieties of cane with marked success. They have thus secured immunity from the Rind disease and they have reason to believe that other diseases will be successfully combated by this method. They have demonstrated that the Bourbon (Lahaina) cane is particularly susceptible to the rind disease and have been forced to discard it for other, more resistant varieties. The root disease which during the past few years has there caused a vast amount of damage, seems to attack equally well all varieties of cane, but they have by no means given up this method of fighting the disease, believing that in time a varietiy of cane will be found which will solve the problem.

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Communications.

COST OF PRODUCTION IN CUBA.

Editor of Planters' Monthly:

Desirous of contributing my mite to the sugar literature of the most advanced and progressive sugar country in the whole world—and the one whose developments I watch with the greatest interest—I send you the translation of an article upon the cost of production in Cuba, published by "El Comercio" of Cienfuegos, which, as its name indicates, is the commercial paper of that city. As I have seen no exception taken to its data, it is presumably correct, and I therefore suppose it may be of some interest to your readers, as a basis for comparison. The prices are all in Spanish gold, usually at from 9 to 10 per cent. discount. It reads as follows:

"Let us suppose a central factory, whose output is fifty thousand sacks. The major part produces much more; but this type is preferable, because its net yields in money are smaller relatively than those of greater size, in which the general expenses, that are the same or slightly higher, are distributed over a larger output.

"Let us see, then, what it costs, or ought to cost, a factory of this class to put a sack of sugar in the warehouse at the place of shipment, basing it upon a price of 4½ reales the arroba (25 lbs.), or, say, $0.5312 cts.

"A boiling house under proper direction ought to yield approximately 11 per cent. of sugar, including first and second products, but that our calculations may be less vexatious, we will suppose that the whole crop of 50,000 sacks be of first sugars, reducing the yield to 10 per cent. in order that the deduction may compensate the difference of price in the two products.

"Upon this basis, if a sack weighs 13 arrobas (325 lbs. usual weight) the manufacturer must acquire from his 'colono' (tenant farmer) 130 arrobas (3,250 lbs.) of cane, delivered at the railroad track, in order to produce it, and this will cost him at the price of 4¼ reales, 5½ arrobas of sugar for 100 of cane—or $3.7984-37. The loading of these 130 arrobas of cane will cost ten cents each, which we put in gold, although this amount is generally paid in silver (at 20 to 25 per cent discount.)

"The hauling of this cane by rail should not cost in any case, even when the road belongs to the factory (and all its expenses, including interest and amortization of the money invested in this auxiliary, are carried in a separate account) over 25 cents. We know of estates where it does not cost them 18 cents. The cost then of the 130 arrobas (haulage) will be $0.3250 cents.

"The Administrator (Manager) of a central factory, who spends more than 80 cents to grind, defecate, evaporate, 'centrifugate' and fill one sack of sugar, ought to vacate his post; however, allowing for time lost in stoppages, breakdowns, and bad weather, we will allow $1, which will also cover taxes and the general yearly expenses of the estate.

"The transportation of a sack from the centrifugal house to the ware house at the port of shipment, ought not to cost more than 40 cts. and there are innumerable estates where, selling for cash, it does not cost them even 20 cts. Finally, storage at the port of Cienfuegos—the district for which these calculations are made—costs only 10 cts. per sack.

"To resume: For the manufacture of one sack there is expended:

"For cane	$3.798437
" Loading	0.130000
" Haulage	0.325000
" Manufacture	1.000000
" Empty sack	0.200000
" Freight	0.400000
" Storage	0.100000
Total	$6.953437

"Multiplying the cost of one sack by 50,000, we have $302.-671.87.

"Let us see now the product:

"One sack of 13 arrobas at $0.53125 gives	$	6.90625
Cost of sack		0.50000
	$	7.40625
And 50,000 sacks		$370,312.50
Less		302,671.87
Remaining	$	67,640.63

"Now a central factory with a capacity of 50,000 sacks is not worth, nor can it be worth, more than $25 per sack, or $750,000; and it can be built for much less. In such case, setting aside 10 per cent. for amortization, this will be reduced to $600,876.57, which in relation to the cost of the factory will leave 6.11 per cent. on the money invested. But as the sum of $750,000 as the cost of the factory is evidently an exaggeration, you may always, without risk of being optimistic, calculate upon 10 per cent. as the profit that the money invested in the sugar industry can produce at the present price of sugar. The reader will judge for himself whether it is worth his while to invest his money in it or not."

I have translated the preceding article with all the exactitude that the idiosyncrasies of the two languages permit, without rectification of amounts, and little comment is needed as it speaks for itself.

However, it should be borne in mind that the type of factory cited, is—as the author freely admits—far from being the best in Cuba, and more than twelve years ago there was at least one in the Island that—owing to the exceedingly rich lands on which its cane was produced by tenant farmers at a very moderate cost, and to its location on the coast, where its products could be loaded directly upon a chartered steamer at its own wharf—produced sugar at one cent and a small fraction per pound. And this in spite of the fact that its manufacturing operations were quite far from being as perfect as they might have been, within the knowledge of those days. There seems to be no reason to doubt that more than one factory is producing sugar today in Cuba at a cost quite as reduced, and for less perhaps. There is a very large margin for improvement in the Cuban sugar industry, and one of its principal defects is one that is seldom if ever taken into account. The factories as a rule belong to a single owner, who is their self-elected director, and if there is anything in the world where two, or more, heads are better than one, we may certainly expect to find it in so complex a task as that of the production of sugar, as all those innumerable qualities the highest success exacts, are seldom, or never, united. A large factory under a board of directors is far more likely to produce the cheapest sugar than a comparatively small one at the beck and nod of a single individual, more or less deficient.

In Cuba boiling to grain is usually very defective, and still worse may be said of all the rest of the boiling house work where it is not under chemical control, which is not yet common; but the worst of all is the ignorance displayed in the production of the raw material. Beyond the mere putting of the stalk into the ill-prepared ground, and preventing the weeds from killing the crop, by the rudest and most wasteful means, cane cultivation in Cuba may as a rule be said to have no existence. With the example set them by Hawaii and Louisiana, this discreditable fact shows how far below the requirements of the case the self-elected directors-in-chief of a great industry may linger.

It is expected that the Experiment Station, to be established under the guidance of an eminent American director, through the saving wisdom of Cuba's president, will remedy this lack of intelligence, energy, practical ability, want of *savoir faire*—or whatever, in the name of all the little gods of sugar making it may be—but it is not at all likely that any further experimentation will be of any use to those who have never availed themselves of all that has already been done indirectly for their benefit in this line of progress by your Station and those of Louisiana, Java, and the British West Indies. A mere recognition of the necessity of cheapening the cost of their raw material, would have been sufficient to induce men of more practical capacity to bring men from abroad to convert one of the cane farms of each factory into a model for the rest. That so easy a remedy has not become general may be explained, perhaps, by the supposition of some inexplicable want of capacity for higher practical progress, inherited from retrogressive Spanish ancestors.

In the meantime, instead of introducing improved implements to do better with one laborer the work that is now done with from two to six hands, the cry still goes up to the government, clamoring for the importation of more laborers at the expense of the whole people, with the purpose of continuing this woeful waste of their time and strength by the unspeakable ignorance in modern systems of cultivation which pervades the minds of those who will direct their operations in the field. Unfortunately for Cuba, under present conditions the importation of mere laborers at the public expense, is simply giving to those who do not know how to use what they already possess, new sources for waste and a new encouragement for the perpetuation of their ignorance, making it a still greater evil by taxing the innocent to pay for it.

And yet and withal, a seemingly unwise Providence appears to be at special pains to protect this Cuban industry, for some inexplicable purpose, far beyond the measure of its deserts, and in an infinity of ways. Take the invasion of the leaf-hopper, for instance. If Cuba, instead of Hawaii, had been selected for this new experience, her planters (if we are to judge them under the light of past experience), instead of showing their independence, as yours have done, by doing their own work in their own wise way, would most of them have sat with folded arms, calling upon the government to come to put the hoppers out, until never a stalk was left for seed to begin anew.

It even seems as though this special Providence, with its untiring zeal, were about to intervene again in the behalf of this class of Cuban planters in order to save them from their inability to grow cane economically, after a long experience of three centuries in the art. If the statements of the newspapers be true, in those parts of the Island where colonists from the United States have settled, their poor, uneducated Cuban neighbors are doing what an immense majority of the educated planters have found no means of doing—imitating the methods of the American farmer. If this be true—and it is the only way in which the improvement of Cuban agriculture seems destined to be brought about—some years hence (God only knows how many), these derelict planters will suddenly wake up some fine morning to the astounding fact, that a way to produce cheap cane in Cuba has been found by the "inalphabetical Guayjiro;" and after duly digesting the new discovery, an unwelcome one to many, who would rather be ruined in some sugar crisis and their own way, than be taught their errors, will sit about in groups, emphasizing with gold-headed walking sticks, the immeasureable advantage of always waiting for someone else to be at the risk and expense of doing for you what, as a mere question of dignity, every man should at least endeavor to do for himself.

However this may be, one thing is very certain: If the planters of Hawaii, instead of their restricted sphere, had possessed an immense extent of rich lands, like those of Cuba, and her copious rainfall, they would now be supplying all the sugar needed in the United States, leaving the industry of this Island either out in the cold, or on a desperate hunt for a new market.

SANTIGO DOD.

THE CHANGA, OR MOLE CRICKET (*Scapteriscus didactylus* Latr.) *IN PORTO RICO.*

[Bulletin No. 2 of the Porto Rico Agricultural Experiment Station. O. W. Barrett.]

Since the hurricane of 1876 the mole cricket (*Scapteriscus didactylus*), or "changa," as it is popularly called, has continued to be by far the most serious insect pest that the Porto Rican agriculturist has had to deal with. Its damages to tobacco, cane, and small crops in the island amount to probably more than one hundred thousand dollars annually. Its habits are well understood by the planters, but there seems as yet to be no definite method of combating it successfully, and an authority states that "nothing appears to be known of its economic status."

Though the species of mole cricket common in Port Rico has been known for many years, it seems that Brunner and Redtenbacher were the first to report it (1892) as inhabiting this island; and although it is known to occur from Uruguay to Florida on the continent, and also in Cuba, Jamaica, Haiti, and St. Vincent in the West Indies, it appears to be more injurious to agriculture in Porto Rico than elsewhere.

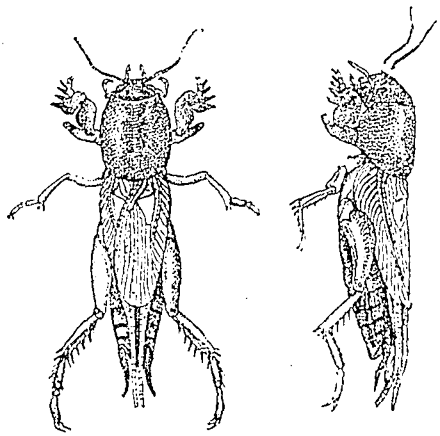

FIG. 1.—Changa (*Scapteriscus didactylus* Latr.): Adult from above at left, from side at right (from drawing made in the Division of Entomology).

