BULLETIN

OF THE

BOTANICAL DEPARTMENT, JAMAICA.

EDITED BY

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NEW SERIES. Vol. VI.

1899.

ASTON W. GARDNER. & CO.,
Printers, Publishers, Bookbinders, &c., &c.,

1899.

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New Series.] JANUARY, FEBRUARY, MARCH, 1899. Vol. VI, Parts I-III

A VISIT TO MONTPELIER.

By William Harris, Superintendent, Hill Gardens.

Montpelier, the property of the Hon. Evelyn Ellis, is situated in the parish of St. James, on the border of the parish of Hanover, and is $102\frac{3}{4}$ miles from Kingston on the Montego Bay line. This line of railway is laid through some of the most fertile, and most picturesque parts of Jamaica. Between Kingston and Montpelier there is an infinite variety of views of hills and vales, and as the train winds in snake-like fashion round the sharp curves through the cockpit country, the scene is ever changing and charming. For the tourist or pleasure-seeker who wishes to see something of this beautiful island, no more delightful trip could possibly be provided than the railway journey between Kingston and Montpelier, or Montego Bay which is only 10 miles further on. Immense Guinea-grass pastures with magnificient shade trees ; Banana, Sugar-cane, and Logwood estates ; Orange groves, Pimento or Allspice groves, and cattle pastures are passed by in rapid succession. Tropical fruit trees are plentiful everywhere along the line, the handsome foliage of the useful Breadfruit tree being especially noticeable.

Montpelier is reached in due time, and the visitor cannot fail to be struck with the general air of prosperity which is everywhere observable. The Station is built of cut stone, and is a serviceable, yet elegant building with a piazza right round it, and handsome foliage plants in pots assist considerably in producing a refined effect not usually seen in connection with buildings of this class.

A short distance from the Station the Montpelier Hotel is situated on the summit of a low hill, and commands a fine view of the surrounding country.

Tobacco Cultivation.—Opposite the Railway Station may now (January) be seen a field of tobacco, which is a model of high-class cultivation. There are 60 acres of tobacco in this field, and the plants are in a most excellent condition, planted in rows which are perfectly straight. The entire field has been planted out with seed imported from Havana and distributed by the Department of Public Gardens.

During the month of February four more plots are to be planted out with seedlings of the following varieties:—Sumatra (seed from Public Gardens) Vuelta de Abajo ; Silky Pryor ; Connecticut seed leaf ; (the three last varieties imported by Mr. Zurcher)

About six months ago this land was a pasture in bush, with a great many large trees. The lower portion of the land was swampy and had to be drained. The bush and trees were cut down, and the large roots and rocks were blown up by dynamite. Trenches from three feet to five feet deep were dug to carry off surface water after heavy rains. After getting rid of the bush, the land was ploughed and cross-ploughed ; harrowed, and broken up with clod-crushers and cultivators ; all stones, roots and rubbish removed ; the heavy land drained, and the whole so thoroughly turned up and pulverised as to resemble an immense garden seed-bed. Water-pipes were laid down through the plantation so that the young plants may be watered during dry weather till they are established. The plantation is divided into plots of equal dimensions, each plot contains 2 acres. There is a coloured plan of the plantation giving the number of each plot, and a very carefully kept record shows the date of planting each plot, the number and distances of plants put in, the dates of hoeing, moulding, disbudding, topping, suckering, and of cutting. The following is an example :—

1st Plot planted 3rd and 4th November 1898.
1st Hoeing 14th November.
2nd Hoeing 30th November.
3rd Hoeing 16th December.
1st Moulding 30th November
2nd Moulding 16th December.
Disbudding commenced, 9th December
Topping commenced 14th December.
Suckering 27th December.
First plants cut 28th December.
Second lot cut 30th December.
Third lot cut 5th January, 1899, and every day after.
The total plants put out, in round numbers, is 450,000.

The most remarkable thing about the plantation is that there is not the vestige of a weed to be seen. A large number of labourers are employed, and the owners believe in thorough supervision.

Every gang of 8 to 12 labourers is supervised by a headman, and these are in turn supervised by experts, who are again under the direction of a Cuban manager and his assistant, and the whole is under the personal supervision of the courteous and energetic co-proprietor, Mr. O. Zurcher. A cook and water-carrier is provided for each gang. The wages paid are—men 1/, women 6d, and headmen 1/3 and 2/ per day. Everything is being done, and no expense is spared, to make this experiment a success. Gangs of children are employed searching for caterpillars and grubs. Two kinds of caterpillar are troublesome; one cuts round holes in the leaves which render them useless for wrappers, and considerably reduce their value; another cuts the plants below the surcace of the ground and of course kills them. Thousands of these pests are captured every day by boys and girls. In addition to the gangs of children, about 50 turkeys are employed, and are slowly driven up and down the rows by women. The birds have become so accustomed to their work that they seem to know what is required of them, and they destroy enormous numbers of pests. To still further diminish the numbers of troublesome pests, large bath-pans are stood on elevated platforms, about six or seven feet above the ground, and are half filled with water with a little kerosine oil floating on the surface. Over each bath-pan a hurricane lantern is suspended. The lanterns are lighted after dusk, and the lights attract moths and other nocturnal insects, and large numbers of them are drowned in the bath-pans. We may infer that many of the insects thus destroyed are females about to lay their eggs, so that by this simple, and comparatively inexpensive contrivance, much trouble and loss are avoided. I may mention here that a small plot of land is being cultivated in the following fashion: the bush was cleared and burnt; and at a distance of 18 inches in the row, holes were dug 1 foot deep by 9 inches diameter; distance between the rows 3 feet. This will be planted, and will receive the care usually given to the Tobacco plant, and the results will be carefully noted. The tobacco curing houses are situated in the midst of the plantation, on rising ground. One house was complete, and at the time of my visit was being rapidly filled with tobacco, another was in course of contruction; and a third one will probably be necessary. The greatest care is taken that the tobacco leaves shall not come in contact with the ground; they are gummy, and if allowed to touch the earth small particles of soil adhere to them, and these, when dry, become gritty and injure the leaves, and altogether lessen their value. The plants are cut, carefully strung on bamboo poles, and are removed to the curing house without loss of time. The curing houses are each 109 feet in length by 29 feet in width, and will hold about 100,000 plants each. There is a path down the centre of about five feet wide, and the sides are then divided into seven sections, each 12 feet by 12 feet.

The buildings are substantial structures, made of good Pitch Pine lumber, thatched with leaves of the thatch palm (Thrinax). The sides are boarded, and the boards are placed upright from the sills to the wall plates ; every alternate board is hinged, and they are made to open outwards and act as ventilators. A hygrometer is kept in the curing house and is frequently consulted, and the ventilation is regulated according to the moisture indicated by the instrument. The mean humidity daily varies between 68 o/o and 88 o/o highest 94 o/o lowest 54 o/o.

An expert tobacco curer is now on the way out to take charge of the crop during the curing process. Just behind the curing houses there is an ash shed capable of holding 400 barrels of ashes, to be used for fertilising the land for next crop. This will be for the present the only form of manure, or fertiliser used for tobacco.

I was shown some corn (maize) plants, the seeds of which were sown on the 9th November ; two months later the ground was required for tobacco, and the corn plants, then about three feet high, were pulled, and are being dried, when they will be used for feeding stock.

Dried Banana Factory. Leaving the tobacco field, the dried banana factory was visited. Visitors are not usually admitted to this part of the establishment, a special permit being necessary. The drying operation is a secret ; much valuable time, and large sums of money having been spent in perfecting the process. Failure followed failure in the first attempts to turn out a marketable article, but nothing daunted, the proprietors persevered, and that they have at last succeeded may be judged by the fact that the first order received by them was for five tons, and a subsequent standing order for five tons dried bananas per week.

The bunches of green bananas are hung on racks to ripen in a room fitted up for that purpose. They are prepared and passed through the dryers, the machinery of which is worked by a powerful steam engine going day and night. The dried bananas are then placed on sorting tables and are carefully graded and packed by girls, this branch of the establishment being under the direct superintendence of a lady.

In a line with the dried banana factory are shops for carpenters, and blacksmiths ; a large store, fully stocked with all kinds of engineers' carpenters', blacksmiths', agricultural and other tools and hardware, everything of the best ; a place for everything and everything in its place. Adjoining are the offices of Mr. Zurcher and the manager, etc. also a large Silo in which 2,200 cart-loads of grass are now under pressure.

In addition to silage, hay and other cattle foods, a food made on the premises is being tried. This, I understand, consists of green bananas and the fruits of bastard cedar (Guazuma) specially prepared, and it is said to be excellent, and nutritious.

These foods are not being given to the cattle in a careless, haphazard way, but in stated quantities at stated times and the cattle are weighed at regular intervals and the results recorded. In connection with the establishment there is a fully equipped laboratory in charge of a highly qualified analytical Chemist, who is always at work analyzing various samples.

The foregoing are only a few of the many experiments being carried on at this huge Model Farm, or private Experiment Station. The various experiments are in charge of men, each of whom is an expert in his own particular branch ; no expense is spared to make everything a complete success, yet, at the same time, money is not wasted, but is judiciously spent, and a careful account is kept of expenditure, and of failures as well as successes.

Apart from the large sums spent on labour, and on supervision, such an establishment must be productive of an immense amount of good in the district in which it is located, and, also, in the surrounding district.

The large numbers of young men and labourers employed are taught to do everything in the proper way ; nothing is shirked ; slovenly work is not tolerated ; everything is done thoroughly. Ploughs, harrows, cultivators and other useful agricultural implements are in constant use, and not merely one or two of these, but many of each ; substantial buildings have been put up ; and others are in course of erection ; good stone-walls have been built, and superior fences erected ; swampy land has been drained, and dry fields have been supplied with water ; pastures which at one time were in dense bush are now kept in excellent order ; improved breeds of cattle have been imported at great expense, and look sleek and happy. These are some of the object lessons placed before the people of Montpelier and the surrounding districts, who cannot fail to profit by them. I firmly believe that one visit to an experiment station, conducted on somewhat similar lines, would do more towards enlightening a sceptical man than a month's talking, however convincing the arguments put forward might be.