DESCRIPTION.

The changa (fig. 1) is an insect found throughout the island, living in galleries in the ground. It is about $1\frac{1}{4}$ inches long in its adult stage; its color is a light brownish fawn more or less mottled with darker areas above and a uniform light brown beneath. Its shape is approximately cylindrical and proportionately longer than that of the true cricket. The head has a pair of moderately long antennæ, of about eighty joints, which are exceedingly sensitive; a pair of well-developed eyes, and between and slightly above these are two comparatively large ocelli, or secondary eyes; and two pairs of jaws, one pair being very strong and possessing six teeth and a blade each. The expression of the face has a fancied resemblance to that of a monkey, whence the name, "chango," being the popular name in Spanish for a pet monkey.

The top of the prothorax, which is that part of the body immediately behind the head, is somewhat shield-shaped and strongly convex, with no median ridge or groove, and is used in pressing back the loose earth at the top and sides of the burrow. When in the act of burrowing the head and prothorax are slightly rotated, thus bringing the sides of the latter like a smoothing trowel in contact with the earth wall and keeping it "trimmed."

The abdomen is flattened beneath and strongly arched above; it is terminated by a pair of slender, flexible stylets, the office of which is unknown; the so-called genital plates are very similar in both sexes, and there is no ovipositor in the female.

The first pair of legs are good examples of specialized structure; all the parts are greatly modified and peculiarly adapted to the excavation of burrows or tunnels in the earth. The first joint is proportionately short and has a bony process which supports the second and third joints when inflexed. The second joint is large and produced beyond the third joint into a spade-like tooth which braces the teeth of the fourth joint from the inside when the leg is bent at the beginning of a stroke. The third joint is so short and broad as to be almost triangular and is unarmed, but has a strong ridge at its outer and lower side which holds the fourth joint from twisting when doubled back. The tibia, or fourth joint, is extremely irregular in shape, strongly attached to the third joint, and possesses a pair of large bone-like projections which are slightly concave on the outside. The auditory organ is situated on the front of the upper part of the tibia and is protected by a raised fold of the surface; it may be noticed as a white membrane stretched drumhead-like over a cavity near the third joint. Thus it can truly be said that the changa "hears through its elbows," though that does not prevent its hearing well. The tarsus, or foot, is attached not at the end of the fourth joint but about midway on its outer surface; it has three flexible joints and a pair of separately movable sharp claws at the tip of the last one; the first and second joints, or knuckles, are produced at nearly right angles on the lower side into large, black teeth, more pointed than those of the tibia and supported by the latter except when fully extended.

When closely bent the whole leg has a somewhat elliptical outline and is a model of strength, compactness, and adaptability to purpose. Indeed, with the 4 picks and 10 shovels of its first pair of legs, it is no wonder that the changa can burrow its own length in ordinary soil in the space of half a minute.

The second and third pairs of legs are of medium size; they present several short but strong spines, and their feet have three joints each, with a pair of claws which are independently movable. Although not structurally fitted for jumping, the three pairs of legs acting in unison suffice to enable the changa to make clumsy leaps of several times its own length.

The wings are fairly large and much exceed the wing covers, extending to the tip of the abdomen; they are nearly twice as long as broad and are very delicate and folded into minute plaits.

The tegmina, or wing covers, are short, rounded, thin, and more flexible than is usual among the insects of this order; the tegmina of the males have a fairly well-developed stridulating organ, which can be seen upon close examination to be composed of several strong veins about the center of the wing cover which are provided with tooth-like ridges, and it is by rubbing these veins together that the male produces his short and low, but distinctive, chirrup.

The entire surface of the body is covered with a short, sparse, yellowish down, though in adult specimens the head, legs, and wing covers are nearly naked. These minute hairs serve to prevent the surface of the body from becoming wetted by contact with the very wet soil through which the changa sometimes has to burrow; it also, by holding the air, enables the changa to float readily upon the surface of water, and this fact enables it, when washed out of the surface soil into a stream or pool, to escape drowning. The integument of most parts of the body is soft and so nearly transparent that the tracheæ, or breathing tubes, may be seen ramifying directly beneath it. These tracheæ, or tube-like lungs, radiate from the large abdominal spiracles through which the changa breathes. These breathing pores, 12 in number, are situated in two longitudinal rows—one on either side of the abdomen.

LIFE HISTORY.

The eggs of the changa are deposited in a heap on the floor in the enlarged end of a side gallery, and from a few inches to a foot or more beneath the surface of the ground. They are of a dirty yellowish color, elliptical in outline, smooth, and about 3 mm. in length by 1 mm. in diameter. They are laid in January, February and March, and hatch in about two weeks. It is possible that the egg-laying season varies much, according to climatic conditions and the individual female, for eggs in some stage of formation are usually to be found in female specimens at whatever time of the year the examination is made. Each female deposits from 50 to 100 eggs, and it is believed she dies soon after ovipositing, but this has not been proved in our breeding-cage experiments, because the adult specimens generally die within two weeks after entering cages.

The young changa is at first nearly white, but soon changes to a dark-fawn color above and its exterior is everywhere clothed with short hairs of the same color. The larva, as the young is termed, shows greater activity and saltatory powers; it can readily jump twenty-five times its own length. The growth of the young changa is comparatively slow and maturity is probably never reached within one year, and perhaps a year and a half is not a long life for a changa in this region. The Northern mole cricket (*Gryllotalpa borealis*) is believed to live for three years. It is not known how many times the skin is cast, but probably there are at least three, and perhaps five, moults before reaching maturity.

GENERAL HABITS.

The young changa very seldom leaves the ground unless driven out by water, but the adults are frequently to be seen hurrying over the surface even in the daytime. Their gait is more clumsy and irregular than is the case with most crickets. When greatly excited they supplement their ordinary gait with short jumps.

The adult males frequently fly at night and are attracted to light. Though their flight is laborious, like that of a large beetle, and not long sustained, they sometimes rise to a light 20 feet or more above the ground. They seem to prefer dark, cloudy nights in which to make their aerial excursions. There are doubtless other conditions which are important regarding the flight of the changa, because of two apparently very similar evenings the changa may emerge in great numbers in one, whereas during the other scarcely a single one may be seen. From 7 o'clock until 10 o'clock are the hours preferred for their flights. Thus it does not, as has been stated, fly only at twilight.

The changa is sensitive to humidty. Unless the surface of the soil is moist they remain at a depth of several inches, and if the soil is saturated they come to the surface and escape or remain hidden in grass clumps. Whenever the soil is moist and not too hot, be it night or day, its work of destruction is carried on, though, of course, much the greater amount of damage is done at night. Its habit of burrowing just beneath the surface in a great measure saves it from the attacks of lizards, but not entirely from fowls and blackbirds, that are quick to notice the slightest movement of the earth on top of the burrow and to recognize the cause thereof. These burrows may be traced often for several feet, or even yards, the loosened and raised convex surface plainly indicating the course taken, and at the end of the visible portion of the burrow there may be noted an opening, either the entrance or exit, or else the descent of the burrow. These burrows, ramifying through the soil in the vicinity of food plants, are kept open and utilized for a considerable length of time by all the mole crickets frequenting that soil area. Thus it will be seen a changa can readily pass from the roots of one food plant to those several feet, or perhaps even yards, distant without emerging from the ground or making any new gallery. This fact partially accounts for the great number of small seedling plants which may be destroyed by one or two crickets in a plat of ground in the space of one night. Keeping the earth pressed firmly about the roots of a plant closes the burrows and greatly hinders the changa's operations.

When removed from the ground, or sometimes when surprised on the surface, the adult changa has the habit of feigning death. This "'possum" act may be prolonged several minutes. After a few minutes of intense activity directly after coming to a light, the changa usually strikes an attitude of meditation, as it were, and remains absolutely motionless for a considerable length of time.

The female of the northern mole cricket (*Gryllotalpa borealis*) is said to care for her young until they reach the second moult; but though we have often found very young changas they were always apparently unattended.

FOOD HABITS.

The changa's food consists almost wholly of living plants; the stomach, however, is always found to contain more or less mud and sand, which is probably unavoidably eaten along with the roots. Portions of decaying plants and the leaves and stems of living plants are sometimes eaten. When food is scarce the leaves and roots of plants, especially those of the "yerba dulce," are drawn into the galleries, sometimes to a distance of a foot or more, there to be consumed at leisure during the daytime. In captivity, even with plenty of its normal food, the changa will eat the dead and dying individuals of its own kind; and we suspect that it varies its normal diet with an occasional earthworm, should their respective galleries happen to cross; indeed, we have kept specimens in cages on an unmixed diet of earthworms for a week or more.

The usual point of attack on a plant is the crown or junction of stem and roots, but the whole root system and a good part of the stem is frequently devoured. In eating the stem the changa often remains just beneath the surface and pulls down the plant as fast as it is consumed; thus a plant 4 inches in height in the evening may appear only 1 or 2 inches high the next morning.

Plants having a poisonous or acrid sap are free from attacks. The economic plants most injured by the changa are cane, tobacco, and rice. Among the small crops the tomato, eggplant, turnip, and cabbage are most affected. Very little is known as to the extent of the damage upon the coffee crop, but a considerable percentage of the young seedlings in the nursery beds belonging to the experiment station have been deprived of their taproots. Young seedlings of citrus fruits are frequently attacked, but much of the loss usually attributed to the changa is due to the grubs of the orange-leaf weevil (*Exophthalmus spengleri*), or to those of the smaller May beetle (*Lachnosterna* sp.), or to a peculiar bacterial or fungus disease known locally as "sancocho," which causes the bark of the roots and stem near the soil surface to decay.

Of ornamental plants the coleus seems to be a favorite food. The castor-oil plant, watermelon, bean, sweet potato, cassava, and "yautia" are seldom or never attacked.

It seems that in its habit of gnawing away a ring of bark from roots and underground parts of stems of some plants and of eating directly into the heart of others the changa shows a sort of mania for killing quite beyond its hunger-satisfying instinct.

INTRODUCTION INTO PORTO RICO.

It is the current belief among the better-informed agriculturists here that the changa first reached Porto Rico in a shipload of guano brought from South America about the year 1850 but since the same species is found throughout tropical America from Uruguay to Florida it seems more probable that the changa was here before the guano arrived. However, it was not universally considered a serious pest until after the hurricane of '76, which practically destroyed its worst enemy, the blackbird. For the next few years the changa was so abundant in some localities that they often came to the lights in the houses in such numbers as to literally cover the floor with a loathsome wriggling mass of their bodies. Since about 1885 their numbers were slightly diminishing until the hurricane of August 8, 1899. It is said by some that they first appeared in the west end of the island and have gradually migrated eastward.

The vicinity of Mayaguez was the first district of the island to suffer from this plague, and it happens that the estate recently purchased by the insular government for the permanent use of the experiment station at Mayaguez, which was formerly known as "La Carmen," was the first estate to abandon the cultivation of cane on account of the ravages of the changa and the cane disease which was believed to always follow the changa's attacks.