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RECENT EXPERIMENTS ON DENITRIFICATION. *

Notwithstanding the high position that artificial manures now take in the estimation of farmers in all parts of the world, it cannot be said that they have done anything to displace the use of farmyard manure, which must still be regarded as our most general and important fertiliser. All the farmyard manure produced in this country is still applied to the land, and artificials find their legitimate place as sources of plant food on areas that the available supply of home-made manure is insufficient to dress.

So important is the part played by farmyard manure in modern agriculture that it is a matter of surprise that a greater amount of scientific attention has not been devoted to investigating methods by which it may be best conserved and utilised. Recently, however, the German Agricultural Society has turned its attention to the subject with much vigour, and has enlisted the services of a large number of distinguished scientists for the work, of whom perhaps the best known are Wagner of Darmstadt, and Maercker of Halle. Although the investigations are still in progress, they have already furnished results of such a startling character that, whether we accept them as practically applicable or not, we are at least forced to give them our serious attention.

Nitrogenous Compounds in Farmyard Manure.

The most valuable constituent of farmyard manure is undoubtedly the nitrogen, and it is chiefly with nitrogen that investigators have so far dealt. This substance exists in the mixed mass that we call farmyard manure, partly in the solid faeces, partly in the liquids, and partly in the litter ; and accordingly it becomes of importance to determine the relative values of the nitrogen in these three main groups.

In the fresh solid excreta of the horse, cow, and ox, Maercker has shown that the great bulk of the nitrogen (generally 80 to 90 per cent) is in the albuminoid form, the rest being present as ammonia, nitric acid and amides. The constituents and action of sheep dung were also investi-

* From Journal of Royal Agricultural Society of England, Vol. VIII.

gated, but as this manure is seldom dealt with as farmyard manure in this country we need not occupy space in examining it.

Of the four forms of nitrogen in the dung, that present as albuminoids is extremely slow in its action, and probably but little of it is ever assimilated by plants at all. The other three forms are, however, easily appropriated by plants, the ammonia and nitric acid being of equal value with nitrogen in the form of sulphate of ammonia and nitrate of soda, while the amide nitrogen is also nearly as active.

The nitrogen in urine is originally, for the most part, in the form of urea, a substance which passes with great rapidity into carbonate of ammonia and is practically as available as sulphate of ammonia, although, no doubt, more liable to waste. Wagner found that at ordinary temperatures the nitrogen in a mixture of urine and water was practically all converted into ammonia in three or four days. The nitrogen in straw is chiefly in the albuminoid form and is of but little value.

Action of Dung on other Nitrogenous Substances.

When various samples of pure horse, cow, and ox dung were employed for supplying nitrogen to plants cultivated in pots filled with soil that contained abundance of phosphoric acid and potash, the results were of a most unexpected character. Maercker found in the case of oats that where he applied no nitrogen the yield was 44.82 grammes of grain and straw, and when he added 1.50 grammes of nitrogen in the form of nitrate of soda the produce was 128.37 grammes an increase amounting to 186 per cent. When, however, he used 2.25 grammes of nitrogen derived from two different samples of horse-dung, from cow-dung, and from ox-dung respectively, the yields were only 35.91, 23.33, 41.65, and 46.60 grammes. Both samples of horse-dung reduced the yield, in one case by 20 per cent., and in the other by 48 per cent. while in the case of cow dung, the reduction was 7 per cent. Of the four kinds of dung, only that of the ox was capable of increasing the produce, and that to the extent of but four per cent. The appropriation of nitrogen by the plants was in much the same ratio, in two cases there being slightly more of this element in the yield produced under the influence of dung than when the soil was unmanured, while in the other two cases there was less. Maercker repeated this experiment with white mustard, and obtained practically concordant results. Without any nitrogenous manure he obtained 3.1 grammes of produce, with 0.75 gramme of nitrogen in nitrate of soda the yield was 41.3 grammes, while with 2.25 grammes of nitrogen in two samples of horse-dung the yield was only 3.9 and 3.2 grammes, a trifling percentage of the added nitrogen being recovered in one case and none in the other.

Wagner's experiments were conducted with white mustard, each test, as in Maercker's case, being repeated three times, and the results show great uniformity. Without any nitrogen, beyond what the soil contained the average yield of mustard was 1.6 grammes, while it amounted to 35.6 grammes when 2 grammes of nitrogen in the form of nitrate of soda were applied to each pot. Using the same quantity of nitrogen, the yield with cow-dung averaged 0.5 gramme, and with horse-dung, 0·4 gramme a drop of 69 and 75 per cent. respectively. In both cases not only had no nitrogen been appropriated by the plants from the dung but it was even found that the plants upon the dunged pots contained less of this element than the plants grown without any added nitrogen. Even assuming that the albuminoid nitrogen in dung is absolutely inoperative, there still remained an appreciable amount of ammoniacal and amide nitrogen which, if applied alone, would certainly have produced an increase in the crop. In some way or other, then, the action of this active nitrogen was hindered and the results on certain of the other pots throw some light on this matter. In Maercker's experiments it was found that whereas 0·75 gramme of nitrogen in the forms of nitrate of soda and urea respectively were capable of more than doubling the yield when applied to the soil without dung, their action was very much less when they were added to soil that contained either horse, ox, or cow-dung. By a series of experiments and calculations Maercker showed that from 12 to 47 per cent. of the nitrogen in nitrate of soda was dissipated through the contact with the various forms of dung in the soil, and the loss was greatest when the largest quantity of dung was used.

Wagner also tested the action on mustard of nitrate of soda alone and in conjunction with horse-dung, and found that whereas 65 per cent. of the nitrogen in the nitrate was recovered when it was applied alone, only 30 per cent. was recovered when it was added to a soil holding a moderate dressing of horse-dung. And not only did the horse-dung greatly depress the nitrogen-recovery from nitrate of soda, but it acted in a precisely similar manner when the active nitrogen was furnished to the soil in the form of urea and chopped lucerne. With urea the nitrogen recovery was 60 per cent. when used alone, but only 49 per cent. when used with dung; while in the case of chopped lucerne the respective figures were 38 and 8.

In another very extensive and thorough going experiment with oats, Wagner tested the result of the application of nitrogen to pots holding eighteen and a half kilogrammes of soil, the nitrogen being derived from nitrate of soda, sulphate of ammonia, blood meal, chopped grass, cow urine, horse and cow-dung, and various samples of farmyard manure. The figures are too extensive to be dealt with as a whole, but attention may be called to some of the results obtained. Thus, when nitrate of soda was used alone to the extent of two and four grammes of nitrogen per pot, the nitrogen recovered in the crop increase was 77 per cent. and 59 per cent. respectively. That the larger dose of nitrate had still ample opportunity to act is evident from the fact that it increased the average yield from 244.3 grammes (the yield with the smaller dressing) to 285.9 grammes per pot. The fresh horse-dung, containing two grammes of nitrogen, produced 9.1 grammes less yield than the unmanured pots, and the produce also contained less nitrogen. When 2 grammes of nitrogen in horse-dung were added to pots containing 2 grammes of nitrogen derived from nitrate of soda there was a depression of the yield from 244.3 grammes to 177 grammes; when the dung was added to pots holding sulphate of ammonia there was a drop in the yield from 231,5 grammes to 165.7 grammes; when added to pots getting chopped grass the drop in produce was from

156.0 to 62.6 grammes and when added to pots getting cow-urine, the drop was from 216.7 to 146.1 grammes. Or, from the point of view of nitrogen recovery, the case may be stated thus : that whereas 77 per cent. of nitrogen was recovered when nitrate of soda was used alone, only 52 per cent. was recovered when in the presence of horse-dung ; the percentage reduction in the case of sulphate of ammonia being from 69 to 50 ; in the case of chopped grass from 43 to 20 ; and in the case of urine from 69 to 40.

What, then, is the cause of the depressing action of dung, especially horse-dung, on more active forms of nitrogen ? It might be urged that the dung in some way or other prevents the organic nitrogen in, say, green manure from being converted into ammonia ; but that this explanation is valueless is proved by the fact that the dung also materially interfered with the action of sulphate of ammonia. Nor can it with justice be urged that the depressing action of the dung is due to its interference with the nitrification of ammonia for the loss was quite as great when a ready-formed nitrate was applied to the soil.

When fresh or comparatively fresh dung is applied to a crop, and especially to a cereal crop, it frequently causes the plants to assume a pale yellow, unhealthy colour. This unhealthy condition might be due to one or other of two causes : either the dung might unfavourably affect the physical condition of the soil ; or, while itself offering no available nitrogen to the plants, it might have an injurious influence on the available nitrogen naturally present in the soil. In the latter case the unhealthy character of the crop would be due to the plants being more or less starved as regards nitrogen, and that this is the true explanation is clearly indicated by Wagner's pot experiments with oats. When the plants were about six inches high it was found that those in the dunged pots were much yellower than those in the unmanured soil, and while in this condition they received a weak solution of nitrate of soda. Doubtless some of the nitrate was rendered inoperative through contact with the dung, but enough was absorbed by the plants to produce a marked change in colour in three days, while in a week the sickly yellow colour had entirely disappeared.