INFLUENCE OF SOIL CONDITIONS.

The mountain districts of the interior are usually more free from the changa than the coast region. This is very largely due to the fact that the mountain soils are clayey, while those of the coast plains and the broad valleys are of an alluvial sandy loam. It is obvious that the changa can not work in clay, on account of its tenacious and noncompressible nature; while in the loose granular structure of a loamy soil the changa readily presses aside the particles of earth and forms a gallery without excavating or bringing to the surface any of the displaced material.

As previously stated, saturation or overdryness of the soil are conditions avoided by the changa. Prolonged rains in lowlands are probably destructive to many of the young, which have to come to the surface to escape drowning; and during a prolonged drought tbey descend to a considerable depth, and it is possible that in an open field some of the young die from their inability to find food or to migrate, as do the adults, by an overland trip.

We find that the changa evinces an aversion to making a surface burrow up the side of a plant hill or ridge of earth. For this reason single plants should be "hilled up" when practicable.

In sandy cane lands two and sometimes three plantings of the cane are necessary on account of the greater numbers, as well as greater destructiveness, of the insect in these soils; whereas in a cane soil that carries a high percentage of clay, as in those in the vicinity of Rio Piedras, only about 1 per cent of cane cuttings is destroyed by the changa. These rules hold good also for tobacco, rice, and other crops; the more clayey the soil the less damage can be done by the changa to crops grown therein. There is a difference of opinion among cane planters here as to the method of setting the cane cutting in the soil. Some aver that the cutting has a better chance of life when planted horizontally, because of the number of roots produced at all the nodes, while others claim that a changa will remain near a cutting until all the tender roots are devoured anyway, and therefore the upright position is better, which gives the continually forming roots a chance to grow and harden beyond the changa-food stage between the brief visists of the changa. But we believe the best plan to avoid the attacks is to lay the cane cutting, with its leaves still attached, upon the soil in a slight depression. Thus as the young roots start they are toughened by the influence of the air and the light, and when they are covered with the hoe, lightly at first and more deeply later, they are too hard for the changa's jaws.

Though our personal obseravtions have not yet extended over an entire year, there is little doubt that the changa's period of greatest activity, as evinced by their coming to light and by their depredations in fields, is at the end of the rainy season; that is, in October, November, and December.

REMEDIES.

Generally speaking, preventive measures seem more advisable for small crops or limited areas than destructive remedies, with one exception, viz, the use of trap lights.

We may group the prophylactic remedies into two classes—the physical, or those which prevent the attacks of the changa by obstructions, and chemical, or those which prevent the attacks by the use of chemical substances having a repellent odor.

The most common means of preventing the destruction of small plants is by wrapping them in the leaves of the mamey (*Mammea americana*). This method is very common among the tobacco growers of the island. At the time of transplanting, the young plant with a small quantity of earth is wrapped in one or two mamey leaves laid lengthwise around the ball of earth; when placed in the soil the leaf forms an impassable barrier, although there is some danger that the changa may hop over the top ring of leaves or enter at the bottom and thus gain access to the plant itself. We find, however, from our experiments at the station that the wrapping of the young plant in this manner retards the growth of its root system and probably in a measure suffocates the roots by preventing the free circulation of air and water in the soil about them. The thickness and gummy sap of the leaf prevent its decay in the soil for from two to six weeks. If carefully placed, however, the leaf or leaves may be drawn from the soil after the plant has attained sufficient size and vitality to enable it to resist the changa's attacks. Sections of banana leaves are also used like those of the mamey.

An improvement upon the mamey-leaf wrapper is the wire gauze "sleeve." This system has been successfully used by the Porto Rico Fruit Company, at Bayamon, in saving a plat of tomatoes in a badly infested district. Galvanized-iron wire cloth having meshes too small to admit the passage of a half-grown changa is cut into pieces about 6 by 10 inches. These pieces are rolled into cylinders, into which the young plants are set at the time of transplanting. These cylinders have the advantage of lasting for several seasons, of allowing the roots to extend outside the cylinder, and of allowing a thorough ventilation of the soil. These sleeves may be made of various dimensions to suit the kind and size of plant to be protected. It is always necessary to see that the vertical edges overlap a little, so that an entrance can not be forced between them; and it is well to allow the top rim of the cylinder to protrude 1 or 2 inches above the surface of the soil. Their diameter should never be less than 3 inches, except for very small plants; the length may be 6 to 12 or more inches.

Cheese cloth has been tried as a barrier, with not much success, because it rots very quickly, and as soon as it begins to rot the changa readily forces a way through it. Cheese-cloth covers for raised wooden beds and seed boxes have been successfully used by the American Fruit Company, at Rio Piedras. The cheese cloth was stretched on square frames of the same width as the boxes, and these frames were removed during the daytime. They effectually prevented the entrance of the changa during its nocturnal migrations.

A mulch of tobacco stems just below the surface of the soil proves quite ineffectual; the galleries are made even more readily through it. Tobacco dust separately or mixed with other fertilizers is likewise nonpreventive.

The use of the pomace from the castor-oil presses has also been tried, but with little success. All parts of the castor-oil plant are known to be poisonous when eaten, and it was thought that its presence about seedling plants would keep away the changa; but unless a great quantity of the seed-cake refuse is used, the changa readily passes through it.

Barriers made by pouring coal tar into a depressed narrow ring in the soil about a plant and then lightly covering it with earth have been tried without success. A desperate changa will even tunnel directly through the tar itself, apparently oblivious to its strong odor.

Clean cultivation may be called a physical remedy. The removal of weeds and grass from a cultivated crop necessarily removes a portion of the changa's food plants, and although at first thorough cultivation seems to indirectly incite the changa to even more ferocious depredations, we have found that the adults emigrate from a clean cultivated field; it is obvious, of course, that the wingless specimens must remain, or else make an overland trip, which is strongly contrary to their instinct. Many of our first experimental plats were completely devastated during the first three or four months of our occupation of the grounds at Rio Piedras, but by keeping down the "yerba dulce" and all other native food plants of the changa their numbers have rapidly decreased until at present the only damages are those perpetrated by occasional tramp-like specimens. Moreover, keeping the ground clean a plat of ground of changas. In this way the pests may be kept in control in small areas at a slight expense.

Several years ago the idea was conceived by several native planters to form a society or corporation with a capital of some hundreds of thousands of dollars for the extermination of the terrible pest. Their idea was to establish substations throughout the island, at which a bounty would be paid for every specimen of changa brought in. It was thought that by paying a cent apiece, or perhaps less, the incentive would be so strong that the task of exterminating the plague would be readily accomplished. Although many of the more wealthy agriculturists expressed their willingness to subscribe liberally in this undertaking, the plan was never carried into effect. The impracticability of this plan depends largely upon the impossibility of securing all the specimens in a given area; if even 1 per cent were left it would be merely a question of time when the task would need to be done over again.

The subject of trap lights has attracted considerable attention, especially within the last two or three years, but for some reason their use has never become universal. In badly infested districts planters frequently light large fires of grass or brushwood during nights when changas are flying abundantly on their plantations. The effectiveness of these dull smoking fires is probably not so great as might be expected, for our experiments show that the changa is not attracted by a dim light. Two or three forms of cumbersome and complicated lanterns have been devised; and one device especially deserves mention for its ingenuity—a lantern suspended above a cloth funnel leading into a tin receptacle at the bottom. This plan renders practicable the use of the living insects caught in the cloth funnel as food for fowls. The old Spanish agronomic substation at Martin Pena, near Rio Piedras, experimented with a trap light, but we can find no records of these trials.

Our experiments show that the best and cheapest form of trap light is a lantern (the larger the better), suspended above a receptacle partially filled with water, to which a little kerosene has been added. The changa is drawn to the light and striking the chimney of the lantern or lamp falls into the receptacle beneath. The water in this receptacle gives it stability and the layer of kerosene on top quickly kills the changas by stopping their breathing pores. The cost of running a trap like this is from 1 to 5 cents a night, depending, of course, upon the size of the wick used. A coat of tar spread over a level surface of boards or zinc beneath the light holds fast nearly all of the insects which drop into it, but it was found much less satisfactory than kerosene, principally because the surface soon dries or becomes clogged. Probably an electric around and between the cultivated plants affords a much better opportunity to the insectivorous birds for detecting the changa; so much so that in a clean cultivated open field, which is well policed by birds, it is almost sure death to a changa to appear above ground, or even to disturb the surface soil in its tunneling operations during the daytime.

Whenever practicable a field should be plowed and kept free from weeds for several weeks prior to planting. This plan not only starves out the pests, but gives the birds a chance to destroy them.

Special search with hoe or spade in badly infested grounds just after a heavy rain may sometimes be relied upon to rid light or acetylene gas light would be much more advantageous than a lantern, but the cost would perhaps be prohibitive.

Lights placed at the sides of a field should be provided with reflectors to throw all the light into the field. Fortunately there seems to be very few species of beneficial insects caught in the traps here; on the contrary, two species of cutworms, two or three species of the very injurious May beetles (*Lachnosterna* spp.), and the very numerous leaf-hoppers which infest plants of the bean family are caught in considerable numbers in the traps. A chimneyless trap light has proved almost utterly valueless as a changa killer; the flame is smoky and even a light breeze causes the tin sides to become coated with a deposit of soot, which of course destroys their deflecting power. The cost of a trap light should not be above $2, and by using a common lantern and five-gallon kerosene tin, the cost may be under $1; the cost of oil should not be above 3 cents a night, even if the light be burned during the entire night, which is unnecessary, since the changa does not fly much during the cool hours after midnight.

Among the repellent remedies which have been tried at the station naphthalin has been found the most effective. The flake, or white crystalline form, was the kind considered. Various experiments have been tried with this substance placed in holes in the soil at various distances apart and at various distances from the plants. It was found to have little or no deleterious effect upon the plant itself, even when considerable quantities were placed close to the roots of tender plants; but its volatile nature renders it necessary to repeat the treatment every two to five days, depending upon the nature of the soil and upon the temperature of the atmosphere. We found that a dose of one-half to one drachm of the crystals in holes one to two and a half inches deep and 1 foot apart would prevent the entrance of the changa into the included area; renewing the naphthalin charge every three to four days kept the soil saturated with the vapor. An adult changa placed in a closed liter jar with 1 drachm of naphthalin becomes paralyzed in about three hours, but is not absolutely dead until after twelve hours. The cost of naphthalin is now only 5 to 6 cents per pound, but even at this low price its use is advisable only for valuable plants in clean cultivated areas.

Many experiments have been tried with carbon bisulphid, or "fuma." These show that although a moderate quantity of the substance suffices to repel the changa, its extremely volatile character and its somewhat high price (12 to 20 cents per pound) practically prohibits its use as an economic reagent. The vapor of "fuma" seems to be less obnoxious to the changa than that of naphthalin, although it is of course a much more powerful insecticide. An adult changa placed in a closed liter jar becomes paralyzed within one minute after the addition of two or three drops of the liquid; and death soon follows unless the specimen be removed from the vapor. However, an adult specimen placed in an air-tight wooden box containing 150 cubic inches with 5 drops of "fuma" dies in from three to ten hours—that is, by a physiological effect of the poison rather than by asphyxiation. Two drachms of the liquid in a 2-drachm vial with a loose stopper of cotton or tin foil was found to last from two to five days when sunk in ordinary soil to a depth of 3 inches below the surface.