To show that the disappearance of the nitrogen of nitrate of soda in presence of dung is not due to its sinking into the subsoil, and is only partly due to its appropriation by plant-roots, Wagner carried out the following experiment, in which no plants whatever were grown. A number of pots were filled on June 1st, with 3.4 kilogrammes of garden soil, to which had been added 0.66 gramme of phosphoric acid and 0.49 gramme of potash in the form of potassium phosphate. Certain of the pots received ½ gramme of nitrogen in the form of nitrate of soda ; others received 600 grammes of horse dung, while others received both. Six weeks later, namely on July 10th, the soluble contents of the pots were carefully extracted with water, when it was found that where no dung was used the nitrate of soda was still present to the extent of 93 per cent., whereas in the pots getting horse-dung only 42 per cent. of the nitrate of soda remained. Not only had the dung dissipated a very large quantity of the nitrogen of the nitrate of soda, but it had also acted on the natural nitrates of the soil, and destroyed them as well. This is proved by the fact that whereas the filtrate from the soil receiving no nitrogen contained on the average 0.72 gramme of nitric nitrogen, that from the pots which contained horse-dung showed only 0.15 gramme of the same form of nitrogen. On other pots similarly treated mustard was grown, the yield being much reduced by the addition of horse-dung to the soil, whether with or without nitrate of soda.

In another set of experiments Wagner put 2 kilogrammes of soil into a series of basins, to all of which he added nitrate of soda containing nitrogen varying by 5 gramme from 0.2 to 1.4 gramme per basin. Certain of the basins received no dung, while others were supplied with 200 grammes and 400 grammes of this substance, holding 1 and 2 grammes of nitrogen respectively. The experiment lasted for sixteen days, at the end of which time the soil was extracted with water, and the amount of nitrate of soda that remained unaltered was determined. As a result it was found that where no dung was used practically the whole of the nitrogen of the nitrate of soda was recovered in an unaltered condition, but where horse-dung was present in the soil much of the nitric-nitrogen had disappeared, the percentage disappearance being, as was to be expected, greatest (a) where least nitrate of soda had been used, and (b) in the presence of the large application of dung. Taking the average results, it was found that where the smaller amount of dung was used the nitrate of soda had been reduced to the extent of 26 per cent., while nearly 51 per cent. had disappeared under the influence of the larger dressing.

How does Dung cause Waste of Nitrogen?

It now becomes of interest to ascertain what becomes of the nitrogen that loses its nitric form in the presence of dung. Does it take the form of some insoluble compound, or of ammonia, or of free nitrogen? This part of the subject has been dealt with by Wagner, Maercker, Stutzer, Pfeiffer, Dietzell, and others, and it has been conclusively shown that the nitrogen is dissipated in the elementary form, and, of course, escapes into the air. The method adopted to determine this point is a very simple one, and consists in placing a given quantity of nitrate of soda and dung in a flask of convenient size, through which air is drawn by means of an air pump. Before entering the flask the air is passed through sulphuric acid in order to get rid of any traces of ammonia, and similarly the escaping air and gases are passed through sulphuric acid of known strength. At the end of the experiment the loss of nitrogen is determined, and the difference between such loss and the ammonia produced may fairly be taken to represent free nitrogen. In every case it has been found that the nitrogen has been liberated in the elementary form, and that such liberation proceeds quite as actively when a constant stream of air is drawn through the mixture as when no such artificial air-circulation is secured. If air is altogether excluded denitrification ceases, and it is hindered more or less in proportion to the amount of aëration; but the free natural circulation of air would appear to create as favourable denitrifying conditions as are secured by more rapid and perfect artificial aëration.

That the denitrification and liberation of free nitrogen is due to the action of one or more bacteria appears to be proved by an experiment by Wagner. Two hundred and fifty grammes of fresh horse dung were placed in a flask along with 200 cubic centimetres of carbon disulphide, and the two substances were left in contact for six days. At the end of that time 50 grammes of the mixture were taken out and placed in a flask which was heated in a water-bath at a temperature of 60-65° C for four hours All the carbon disulphide having disappeared at the end of that time, 800 cubic centimetres of a solution of nitrate of soda holding 0.4 gramme of nitrogen were poured over the dung. Another sample of dung was dealt with in every respect in the same way, except that it was not treated with carbon disulphide. In four days it was found that the dung which had not been sterilised with carbon disulphide had reduced 56 per cent. of the nitrate, whereas not a trace of denitrification was found to have occurred in the sterilised solution. After the lapse of other three days the whole of the nitrate had been reduced by the unsterilised dung, while denitrification was just commencing in the sterilised material. In fourteen days from the time of placing the nitrate and sterilised dung together 12 per cent. of the nitrate had been reduced, and such reduction amounted to 19 per cent. at the end of twenty-five days. Evidently, therefore, the carbon disulphide had, to start with, cleared the material of active denitrifying organisms, their subsequent presence being due either to their development from spores that the carbon disulphide had not affected, or to immigration from the atmosphere.

There is thus no escaping from the conclusion that nitrates, whether naturally present in manure or the soil, or when added in so-called artificial manure, are rapidly destroyed by organisms which are very abundantion dung, and are also present, though to a much less extent, in soil. Maercker carried out a large series of experiments with a number of samples of farmyard manure obtained from the dung heaps of various farms, and found that although certain of the samples proved more denitrifying than others, still the results were, on the whole much the same as those obtained with pure faeces. He then proceeded to test the part played by the straw (wheat) in farmyard manure and found that when this substance was chopped up and applied to the soil it reduced the yield of oats by 89 per cent., and the aggregate yield of three crops of mustard, grown in succession in the same pots, by 74 per cent. The comparative merits of mixtures of urine and dung containing variable quantities of straw were also tested, and it was found that the crop was least, and the loss of nitrogen greatest, in the mixture that contained most straw.