Similar experiments have been tried with creosote and creolin; but without stating the uninteresting details of these tests, suffice it to say that even by using a comparatively large quantity of these substances placed in different manners beneath the surface of the soil, little or no repellent action was observed; even young changas will make new burrows directly over a partially closed vial of creolin, although its poisonous effect in a closed receptacle is as great, perhaps, as that of carbon bisulphid. An adult specimen in a box containing 150 cubic inches does not become paralyzed so quickly, but is killed in a shorter time than is the case with the use of "fuma" and with no reviving period between paralyzation and death from the poisoning action. A solution of creolin, containing one-half drachm of the pure liquid in 1 quart of water, poured into the soil around plants serves to repel the changa from a very small area for a comparatively short time.

Pure kerosene poured into the soil about young plants also repels the changa so long as the soil retains strong traces of it; but its harmful action upon plant tissues precludes its use except in extreme cases. A strong kerosene emulsion when poured liberally over a badly infested area will drive out the majority of the changas beneath the surface.

Lime liberally spread over plats has little or no effect in expelling or repelling the changa.

Arsenic in its various compounds is found to be the best substance for combating the changa plague; but its use is attended with some difficulties. The best method of applying it seems to be the following: A quantity of "yerba dulce" plants are gathered and shaken free of dirt and cut into pieces of an inch or less in length; then white arsenic or Paris green is sprinkled over the chopped pieces of grass and the whole thoroughly mixed together so that each piece of the grass will contain more or less of the arsenic. This poisoned bait is then put upon, or just beneath, the surface of the soil in badly infested areas. The changa will come to this bait even when wilted. It is well to lightly cover this poisoned bait, so that fowls will not eat it. A good proportion is one-half ounce of Paris green (or white arsenic) to every quart (liter) of the chopped grass, though of course this formula may be varied considerably. It is well to moisten the grass before sprinkling on the poison, and we believe there is a slight advantage in adding sugar to the water used in wetting the grass. Instead of putting a large quantity of the bait in one place, it is more economical to strew it in lines or narrow rows among the plants near areas where surface burrows are numerous. Death ensues within a very few hours after eating the bait. Since most of the poisoned insects retire to their deepest retreats when suffering from the effects of the poison and die there, the bodies are not readily found by the ants; but if a specimen chances to die near the surface a procession of ants will mark the spot within a few hours. Thus the result of this remedy is not readily seen and its efficiency may therefore be doubted by the hasty observer. But the continued use of the remedy can not fail to keep in check, if not fully exterminate, the enemy in the treated area. Pure Paris green is better for the above treatment than the white arsenic, but at present it is not readily procurable in the island. It can usually be purchased from dealers in agricultural implements for about 20 or 25 cents per pound. The common arsenic, the powdered form of arsenious trioxid, can be purchased at any local drug store, although a physician's permit may be required. Even allowing for a very liberal waste, 5 ounces of arsenic, when used with "yerba dulce," or a similar bait, properly applied and distributed, should be sufficient to kill practically all the changas in one acre of ground within one week.

We find that cuttings of coleus stems 3 or 4 inches in length, dipped in white arsenic powder and laid upon the surface of the soil, is another remedy for the same trouble.

NATURAL ENEMIES.

Unfortunately the changa has few natural enemies in Porto Rico. Its habits of emerging only at night, of spending nearly all its time well hidden beneath the surface of the ground, its comparatively large size, and its great strength, activity, and fecundity, combine to render it peculiarly exempt from the dangers which beset the lives of most insects. There is a singular lack of ground beetles of the family Carabidæ here. With a greater abundance of these predaceous enemies of plant-eating insects, the early stages of the changa would be passed in less security. The parasitic flies (Tachinidæ), which trouble the lives of many species of insects, can obviously never affect the changa. The hair snake (*Gordius aquaticus*) in its third (?) larval stage lives in the abdominal cavity of various species of grasshoppers in the United States, devouring the fatty tissues and finally the viscera. A very large percentage of the black mole crickets (*Stenopelmatus talpa*) of Mexico are similarly eaten piecemeal. But although we have examined hundreds of specimens of both sexes of the changa, we have never found the slightest trace of any internal or external parasites. Moreover, no trace of any fungus disease has been detected on the changa. In the near future we hope to experiment with the fungus which attacks grasshoppers in the Central States. This fungus (*Empusa grylli*) has been sucessfully used to inoculate individauls, which are then turned loose in the fields, where they carry contagion and death to the non-infected individuals. It is extremely doubtful, however, if this fungus can be inoculated into the changa, on account of the widely different habits of the grasshopper and the mole cricket, as well as the different climatic conditions here.

The red mite (*Trombidium locustarum*), which is so common a parasite on grasshoppers in the United States, does not attack our changa.

Probably the most important natural enemy of the changa is a species of blackbird called here the "judia" (the jewess) on account of its enlarged upper mandible. These birds hover about cultivated fields and pastures, and one may often be seen darting down from a tree or fence post on to the surface of the ground and hopping back to its perch with a changa in its beak. Of course they can accomplish this kind act to the farmers and themselves only when the changa, on account of the condition of the soil and of the weather, is working at or just beneath the surface. Several other species of birds, the "mazambique," the "mirlo," one which happens to have the name of "chango," and others are also enemies of the changa. These birds frequently take up their residence near cultivated fields, and should of course be encouraged in this by the farmers who should see that the law protecting the birds is vigorously enforced.

The common lizard also consumes considerable numbers of the changa, but, of course, it can work only in the daytime; besides, a lizard under 6 inches in length can only with great difficulty manage to swallow an adult changa. They may be noticed frequently running about in cultivated fields and gardens carrying in their mouths changas which they are unable to swallow, but which they are determined to hold on to as long as possible. Many changas would probably escape from the small-sized lizards were it not for the fact that a large lizard follows the nonethical custom of dispossessing a weaker brother of his prey whenever an occasion offers.

Domestic fowls often learn to follow a plow and pick up the changas and grubs which are turned up with the earth.

It has been suggested that the horned toad of Mexico and Southern United States might become an important enemy of the pest, but it is extremely doubtful if that desert animal could withstand our humid climate; moreover its habits are strictly diurnal.

The common toad of the United States, being nocturnal in habit, may prove of some use in intercepting occasional marauding changas, and arrangements have already been made to introduce it into this island.

Combined and intelligent effort toward judicious and persistent application of the remedies as advised in this bulletin will keep the changa under control in Porto Rico.

The changa is justly considered one of the greatest difficulties the Porto Rican agriculturist has to deal with at present, but it is not sufficiently important to prevent the successful cultivation of any tropical product in the island. Indeed, its injuriousness has been frequently overestimated by discouraged planters; it has been blamed for the unprofitableness of various crops in many localities when poverty of the soil, fungus and bacterial diseases, poor agricultural methods, or unfavorable ecological conditions have been the true causes.

SUMMARY.

The changa is a comparatively large insect of the order Orthoptera; its habits are subterranean and nocturnal; its food consists largely of roots of plants. The female lays her eggs in the galleries under ground. The life of an individual is about one year. Its enemies are lizards and birds, but since these are strictly diurnal in habit, the changa suffers comparatively little from them.

The damage to crops in this island by the changa amounts to probably more than $100,000 annually. The crops injured most are cane, tobacco, and rice; a few crops are exempt from attack. The depredations extend over the entire year.

Comparatively little damage is done in clayey soils; moist, sandy loam is preferred. Saturation and extreme dryness of the soil are conditions which prevent the changa's operations.

The old method of protecting the roots of seedling plants with mamey leaves is more or less deleterious to the plants; but the great cheapness of this method commends it to the tobacco grower. The coarse wire gauze cylinder is recommended for tomatoes and valuable plants.

Clean cultivation, both before and after planting crops, is recommended, because a large portion of the changa's ordinary food supply is thus cut off. Hilling up is also recommeded where practicable. Special search with hoe or spade soon after a rain may be relied upon to some extent in small plats.

Plowing during the winter and spring months will bring to the surface numbers of the eggs and young larvae, and this exposure to their enemies will result in the death of a large percentage of their numbers.

Trap lights are recommended for use on nights when the changa is flying in numbers. A dim light is nearly useless. A large lantern having a reflector and set at the edge of a field or a lantern with no reflector set in the middle of a field, will give best results.

Arsenic or Paris green sprinkled on chopped grass is the best bait; this poison should be distributed in small patches or narrow rows just beneath the surface of the soil.

Napthalin placed in the ground about plants serves to repel the changa, but its use is warranted only in small and badly infested areas.

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DISEASE-RESISTING VARIETIES OF PLANTS.

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It is a fact well known to agriculturists that, whenever a disease attacks cultivated crops, some varieties of the cultivated plant are found to be less liable to the disease than others. It becomes therefore one of the chief functions of the scientific agriculturist to discover and to select such disease-resisting varieties and to recommend them to the practical gardener, farmer or planter for cultivation.

The discovery of disease-resisting varieties might at first seem a simple matter, but there are many difficulties to contend with. In the first place these hardy varieties are usually inferior, either in the quantity or in the quality of their produce, to the less resistant forms, and the practical agriculturist will often prefer to take the risk of losing the greater part of his crop by disease, than the certainty of having a smaller or otherwise inferior crop. Then again the plant-breeder has to deal with the fact that, if cultivated plants can vary, and vary in such a way as to become more resistant to certain animal or vegetable parasites, these parasites can also vary, and vary in such a way that they become capable of attacking plants which were previously immune to them, so that after our disease-resisting variety has been in cultivation for some years, it is found to be just as liable to disease as any other variety. That a fungus can vary and adapt itself to different hosts is shown by the behavior of the wheat rust (*Puccinia graminis*). Ericksson demonstrated that this fungus is split up into several special varieties or races, "each of which grows well on some grasses but refuses to infect others. Thus the variety which infects wheat refuses to infect barley or oats, while that variety which grows on rye will not take on wheat and so forth. Now it is important to notice that these specialized races are indistinguishable one from another by their visible microscopic characters: they are all botanically of one species (*Pucciniagraminis.*)[1]" That is, this fungus is adapting itself to live on special kinds of grasses, and many other fungi are doing the same thing. It is therefore easily conceivable that a fungus will gradually adapt itself to living on a variety which at present it is unable to infect.

Another difficulty in breeding disease-resisting varieties is the fact that a variety which has proved itself resistant in one locality may succumb very easily in another. Experiments to test the resistant powers of any variety must therefore be conducted in every locality in which it is proposed to introduce that variety.

The agriculturist has two chief methods of obtaining disease-resistant varieties:—

(1) The introduction of hardy varieties from other localities.

(2) The breeding of new varieties either by simple selection or by hybridization.

Very often the two processes are combined, more especially the introduction of new races and hybridization. A new variety is introduced and it is found that, though resistant to disease it is inferior in its produce or is not so resistant to unfavorable climatic conditions as the native varieties. It is then crossed with one or more of these varieties in the hope of obtaining a hybrid form combining the good qualities of the native and foreign parents.

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[1] H. Marshall Ward. *Disease in Plants.* p. 176.

The breeding of disease-resistant varieties by selection is (on paper) a simple matter. A crop is sown in a locality known to be infested with the disease, most of the plants will probably be attacked, but some few will, perhaps, not be attacked, or only slightly. Seeds are taken from these plants and are sown. Probably most of the plants so obtained will again be attacked but some proportion, possibly in this case a larger one will escape. The seeds from the plants not attacked are again selected and used for planting. This selection is continued, for generation after generation, until practically the whole crop is free from disease at a time and in a locality where other varieties suffer badly. Of course the breeder may find that while he has been breeding a disease-resistant variety of his cultivated plant he has, unconsciously, been breeding at the same time a specially virulent variety of the parasitic insect or fungus, so that all his efforts are of no avail. Again, he may find that his special variety is perfectly useless outside the locality in which it has been raised, and he must remember that his variety must not be inferior in quantity or quality of produce to the best varieties usually cultivated. However, the plant-breeder is prepared for these difficulties; he knows that they have been overcome before, and he is quite content to work for years, knowing that in the end some measure, at least, of success must be his.

Grafting may perhaps be mentioned here as it is a method of obtaining disease-resistant individuals though not varieties. Many of the best varieties of fruit trees for instance, are so subject to insect and fungoid attack that they cannot be raised from cuttings; they are then reproduced by grafting them on to a stock of a hardier variety. For example, oranges are greatly subject to a root disease known as *mal-di-gomma*; to meet this the sweet orange is grafted on to the inferior but much hardier sour orange stock.

Very little is known as to how and why certain varieties are more resistant to disease than others.[1] In some cases the reason can be guessed at with some certainty, but in most nothing whatever is known. In some cases immunity is secured by the variety becoming mature at a time of the year when the fungus or insect is not virulnet; for instance the potato disease in England is most destructive during the hot weather of July, it follows that a variety of potato which matures its tubers before July, will be, to a great extent at least, immune to the attacks of this fungus. Again it has been suggested that the comparative immunity to rust of certain Australian varieties of wheat is due to a greater thickness of the cuticle of the leaves, and to the smaller number of stomata on a square inch of leaf surface. Thick-skinned varie-

[1] H. Marshall Ward. *Disease in Plants.*

ties of potatoes, etc., will naturally be less liable to attack from parasites present in the soil. Thick-skinned apples, tomatoes, etc., will be less liable to attack from fungi which gain access through bruises and other wounds and will therefore store better than thin-skinned forms. In other cases increased resistance is stated to be due to a deeper rooting habit.

The following is an incomplete account of what has been and is being done in various parts of the world to introduce and raise disease-resistant varieties of cultivated plants.

GRAPE VINE.

The two most destructive diseases of the grape vine are the *Phylloxera*, a root-louse which attacks the roots of European vines and almost destroyed the vineyards of France; and the downy mildew (*Plasmopora viticola*), a fungus which attacks the leaves. It was found that certain American vines, such as *Vitis rupestris* and *V. riparia* are highly resistant to the attacks of *Phylloxera*. Unfortunately, as is so often the case, the wine made from these vines is inferior in quality and flavor to that made from the European vine (*Vitis vinifera*). This difficulty was met, in the first place, by grafting European vines on American stocks; by this means the roots were not attacked by the *Phylloxera*, while the grapes were those of the European species. Further, a number of scientific agriculturists endeavored to raise a new variety of vine which should combine the disease resistant properties of the American vine with the superior produce of the European. *Millardet*[1] after very numerous experiments in hybridizing European with American vines finally succeeded in raising hybrids with roots proof against *Phylloxera*, leaves proof against the downy mildew, and grapes which produce wine of the desired flavor.

WHEAT.

Wheat is the chief cereal crop of Europe, and of some parts of the United States and Australia. In all these countries it suffers damage by the rust fungus (*Puccinia*). The damage done is sometimes enormous; thus it was calculated[2] that in 1891, the loss, in Prussia alone, by the rusts of wheat, oats and rye, amounted to £20,628,147, or nearly one-third of the total value of the crop. Moreover it has not been found possible to devise any remedial methods to combat the disease.

In Europe, the United States and Australia experiments

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[1] Millardet. "Notes sur le vignes Americaines." Ser. III *Mem. de la Soc. des Sciences de Bordeaux*, 1891; *Journ. d'agriculture pratique* 1892; *Comptes Rendus*, 1894.

[2] *Zeitschrift fur Pflanzenkrankheiten*, 1893.

have been conducted for many years with a view to raising varieties of wheat resistant to rust.

In Europe the most noteworthy results are those of Eriksson[1] in Sweden. After carrying on cultivation of wheat for a number of years Eriksson obtained varieties which he proved to be resistant to rust. It is interesting to note that when these varieties were introduced into Australia they were found to be liable to rust; here, however, the matter is complicated by the fact that the rust most prevalent in Sweden is the golden rust (*Puccinia glumarum*), while those most prevalent in Australia are *Puccinia graminis* and *P. dispersa*.

In Australia[2] experiments have been and are being carried on under the Departments of Agriculture of Victoria,[3] New South Wales,[4] Queensland and South Australia with a view to raising new, rust-resistant varieties of wheat.

At a conference of delegates from the Australian wheat-growing colonies a committee was appointed to draw up a series of resolutions with regard to wheat rust.[5] Resolution (4) submitted to the conference was as follows:—

"This Conference, fully believing that no such cereal as rust-proof wheat has yet been discovered, but that—as shown from experiments already carried out by importing different varieties from countries outside the Australian colonies and by carefully selecting within the colonies—certain kinds have proved to be constitutionally able to resist to a considerable extent the ravages of this pest, recommends a continuation of this work of selection and importation, with a view to securing varieties most likely to prove remunerative to the wheat farmers of the various colonies.

"And, it having been found, from evidence submitted to this Conference, that certain varieties of wheat believed to be rust-resisting when grown in one locality have succumbed to the pest when grown in another locality, this Conference considers that it would not be justified in specifying any particular varieties as possessing rust-resisting qualities under all conditions."

The experiments have been continued, and by importation, selection and crossing, several new varieties of wheat have been obtained which are, at the same time, rust-resistant and produce good crops. For instance, Mr. McAlpine in the ac-

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1 Eriksson. *Zeitschrift fur Pflanzenkrankheiten*, 1895.

2 "Rust in wheat." *Minutes of Proceedings at a Conference of Delegates from Victoria, South Australia, New South Wales and Queensland, Melbourne*, 1890.

3 *Guides to Growers, No. 35*, Rust in Wheat. Experiments 1894 to 1896-7. Department of Agriculture, Victoria.

4 Farrer. The making and improvement of wheat for Australian colonies *Agricultural Gazette of New South Wales*, Vol. ix, 1898.

5 "Rust in Wheat." *Ibid*, p. 41.

count of the experiments at Port Fairy, in Victoria, in 1897-8, while pointing out that there is no such a thing as a rust-proof wheat, says that "there are rust-resistant wheats which can so constitutionally resist the rust under certain proved conditions that in a rusty year the yield will not be seriously affected."

To take examples from among selected wheat grown on a large scale; "Ward's Prolific is a good milling, good-yielding, and rust-resisting wheat, having stood the test for eight years. It also holds the grain well, and is comparatively early." Another form, which is a composite hybrid raised by Mr. Farrer of New South Wales, is reported as yielding well (42 bushels per acre), and promising to be a good milling wheat and not badly attacked by rust.[2]

In the United States the Division of Vegetable Physiology and Pathology has for many years been investigating many problems connected with wheat production, among them being the question of the raising of disease-resistant varieties. In Bulletin No. 24 of this Division Mr. Carleton[3] gives an account of the work already done and that being carried on. He describes how the chief varieties of American wheat have been produced, some by introduction, others by pure selection, and others again by simple or composite hybridization. He gives an account of the work done in hybridizing by the Gartons in England and by Mr. Farrer in New South Wales to a great extent with the object of securing disease-resisting varieties, and suggests the lines upon which experiments in wheat raising to meet the varied requirements of the different wheat districts, should be carried on.

In England Messrs. Garton of Newton-le-Willows have for years been carrying on experiments in hybridization, often of a most complex character. As a result numerous varieties of wheat have been obtained which are not only rust-resisting but also possess many other desirable characteristics.

COTTON.

In the United States, the "wilt" disease of cotton is known to occur in South Carolina, Alabama, Georgia, Arkansas and Florida; the loss caused by the disease has been very great and fears were felt that it might ultimately spread to such an

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[1] *Guide to Growers, No. 37.* Wheat experiments 1897-8; Department of Agriculture, Victoria.

[2] See also *Agricultural Ledger*, 1897, No. 16, "Rust in wheat in the Australian Colonies." (Calcutta) for a precis of the literature of the Australian Inter-Colonial Wheat Conference.

[3] "The Basis for the Improvmeent of American Wheats" by Mark Alfred Carleton, *Bulletin 24, U. S. Department of Agriculture, Division of Vegetable Physiology and Pathology*, 1900.

extent as possibly to threaten the life of the industry. The study of this disease and its control were undertaken by Mr. W. A. Orton, of the Division of Vegetable Physiology and Pathology of the U. S. Department of Agriculture.[1] Fungicides applied to the soil proved of no avail, and though hygienic treatment by rotation of crops, removal of diseased plants, etc. was recommended, the most encouraging results were those obtained in endeavoring to find a race of cotton resistant to the disease. In an experiment to test the disease-resisting power of various races, twenty varieties of cotton were planted in a field that was thoroughly infested with the wilt disease; their comparative resistance was determined by counting the number of plants remaining healthy, those partially diseased, and those killed.

The experiment shows that while none of the varieties in cultivation are disease-proof, there are a few which are disease-resistant. The Yannovitch and Mitaffifi varieties are both Egyptian races and their resistance is an example of the advantages obtained by the introduction of varieties from other countries; the Yannovitch is said to be a hybrid between Sea Island and Egyptian cotton. It is an interesting fact that it was found that the wilt fungus (*Neocosmospora vasinfecta*) was able to infect the roots of these resistant varieties, but was unable to enter the main root system.

The raising of new resistant varieties is only being begun, but certain trials are worthy of mention. Mr. Elias L. Rivers, of James Island, S. C., selected a healthy plant of Sea Island cotton growing in a badly infected field in 1899. He sowed the seed from this plant in a single row through a field that had been infested with the wilt disease for several years. The other rows were planted with seed from his main crop, grown on non-infected land. Of the ordinary cotton 95 per cent. of the plants were killed, while in the row planted with seed from the resistant plant not one plant was killed by the wilt disease. The quality of the lint was good though not equal to that of the crop from which the selection was made. It is hoped that by continuous crossing and selection the quality of the cotton will be improved without loss of resistance to the wilt disease.

Selection and crossing both of various native varieties, and of these with the imported Egyptian varieties, are being carried on "with a view both to resistance and to quality of staple."