Wagner's researches into the action of straw (rye) also show that this substance either contains denitrifying organisms in great abundance, or else it induces conditions highly favourable to denitrification. Thus, when a mixture of 300 grammes of dung, 2 grammes of nitrogen in nitrate of soda, and 4 litres of water, was placed in a flask, it took twelve days for complete denitrification to be effected, whereas seven days only were necessary when the mixture received an addition of 100 grammes of straw. In another case 2 grammes of nitrate nitrogen were completely denitrified in twenty-two days in a mixture containing rotten dung, whereas when 100 grammes of straw were added the process was completed in eight days. In a third series of experiments Wagner found that in a mixture of garden soil, water, and nitrate of soda the process of denitrification was not quite completed even after 400 days, whereas it was completed in six days when chopped straw had been incorporated with the mixture. Wagner obtained strictly confirmatory results when he tested the action of straw on the growth of mustard. With nitrate of soda only the yield of dry material amounted to 100.2 grammes and contained 2.495 grammes of nitrogen whereas the addition of a small quantity of straw—equal to less than 1 per cent. of the soil—reduced the yield to 71.5 grammes, and the nitrogen contents to 1.773 grammes.

Can the Denitrifying Action of Dung be Prevented.

If we accept the results indicated above as proving that farmyard manure has powerful denitrifying properties and it would appear to be impossible to escape from such a conclusion the question comes to be. What can be done to mitigate the nitrate-destroying action of the dung? Both Maercker and Wagner found that the denitrifying ferments disappear to some extent with age, as the following experiments will show. Maercker prepared a series of pots which he filled with soil, and to all of which he added fresh horse-dung holding 2 grammes of nitrogen. In one case he applie nitrate of soda (holding 1 gramme of nitrogen) along with the dung, in another case the nitrate was withheld for fourteen days, while in another case it was not applied for twenty-eight days. In each case mustard seed was sown at the time the nitrate was applied. When the nitrate was applied along with the dung, the dung reduced the yield (as compared with that got by nitrate only) by 38.8 per cent.; when the nitrate was not applied till fourteen days after the dung, the reduction in the yield which the dung induced amounted to 52.4 per cent; while in the case of the latest application—namely, twenty-eight days after the dung—the crop was reduced by 54.4 per cent. Evidently, therefore, four weeks had done nothing to modify the denitrifying properties of the dung—and, in fact, it proved more powerfully denitrifying after lying in the soil for fourteen and twenty-eight days than it was to start with.

Directly after the first crop of mustard had been reaped a fresh supply of seed was sown on all the pots, and simultaneously one gramme of nitrogen in the form of nitrate of soda was applied. The result with this second crop was that the dung in one case reduced the yield by 8.2 per cent., and in another case by 5.7 per cent., while in the third case the combination of nitrate and dung produced a yield that was 7.1 per cent. higher than that grown by nitrate of soda alone.

When this second crop had been cleared off, seed for a third was sown (the respective dates of the three sowings being separated by intervals of about five weeks), another gramme of nitrogen in the form of nitrate of soda being simultaneously applied. Neither in the case of the second nor of the third crop was any dung applied. The results were practically the same as in the case of the second crop, the dung on two occasions reducing the yield by 13.5 and 9.5 per cent. respectively, while in one case it increased the yield to the extent of 2.2 per cent.

Evidently, therefore, the denitrifying power of the dung is lost to a large extent by contact with the soil for two or three months.

Wagner carried out a series of experiments which also go to show that the denitrifying bacteria are much less energetic in old than in new dung. The system which he adopted was as follows :—A number of cemented pits of a capacity of one cubic metre (about 35 cubic feet) were prepared, and into each of these 500 kg. (about half ton) of fresh horse dung was placed. From these pits samples of dung were drawn every fourteen days, and the denitrifying influence of the dung was tested by placing 300 grammes in a flask along with 4 litres of water and 100 centimetres of a solution of nitrate of soda that contained two grammes of nitrogen. These flasks with their contents were placed in a room at a temperature of 50 to 57 ° Fahr., and were daily tested with diphenylamin, so that the time could be accurately determined when the whole of the nitrate of soda had been denitrified. In one series of pits the dung was turned over every seven days, and in another series it was turned once a fortnight, but so far as denitrification is concerned no difference whatever could be detected between these two systems. Confining our attention, therefore, to one series only—that where turning was done every fortnight—we find that the sample removed at the end of fourteen days took thirteen days to denitrify the nitrate solution, that removed at the end of a month took nineteen days, that removed at the end of six weeks took thirty-one days and that removed at the end of two months took forty-one days, while that removed at the end of ten weeks took sixty-five days. Or, looked at from another point of view, it was found that whereas dung fourteen days old completely denitrified the nitrate of soda in thirteen days, denitrification had only proceeded about halfway in the same time in the case of the six-weeks-old dung. Wagner points out that the superior action of well-rotted farmyard manure is probably in large part due to its not destroying the natural nitrates of the soil to anything like the same extent as occurs in the case of an application of fresh manure. This point was demonstrated by Wagner in pot experiments with oats. Nitrate of soda alone produced an average yield of 244.3 grammes, while the yield when equal quantities of nitrogen were added, in the one case in the form of fresh horse-dung, and in the other case in the form of rotton or " humified" (to Anglicise the word " humifizierter") dung, was 177.0 and 243.3 grammes respectively. This variation in the action of the two samples of dung of different ages was also emphasised when they were added to soil which had been manured with 2 grammes of nitrogen derived from cow-urine. With this substance alone the yield was 216.7 grammes, while it was 146.1 grammes when the urine was supplemented by fresh dung and 223.5 grammes when rotten dung was used.