In Egypt also the cotton crop has suffered greatly from fungoid attack.[1] The chief destruction was due in this case

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[1] "The Wilt Disease of Cotton and its Control" by W. A. Orton, *Bulletin 27. Division of Vegetable Physiology and Pathology.* U. S. Department of Agriculture.

to the "sore-shin" fungus (*Pythium*), the wilt fungus was also present but generally followed the attack of the other fungus. Professor Fletcher has studied the disease-resisting qualities of the chief Egyptian varieties of cotton and comes to the conclusion that "Abassi seems to suffer most from the disease and Mitaffifi and Yannovitch least." It is interesting to note that the varieties which were proved in America to be most resistant to the wilt disease, are not only practically immune to this in Egypt but are also the most resistant to the "sore-shin" disease.

COFFEE.

In the East Indies some years ago the Arabian coffee (*Coffea arabica*) was so badly attacked by a fungus (*Hemileia*) that the planters were practically forced to give up the cultivation of this variety. It has been largely replaced by the Liberian coffee (*C. liberica*) a species which is hardier, larger, and more productive than *C. arabica* and which is more resistant to *Hemileia*, but which unfortunately produces coffee of inferior flavor.

Numerous experiments have been made with a view to raising new varieties. Finally it is stated[2] that M. Henri Manes has succeeded in obtaining a hybrid between *Coffea arabica* and *C. liberica* which combines the good qualities of both parents, more especially the fine flavor of Arabian coffee with the resistance to disease of the Liberian.

Experiments with other species of coffee, for instance, *C. stenophylla* and *C. robusta* have also been tried.

The Arabian coffee in Java is also more susceptible to the attacks of a root-knot or nematode worm than the Liberian, and it has been suggested by Zimmerman[3] and others that the disease may be controlled by grafting Arabian coffee upon the more resistant Liberian stock.

POTATO.

In the British Isles and on the Continent of Europe, the potato crop is an important one in some districts. During the years 1845-50 a disease due to a fungus (*Phytophthora infestans*) broke out and did an enormous amount of damage

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1 Fletcher—"Notes on Two Diseases of Cotton." *Journal of the Khedivial Agricultural Society and the School of Agriculture.* Nov. and Dec., 1902, Vol. iv., No. 6.

2 Bordage "Sur un Hybride de Cafeier Liberia et de Cafeier d'Arabie *Rev. des Cult. Col. T.* viii.

3 Zimmerman, A. Het Groepsgewijs afsterfen der Koffie heesters in gesloten plantsoenen. *Teysmannia*, 1897; also De Nematoden der Koffiewortels. I. *Mededeelingen int's Lands Plantentuin*, 1898, No. 27.

to the crop. Various preventive and remedial measures were tried, many with good results. The best results, however, were again obtained by the breeding of hardy varieties and numbers of these are now advertised every year in the seed catalogues. The disease though it appears every year is kept well in hand.

In India the potato is cultivated to some extent in the Bombay Presidency and in some other provinces. In 1891[1] the crop was badly attacked by a fungus which "caused heavy loss to the cultivators and a marked deterioration of quality in the potatoes sold for consumption." The fungus was identified as a species of *Phytophthora*. It was found that the disease could be largely kept in check by the use of fungicides, but most reliance was placed on the distribution of "seed" of varieties which were proved to be disease-resistant. These varieties were a number of forms imported from England. So successful were these races in resisting the disease that experiments carried out with caustic lime and soot and with different methods of cultivation were rendered inconclusive, as none of the plants were attacked.

COW PEA.

The cow pea (*Vigna Catjang*) is an important crop, not only in the West Indies, but also in some of the southern United States where it is the principal leguminous crop. It is grown there for hay, for forage, for seed, and for its value as a fertilizer, and no other crop is known which could fully take its place.

Recently a wilt disease[2] has appeared in certain of the states which has caused great loss. The disease is caused by a fungus, (*Neocosmospora vasinfecta*, var. *tracheiphila*), which attacks the smaller roots in the first place, and spreads through the vessels of the stem, till sometimes it is found even in the smaller branches and in the leaves. As is the case with all root fungi fungicidal treatment is of little value while rotation of crops is hardly practicable as the cow pea is grown as a catch crop more or less continuously on the same land.

The success obtained in raising varieties of cotton resistant to its closely allied wilt disease suggested the possibility of controlling the cow pea wilt in the same manner. Mr. Williams of Monetta, S. C., wrote saying that a variety which he had in cultivation and known as the Iron cow pea was resistant to the wilt disease.

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1 The *Agricultural Ledger*, 1893, No. 4.

2 "Some diseases of the Cow Pea." *Bulletin 17. U. S. Department of Agriculture, Bureau of Plant Industry*, 1902.

Experiments were accordingly carried out by the U. S. Department of Agriculture at Monetta in co-operation with Mr. Williams. One and a half acres were planted, May 29, 1901, in a number of varieties of cow pea, soy bean, velvet bean, and some Japanese forage plants. The varieties were all planted in exactly the same manner and nearly all the plants grew well until July. The conditions after this were rendered more severe by the presence of a root-knot worm or nematode in the soil, and by a severe drought in July and the early part of August. The results of the varieties of cow pea are given in brief as follows:

"The Japanese cow peas tested proved to be very early varieties, maturing in two months from planting, when the American sorts were just beginning to blossom. They were small, but quite prolific, and were not greatly injured by the wilt. This was doubtless because of their extreme earliness, as they matured before the disease developed. These varieties would be valuable for trial in the North and for late planting in the South, but for general use they appear to be inferior to the common kinds. At the last they were considerably injured by wilt and nematode.

"Of the American cow peas, all made a good start and had an equal chance, but none made any crop except the Iron."

The origin of the Iron variety of cow pea is unknown. Although it has proved itself so valuable as a disease-resisting variety, the Iron is stated to be inferior in the quantity of forage and seed produced to some of the other varieties. Experiments in plant breeding are therefore being carried out by the U. S. Department of Agriculture to remedy these defects; and it is suggested that, by selection from resistant individuals of other varieties, it may be possible to obtain a race as hardy as the Iron without its demerits.

In the Gulf States and South Carolina the cow pea[1] also suffers considerably from the attacks of a nematode worm (*Heterodera radicicola*) which produces swellings or galls on the roots. Numerous remedial and preventive methods of dealing with this disease were tried, but none proved satisfactory, being either impracticable or ineffective.

In the experiments mentioned above with the wilt disease it was noticed that the Iron cow pea was not only resistant to the wilt but also to the root-knot worm which badly attacked the other varieties growing side by side with it. Twelve other varieties were grown in the same field as the Iron. In all of them as a combined result of wilt and root-knot it was difficult to find a single plant showing what could be considered normal roots and bacterial tubercles. At the same time "the

[1] v. *supra.* "Some Disease of the Cow pea."

roots of the Iron were uniformly fine and slender, showing no indication of root galls produced by the nematodes, but abundant nitrogen tubercles." Here again it is suggested that an attempt should be made to breed other disease-resistant varieties by selection from resistant plants.

SUGAR-CANE.

The importance of disease-resisting varieties of the sugar-cane is well recognized in the West Indies. In Barbados and Antigua the Bourbon cane, which at one time was the only one planted, was practically forced out of cultivation by its liability to disease, so that the planters were compelled to take up the cultivation of disease-resistant varieties which in other respects were inferior to the Bourbon. At first varieties of cane were introduced from other localities and tried side by side with the Bourbon. The result of one of these experiments with the Caledonian Queen is thus described by Mr. J. R. Bovell:[1] "To such an extent did this cane resist the disease, that while in some fields the Bourbon canes were so badly attacked that they had to be destroyed, the Caledonian Queens were reported to have yielded two hogsheads of sugar to the acre."

Subsequently, selection from seedling plants has been largely carried on with the result that numerous disease-resisting varieties have been obtained, some of which are proving themselves of great value also as regards sugar-production.

At present no hybrid canes have, directly, been raised in the West Indies, but in Java, Dr. Kobus[2] has produced many hybrids. The first hybrid raised was a cross between the Cheribon and Chunnee varieties. The Cheribon is a valuable cane but is unfortunately liable to disease; the Chunnee is an Indian cane, inferior as regards sugar production but vigorous and resistant to disease. As a result of numerous experiments Dr. Kobus has obtained hybrids which combine the high sugar production of one parent with the disease-resisting properties of the other.

VIOLET.

In the United States it is calculated that a million dollars worth of violets are sold every year; the violets suffer greatly from the attack of a leaf-spot fungus[3] (*Altenaria violoe*),

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[1] *West Indian Bulletin*, Vol. I, p. 36.

[2] Kobus. "De zaadplanten der kruising van Cheribonriet met de Englesch-Indische varieteit Chunnee." *Proc. of the East Java Station.* Ser. III. Nos. 1, 12, 21, 33.

[3] "Spot disease of the Violet by P. H. Dorrett. *Bull. 23. U. S. Dept. of Agriculture. Div. of Veg. Physiology and Pathology*—1900.

which is calculated to do damage to the extent of $200,000 every year in the United States.

On investigation it was found that certain varieties were more liable to the disease than others. Thus the variety "Marie Louise" is noted as being far more susceptible than the "Lady Hume Campbell," but unfortunately the latter variety, although hardier and more prolific than the "Marie Louise," does not produce such perfect flowers.

The above sketch of the work being done is necessarily incomplete, but enough has been put forward to show that, throughout the world, whenever the plant-breeder has been able to devote himself continuously to a thorough study of the question, he has succeeded in raising new varieties which if not immune to diseases, are so far resistant to them, as to give the cultivator the upper hand in his fight with these his worst enemies.

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REPORT OF THE LOUISIANA SUGAR EXPERIMENT STATION.

The work of this station during the past year has been continued mainly upon lines given in previous reports. Investigations along field, laboratory and sugar-house lines of the sugar-cane have been continued with much success. The season just closed has been remarkably unfavorable for all kinds of crops. The winter was extremely wet, prohibiting farm work of all kinds; the spring was excessively dry, preventing that preparation of soil and planting of cane so essential to large production. For a few weeks in summer favorable seasons prevailed, followed immediately by a protracted drouth extending well into harvest. Under these conditions the cane crop was materially reduced in tonnage. It was, however, of fair sucrose content and thus in a measure compensated the low field yields.

By irrigation, however, the station to a very large extent, mitigated the severity of the seasons. An early irrigation in spring placed our soils in excellent tilth and two subsequent irrigations pushed forward all of our crops and prevented damage from the early drouth. The cane should have been irrigated again in the fall, but the frequent threatening of rain during the month of September caused almost daily a postponement of the intention to irrigate until finally it was deemed too near harvest to perform such a risky operation.

Accordingly the final yield was materially reduced by this prolonged fall drouth. However, in comparison with the average yields of the State, our results were quite satisfactory.

Again favorable results have been obtained in both the field and sugar house from seedlings Nos. 74 and 95. These canes have been supplied to a large number of planters in this State, and sufficient time having elapsed for them to judge of their merits, it was deemed of value to the sugar interests of the State to collect and correlate their experiences and opinions. Accordingly, a set of questions was sent to each in a circular letter, and the replies received, together with the results obtained on this station, have been made the basis of a communication to the Sugar Planters' Association, by my assistant, Mr. R. E. Blouin, and will later form the subject matter of a special bulletin.

It is gratifying to note the universal esteem of these seedlings, particularly D. No. 74, and the rapidity with which they are displacing other canes in this State.

It may here be remarked that T. No. 111 and T. No. 189, seedlings respectively of D. No. 74 and D. No. 95, have been this year grown in field experiments. T. No. 111 is a small cane, but exceedingly rich in sucrose, this year giving 17.2 per cent., for plant and 18.5 per cent. for stubble. T. No. 189 is a cane of fair size and sugar content. Both are continued in cultivation with the hope that they will prove valuable additions to our fields.

The station is paying unusual attention to the proper preparation of the soil and the fertilization and cultivation of the cane, since it is realized that only by the practice of the best and most economical methods can our planters successfully withstand such adverse seasons as have prevailed during the past four or five years.

The recently enacted reciprocity treaty of this country with Cuba promises a vigorous development of the sugar industry in the "Gem of the Antilles," and with it a depreciation of present values. To successfully meet this strong competition every known economy must be practiced by our planters.

Dr. C. A. Browne, Jr., has continued his laboratory investigations of the sugar cane. Special attention has been paid to a study of the insoluble carbohydrates of the cane, likewise to the composition of cane fibre and its utilization for paper making. The commercial manufacture of paper from bagasse has thus far not proved a pronounced success, as large losses of fibre are entailed with present processes. This is to be lamented, as cane fibre has most superior paper-making qualities. A process, however, has recently been patented by which all losses of fibre are prevented and a small practical test by a modern paper company has shown that bagasse is capable of being worked up into the very finest grades of paper, some of which can bring as high as $300 a ton. A similar test is now being conducted on a larger scale, and if the results prove successful we may hope for the establishment of several paper mills in the sugar producing sections of our State.

Among other laboratory investigations, the action of enzymes, or natural ferments, during the ripening and windrowing of cane, and the concomitant changes in the composition of the juice, have been studied. The losses from the fermentation of cane juice, by yeasts, moulds and bacteria, have also been investigated. During the past grinding season several different methouds of extraction were tested, with special reference to the composition of the juice from each mill. The station has also recently taken up the study of another very important question bearing upon the sugar industry, viz: That of the composition and feeding value of mixed feeds containing molasses. The manufacture of these feeds is attracting much attention at present, and the industry gives promise of assuming considerable importance, since it offers our planters a greater market for their surplus molasses, as well as a more convenient means of feeding this by-product.—Sixteenth Annual Report of the La. Ag. Experiment Station, 1903.

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PROGRESS OF THE BEET-SUGAR INDUSTRY.

A report of the Progress of the Beet-Sugar Industry in 1903, prepared by Charles F. Saylor, special agent of the U. S. Department of Agriculture, and printed by authority of Congress, is about to be issued. It shows that there has been an increase in the number of beet-sugar factories in the United States from 43 at the close of 1902 to 56 at the beginning of 1904. Fifty of these were in operation during the "campaign" of 1903.

According to the report the sugar-beet crop of 1903 amounted to a little more than 2,000,000 tons harvested from 242,576 acres, the average yield being about 8½ tons to the acre. The prices which the farmers received for beets from the different factory companies ranged from $4.50 to $5.60 per ton, the average being nearly $5. The average gross returns to the farmers were, therefore, $42.50 per acre. The estimated cost of growing beets by irrigation is $40 per acre, and in sections where irrigation is not necessary, $30. If $35 be taken as the average for the whole crop of 1903, the average net profit to the farmers was $7.50 per acre. In some of the sugar-beet areas, the returns were very much higher than this general average. As in the production of other crops, much depends on the season, the character of the land, and the kind of farmer who grows the beets. Many farmers have cleared from $25 to $50 per acre. The best result on record for 1903 was secured by a farmer of Otero county, Colorado. He grew one acre of sugar beets at a cost of about $37.50; the yield of beets was 33 tons, for which he received $158, his net returns being about $130.

The amount of sugar made from the beet crop of 1903 was 240,604 tons, as compared with 218,405 tons from the crop of 1902, and 184,605 tons from that of 1901.

Within the past few years there has been a remarkable increase in the percentage of sugar in the beets. A few years ago 12 per cent. of sugar was the standard. Last year in many cases the entire crop sold to a factory averaged 15 to 18 per cent.

There is a prospect that many new factories will be built in the next year or two. Many improvements are being made in methods and machinery used in the growing and handling of beets. The beet pulp produced by the factories is used by the farmers as feed for their stock more generally than heretofore.

The report will be for distribution by Senators, Representatives and Delegates in Congress, and by the Department of Agriculture.

A NEW SUGAR-PRODUCING PLANT.

Several references have recently been made in scientific and other journals to a new source of sugar. We reproduce the following account of the plant from the Gardeners' Chronicle of March 19:

In the early part of 1901 the authorities at Kew, as we learn from Mr. Hillier, received from H. B. M. Consul at Asuncion, Paraguay, fragments of a composite plant credited with possessing a remarkable sweetening property, a few leaves being sufficient to sweeten a strong cup of tea or coffee, giving also a pleasant aromatic flavor. The plant was discovered growing in the highlands of Amambaya and near the source of the river Monday by Dr. Bertoni, and described by him in Revista de Agronomia, ii, pp. 35-7 (1899) under the name Eupatorium rebaudianum. From the meagre material received at Kew, it was found that the smallest portion caused a persistent sweetness in the mouth, and further that the floral structure of the specimen agreed more nearly with the genus Stevia than with Eupatorium, its affinity being with S. collina, Gardner. The foregoing facts are gathered from the Kew Bulletin for 1901, p. 173; and we find upon inquiry that living plants or full herbarium specimens are still desired at Kew to facilitate the identification of this interesting plant.

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SUGGESTIONS FOR THE USE OF FORMALDEHYDE IN THE BEET AND CANE SUGAR INDUSTRIES BASED ON RESULTS OBTAINED IN SIMILAR INDUSTRIES.

In Beet Sugar Factories a Field for Experiment.— If it should become necessary to store beets extensively in best sheds or in silos or otherwise, we are positive that a treatment with a solution of Formaldehyde will prevent any deterioration of the beet brought about by germ diseases, such as fermentation, etc., which can be absolutely prevented by proper treatment. The correct treatment in every individual case should be determined by careful experimenting. The sprinkling with a 2% solution done frequently during the time the beets are being heaped for storage, will probably be sufficient, but may have to be repeated if any sign of deterioration should show itself in time.

For beet sheds or big factory silos a sprinkling arrangement, like that in use for fire purposes may be recommended, or hose connections for hand sprinkling fed from a high reservoir containing the diluted solution, as the diluted solution will not affect the pipes and fittings.

All samples of cossettes should be treated with formaldehyde to prevent deterioration during the time before the tests can be made in the laboratory.

A very promising use of Formaldehyde is at the diffusion battery. Remarkably good results are claimed to have been obtained in Germany. We recommend careful experimenting in that line. Introduced in the diffusion water, the Formaldehyde transforms soluble and non-coagulating proteins and pectines in the chips into insoluables, which are retained in the chips, thus giving both a purer and better diffusion juice and a richer chip for feeding. The Formaldehyde also has a disinfecting influence preventing the formation of ferments. In fact, its first use in the battery was for this purpose. The results of the use of Formaldehyde at the battery may be looked for in higher purity, lighter color and sterile juices. It is very advisable to keep some of the solution at the bottom of sample vessels collecting the samples of chips and diffusion juice for the laboratory.

Such appreciable improvement has been noticed in the quality of the diffusion juice by the use of Formaldehyde that reduction in the quantity of lime used at the saturation has been accomplished. Throughout the entire process Formaldehyde can be employed with great success in preventing deterioration of the juices, especially in thin juices and wash waters from filter presses, daneks, etc., absolutely preventing fermentation where properly used.

In this connection its adaptability to uses with the osmose process is most apparent. We believe by introducing the dilute solution of Formaldehyde into either the water or molasses (preferably the former) before entering the osmogene that the usual destruction of sugar in this process can be avoided. It may prove necessary to again treat the syrup upon entering the evaporator or pan for concentration to prevent the "loss in purity" so often noted at this point, especially when delayed in process. To avoid loss upon melting yellow sugars and to obtain a lighter colored and better liquor it is also claimeed Formaldehyde can be mixed with all yellow sugar. This is especially true of sugars accumulated at the end of a campaign and intended to be carried over until the following season before being melted.

At the close of a season or at any time when the process is stopped or delayed, a thorough washing of tankage, pipes, etc., as well as floors, corners, etc., with a solution of Formaldehyde will prevent the "souring" and the consequent dangers therefrom.

In Cane Sugar Factories.— Good results are reported to us the very first from the use of Formaldehyde in cane sugar mills. Treatment of the juices similar to that above suggested for beet houses having been tried successfully. Of especial value is the treatment of raw sugars which are to be shipped or held for a time, especially in tropical countries.

In some instances the immersion of the bags to be filled with raw sugar in a Formaldehyde solution will suffice to preserve the contents and in all instances this is of great benefit, the sugar bags to be thoroughly soaked in a solution of 1 pint of Formaldehyde to 40 gallons.

We quote the following from a letter received by us from the superintendent of a raw sugar house in the West Indies, whom we induced to give the Formaldehyde a trial:

"I am in receipt of your kind favor of the 19th ult., and about a week ago came in possession of the Formaldehyde you mention, for both of which I beg to thank you very much. We are using the latter for preserving the average samples of mill juice destined for the laboratory and accumulating each day and night, with excellent results. We have also tried it in the juices in process of manufacture, whenever there resulted an unavoidable delay in the work, and have always found it to check fermentation, thus keeping these juices from deterioration. As the Formaldehyde can be used in so many different ways, I shall certainly keep on experimenting with it and shall be pleased to learn the promised results of your experiments at any time."

Concerning the uses of Formaldehyde as above described, in connection with the growing of sugar beets and in beet sugar and cane sugar factories extensive experiments are now being carried on, the results of which we will have from time to time.—Oxnard Construction Co. Bulletin.

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SUGAR MANUFACTURE IN MEXICO.

By George P. Anderton.

Up to five years ago the sugar manufacturing industry in Mexico was conducted principally under the most primitive methods, although for a number of years past a large number of moderate sized sugar houses have been equipped with modern machinery for single crushing, of almost entirely English, Scotch, French and German manufacture.

The profits in the sugar industry in Mexico have always been so satisfactory that up to five years ago the necessity for more economical methods, or for machinery which would extract all possible sugar from the cane, never appealed to the sugar planters. In other words, it was extremely difficult to convince the Mexican planter that there was any necessity for change, as his returns from the business were apparently already as satisfactory as he desired. Furthermore, the foreign manufacturers of sugar machinery seemed also to think it not worth while or not possible to persuade the planters that double milling outfit was immeasurably more profitable; and the industry was, therefore, simply jogging along, as was the industry in Cuba and Louisiana up to the time when prices had so declined as to make it impossible to make fair dividends on the money invested in the enterprise.