Wagner and Maercker have been occupied with, and are still engaged upon, an extensive series of experiments into the conservation of the nitrogen and organic matter of farmyard manure, and the results so far obtained are of the highest interest and value. Space does not, however, permit of our reviewing those results ; but it may be pointed out that, although great loss of nitrogen, combined and in the elementary form takes place in the dung-heaps, the loss is almost entirely confined to the nitrogen of the urea ; the albuminoid nitrogen of the solid faeces and straw being dissipated to a very slight extent. As, however, it is only the nitrogen of the liquids that is of much value, the fact that that element is comparatively stable in the solids cannot prove a source of much satisfaction to farmers.

Reference to English Results.

In concluding this brief summary of a small section of recent German work I may refer to the light which it throws on some of the results that have been furnished by field experiments in this country. During the past few years agricultural societies, county councils, and colleges have conducted a large number of experiments and demonstrations on manuring, and one very conspicuous feature in the results that have been obtained has been the comparative lack of action that has frequently characterised the addition of all kinds of artificial manures to dung. Year after year we, in the North of England, have failed to obtain any increase of crop, worthy of practical attention, when artificials were used with dung, and indeed the artificials have sometimes positively depressed the yield. These results have hitherto appeared somewhat inexplicable, and were generally believed to be due to the fact that an average dressing of farmyard manure offered to crops as much nourishment as they could assimilate, and that supplementary applications of artificials were therefore inoperative. Now however, a flood of light is let in on the subject, and it is evident that nitrate of soda, for instance, when added to dung fails to act to the extent that might theoretically be expected, for the reason that the denitrifying organisms so abundant in the dung instantly attack the nitrate of soda and dissipate the nitrogen in the elementary form. And the researches of Wagner, Maercker,and others have shown that this loss of nitrogen is not confined to nitrate of soda, but is also met with to an almost proportionate extent in sulphate of ammonia and in organic manures. Probably the ammonia first requires to be nitrified, and the organic nitrogen to undergo ammoniacal fermentation and then nitrification, before the bacteria can liberate free nitrogen, but the final result is practically the same in all cases. Hence we have an explanation of the comparative lack of action that has in many English experiments attended the use of sulphate of ammonia, bone meal, dissolved bones, and other nitrogenous manures when added to dung. And not only has it been found that nitrogenous manures fail to act when applied in this way, but precisely similar results have been got with purely phosphatic and potassic manures. Here it cannct be a case of volatilisation of free nitrogen from the artificial manure ; but Wagner's experiments show that the negative results so frequently obtained when mineral manures are added to dung are intimately associated with denitrification.

It has already been pointed out that the denitrifying action of dung is diminished with age, but it now remains to be shown that certain substances when incorporated with dung have the power of greatly intensifying and prolonging its denitrifying action. The two substances used by Wagner that are of most interest to us are superphosphate of lime and kainit. In the end of May 1895 a number of cemented pits were filled with 500 kilogrammes of dung (about ½ ton), and in certain cases the dung as it was filled in was carefully mixed with the two substances referred to, in the proportion of approximately three parts per 100 of dung. On the average the dung was turned every ten days. At the end of ten weeks samples of dung were drawn from the various pits, and a given quantity used to denitrify a definite amount of nitrate of soda. On the average the dung that had been mixed with nothing took sixty-three days to effect complete denitrification, whereas those samples which had been treated with superphosphate and kainit effected complete denitrification in forty-one days and thirty-seven days respectively. On September 13th, after the dung had been in the pits for a hundred and twelve days, samples were drawn, and their denitrifying power tested on nitrate of soda for fifty-six days, at the end of which time the dung which had received nothing had reduced 8 per cent. of the nitrate, whereas the percentage reduction with the samples treated with superphosphate and kainit was 40 and 66 respectively.

In another series of experiments, where the dung was not turned it was found that samples taken at the end of a storage of eleven months denitrified as follows :—

Dung without any addition completely denitrified in 31 days.
,, with addition of superphosphate completely denitrified in 22 days.
,, with addition of kainit completely denitrified in 20 days.