About five years ago, as I have stated above, some American manufacturers of sugar machinery, finding that on account of the political difficulties in Cuba, and the fact that the sugar raising districts of Louisiana were already thoroughly equipped with modern machinery, they needed new fields for their output, in order to be able to continue the manufacture of sugar machinery, naturally sought trade in Mexico, because they knew the industry in that country, although being conducted on a limited scale, was on a sound financial basis, and also that, from their standpoint, the machinery being used there was of antique type and impossible methods.

At first it was found a task of almost insurmountable difficulty to convince the sugar planters in Mexico that first class machinery could be manufactured in the United States, or, even admitting this to be the case, that the American manufacturers could sell machinery in competition with England. Of course, the foreign manufacturers, who up to that time had had the field to themselves, used every known argument to persuade the Mexican sugar planters that machinery manufactured in the United States was shoddy, cheap, and would not stand the wear and tear of ordinary usage.

In answer to the representations of foreign manufacturers the American manufacturers and engineers induced a number of the Mexican planters to visit the United States, and there inspect some modern sugar houses in operation, using only machinery of the highest type and working under the most modern methods. Here they saw that these mills, instead of leaving 60 per cent. of the sugar extracted from the cane in molasses, or bi-product, but 25 per cent. was left and instead of extracting 50 per cent. of juice, they extracted about 76 per cent. of juice; this economical process having been rendered imperatively necessary by the great decline in prices which had taken place practically within ten years.

This object lesson resulted in persuading a few of the bolder and most up-to-date planters to make a trial of the American machinery and methods. The results of their trials were so satisfactory that today it is no unusual thing to see the machinery of American manufacture given the preference over that of foreign makes, even at even figures. As, however, Mexico is still a new field, it devolves on the American manufacturer and engineer to be very careful to see that he only ships the highest type of machinery, as regards material and workmanship.

Especially is it important for the American shipper to learn how he should pack his machinery for export, as in this respect we have still much to learn from the English exporters. It is a very rare occurrence to see machinery consigned from England received in Mexico in a damaged condition, while, unfortunately, it is only too usual with regard to our own shipments.

There are practically three sugar districts in the Republic of Mexico: first, on the west coast, starting south from Guaymas, where irrigation is necessary, as the rainfall in this section amounts to practically nothing. Second, what might be called the central section, and which embraces part of San Luis Potosi and the States of Jalisco, Michoacan, Morellos, Guerrero, in part, and Oaxaca. This central section also requires irrigation, but it is well watered, as a whole, by numerous streams, and there is little or no difficulty in directing the water to the fields through canals and ditches. The third, or which might be called the alluvial section, comprises parts of the States of Tamaulipas, Vera Cruz, Tobasco, Chiapas and part of Campeche. This section requires no irrigation, as the climatic conditions are practically similar to those prevalent in the island of Cuba, there being always an ample rainfall for all agricultural purposes, excepting in Tamaulipas, where irrigation is sometimes resorted to to insure the proper development of the crops.

It can, therefore, be readily understood that wherever irrigation is required it means a large outlay of capital for construction of the necessary canals and aqueducts for the proper distribution of the water to the fields in question. American capital has shown a marked disposition to invest in and build up the sugar industry in what I have designated as the alluvial districts. This is principally from the fact that desirable sugar property in the central portion of the sugar producing sections commands a very high price, and most of the old Mexican landowners are unwilling to part with their properties, as the industry is an extremely profitable one, and is becoming more so as modern methods and machinery are installed.

There is also another reason why American capital shows a disposition to seek the alluvial or coast localities. The reason for this is from the fact that American capitalists are beginning to realize that, the climatic conditions of the lowlands being practically the same as those which have made Cuba hitherto the first cane sugar producing country of the world, and with the cheap labor, which, by the way, is not obtainable in Cuba, and which is rendered possible by the operation of the government on a silver basis, it is probable, if entered into on the proper basis and with the best management, of course, which is necessary for any enterprise, to make a fair profit even in exporting raw sugars to the States; while no doubt for a number of years sugar will continue to sell in Mexico for a price sufficiently high so as to make very large profits, as at present.

From the above it can be readily seen that the sugar manufacturing industry in Mexico is bound to be one of the most important enterprises in that country. A word of caution, however, should be given in this connection to those who desire or intend to embark in the cultivation and manufacture of the product; and that is, that they must be, first, sure of the location of their properties and make sure that they secure lands suitable for the best growth of sugar; second, that their facilities for transportation be, of necessity, such as to enable them to easily reach the markets, not only of Mexico but of the world (in case they desire to enter the export field); third, that in selecting the managers and overseers of their properties they employ only men of exceptional intelligence and broadmindedness, who are able and willing to adapt themselves to the customs of the country in which they must work; and fourth, in making their purchases of machinery, to do so only from the many well known and reliable first class manufacturers in this country.

By adhering closely to these details a sugar plantation in Mexico, particularly at this time, is not only a very profitable enterprise, but with the present magnificent system of government in Mexico the enterprise is a perfectly safe one from every standpoint, it being understood that good management be provided, while even cyclonic disturbances are rare in the sugar district.—Federal Reporter.

PLANTATION DIRECTORY.

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	Aug. Ahrens	Waipahu
Honolulu Plantation Co.	**	J. A Low	Aiea
Laie Plantation	x*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
Hana Plantation	xx	E. Worthington	Hana
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	**	Geo. Ross	Hakalau
Honomu Sugar Co.	**x	Wm. Pullar	Honomu
Pepeekeo Sugar Co.	**x	James Webster	Pepeekeo
Onomea Sugar Co.	**x	J. T. Moir	Papaikou
Hilo Sugar Co.	**	J. A. Scott	Hilo
Hawaii Mill Co.	x	W. H. C. Campbell	Hilo
Waiakea Mill Co.	*x	C. C. Kennedy	Hilo
Hawaiian Agricultural Co.	**x	W. S. Ogg	Pahala
Hutchinson Sugar Plantation Co.	**	C. Wolters	Naalehu
Union Mill Co.	*x	Jas. Renton	Kohala
Kohala Sugar Co.	*	E. E. Olding	Kohala
Pacific Sugar Mill	x**	D. Forbes	Kukuihaele
Honokaa Sugar Co.	x**	K. S. Gjerdrum	Honokaa
Kona Sugar Co.	xxx	E. E. Conant	Holualoa
Olaa Sugar Co.	xx*	F. B. McStocker	Olaa
Puna Sugar Co.	xx*		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		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)
xx	M. S. Grinbaum & Co.	(2)
xxx	H. Waterhouse & Co.	(1)
*x	T. H. Davies & Co.	(9)
**x	C. Brewer & Co.	(5)
x*	Alexander & Baldwin	(6)
x**	F. A. Schaefer & Co.	(3)
xx*	B. F. Dillingham & Co.	(2)
x*x	H. Waterhouse & Co.	(3)
††	Hind, Rolph & Co.	(2)

HONOLULU STOCK AND BOND EXCHANGE, JULY 26, 1904.

STOCK	Capital Authorized	Shares Issued	Capital Paid up	Par Value	Last Sale
MERCANTILE					
C. Brewer & Co.	$ 1,000,000	10,000	$ 1,000,000	$ 100	390
SUGAR					
Ewa Plantation Company	5,000,000	250,000	5,000,000	20	20
Hawaiian Agricultural Co.	1,200,000	12,100	1,200,000	100	102½
Hawaiian Com'l & Sugar Co.	10,000,000	100,000	2,312,750	100	50
Hawaiian Sugar Company	2,000,000	100,000	2,000,000	21	22
Honomu Sugar Company	750,000	7,500	750,000	100	105
Honokaa Sugar Company	2,000,000	100,000	2,000,000	20	13
Haiku Sugar Company	500,000	5,000	500,000	100	100
Kahuku Plantation Company	500,000	25,000	500,000	20	18
Kihei Plant. Co. Ltd.	2,500,000	50,000	2,500,000	50	6½
Kipahulu Sugar Company	160,000	1,600	160,000	100	
Koloa Sugar Company	500,000	5,000	500,000	100	125
McBryde Sug Co. Ltd.	3,500,000	175,000	3,500,000	20	4
Oahu Sugar Co	3,600,000	36,000	3,600,000	100	87½
Onomea Sugar Co	1,000,000	50,000	1,000,000	20	24
Ookala Sugar Plantation Co.	500,000	25,000	500,000	20	10½
Olaa Sugar Co. Ltd.	5,000,000	250,000	5,000,000	20	4½
Olowalu Company	150,000	1,500	150,000	100	
Paauhau Sug. Plantation Co.	5,000,000	100,000	5,000,000	50	12
Pacific Sugar Mill	500,000	5,000	500,000	100	
Paia Plantation Company	750,000	7,500	750,000	100	250
Pepeekeo Sugar Company	750,000	7,500	750,000	100	
Pioneer Mill Company	2,750,000	27,500	2,750,000	100	86
Waialua Agricultural Co.	4,500,000	45,000	4,500,000	100	40
Wailuku Sugar Company	700,000	7,000	700,000	100	275
Waimanalo Sugar Company	252,000	2,520	252,000	100	160
MISCELLANEOUS					
Wilder Steamship Company	500,000	5,000	500,000	100	115
Inter-Island Steam Nav. Co.	600,000	6,000	600,000	100	110
Hawaiian Electric Company	500,000	5,000	500,000	100	95
Honolulu R. T. & Land Co.	1,250,000	P. 3,390 C. 8,000	1,139,000	100	100 70
Mutual Telephone Company	150,000	15,000	150,000	10	8½
Oahu Railway & Land Co	4,000,000	40,000	4,000,000	100	75
Hilo Railroad Co.	1,000,000	50,000	1,000,000	20	17
BONDS	Auth. of Issue		Amt. Issued		
Haw. Terr'l. 4 per cent Fire Claim)	$ 326,000		315,000		96
Haw. Terr'l. 4½ per cent	5,000,000		1,000,000		
Hawaiian Govt. 5 per cent	936,000		870,000		100
Haw. Com'l & Sug. Co. 5 p. c.	2,500,000				
Ewa Plantation 6 per cent	500,000		300,000		100
Haiku Sugar Co., 6 per cent	300,000				100
Haw. Sug. Co. 6 per cert.	700,000				
Hilo Railroad Co., 6 per cent	1,000,000		1,000,000		100
Hono. R. T. & L. Co, 6 p. c.	1,000,000		610,000		105
Kahuku 6 per cent	200,000		200,000		100
Oahu Railway & L'd Co 6 p. c.	2,000,000		2,000,000		104
Oahu Sugar Co. 6 per cent.	750,000		750,000		100
Olaa Sugar Co. 6 per cent	1,250,000		1,250,000		100
Paia Plant. Co., 6 per cent	450,000				100
Pioneer Mill Co., 6 per cent	1,250,000		1,250,000		100
Waialua Agr. 6 per cent	1,000,000		1,000,000		100