Many other experiments could be quoted to show that when soluble phosphates or kainit are added to dung to the extent of 3 per cent.—and this is exactly the proportion in which a farmer mixes an artificial manure with dung when he applies 6 cwt. of the former along with 10 tons of the latter—the denitrifying power of the dung is intensified, and also longer maintained. The result is that the amide, ammoniacal, and nitric-nitrogen in the dung itself is more completely dissipated; and the same is also true with regard to the active forms of nitrogen naturally present in the soil with which the dung, or the ferments that it introduces to the land, may come into contact.

It seems to me that this explains why, when experimenting with 12 tons of dung per acre, we found that in 1893 the average crop of swedes on nine farms in Northumberland was 2 cwt. per acre heavier with 2½ cwt. of superphosphate than when we used 5 cwt. of that substance as a supplement to the dung. In 1894, on eleven farms in Durham, we obtained an average crop of swedes which was greater by 14 cwt. per acre when the smaller dressing of the same substance was similarly used. In 1895, on the average of nine farms in Cumberland, Durham and Northumberland, the crop of swedes was ¼ cwt. per acre heavier by the use of 5 cwt. as compared with 7½ cwt. of superphosphate ; and in the same year on the same farms, 2¼ cwt. of dissolved bones produced a crop that was 4 cwt. per acre heavier than that grown by a double quantity of the same manure. In all these cases the artificial manures were used with equal dressings of farmyard manure and it is only under such conditions that they have produced these anomalous results.

The German investigators whose work we have had under review have not offered any explanation of the prolongation of the denitrifying power of dung by the addition of such substances as phosphoric acid and potash, but it would appear to be reasonable to suppose that it is due to the better nourishment of the denitrifying bacteria under the influence of abundance of available phosphatic and potassic food. They have shown that the organisms can be largely destroyed (a) by frequently turning dung-heaps, so as to induce rapid fermentation, oxidation, and a high temperature, and (b) by adding certain substances, of which the most effective were found to be sulphuric acid and copper sulphate. And similarly, as has been indicated, there are doubtless substances that favour the growth and development of the organisms, and it would appear that some of our commoner artificial manures must be placed amongst the number. The whole subject is of such far reaching importance to agriculturists that it is to be hoped it will in the near future recieve in this country, the scientific attention that it appears to deserve

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DENITRIFICATION AND FARMYARD MANURE. 1

In the preceeding article Dr. Somerville has given a clear account of the very remarkable conclusions arrived at by modern German investigators respecting the behaviour of farm yard manure when applied under various circumstances to the soil. These conclusions, if established, would seriously modify our ideas as to the value of this manure, and as to the conditions under which it can be most profitably employed. The German experiments have been not only numerous, but have been conducted with great care and skill. We have, however, always to distinguish between the facts proved by experiment, and the conclusions drawn from them. The results of the experiments are undoubtedly true, and demand most careful consideration ; but to interpret these results, to grasp the principles which underlie the actions observed, we must first of all be thoroughly acquainted with all the circumstances of the experiments, and we must at the same time take into account any other facts bearing on the question at issue. A true theory is one which will explain *all* the facts, and not merely some of them.

The conclusions arrived at by Wagner and Maercker, with which we have in the first place to deal, are briefly the following :—

1. The solid excrement of the horse and cow is practically without value as a manure for plants.

2. When applied to the land, fresh horse or cow dung (2) destroys the nitrates naturally contained in the soil, or added to it in the form of nitrate of sodium, and the crop which immediately follows is consequently less than if no dung had been applied.

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(1) From Journal of Royal Agricultural Society of England, Vol. VIII

(2) In this paper the term " dung" is used to designate the solid excrements unmixed with urine or litter ; while " formyard manure" is employed in its usual sense, as the name for the mixture of the solid and liquid voidings of the animal with litter.

3. The use of horse or cow dung likewise seriously diminishes the return obtained from applications of sulphate of ammonium, urine or green manures.

4. Straw is also practically without value as a manure, and like dung, energetically destroys the nitrates in the soil.

5. Ordinary farmyard manure when applied to the soil acts in the same general manner as the dung and straw which form its principal constituents.

6. The denitrifying power of dung, straw and farmyard manure, is due to the presence in these substances of a special organism having the power of reducing nitrates.

7. The denitrifying power of dung, or of farmyard manure, is considerably diminished when the manure has become old and humified. The destruction of nitrate of sodium in the soil is also much less when the manure has been applied some time before the nitrate.

8. When the farmyard manure has been preserved by mixing with it superphosphate or kainit, its denitrifying power is little altered by age.

The whole of the German experiments, showing the actual effects of various manures on crops, appear to have been carried out in large zinc pots. Such pots are usually without drainage. They are provided with an outside pipe communicating with the bottom of the pot ; through this pipe water is supplied. An experimental series of pots usually occupies a truck, running on rails, and during inclement weather the whole of the pots can be brought under cover. This mode of experimenting has been carried to great perfection in Germany.

It is evident, from what has been said above, that the destruction of nitrates in the soil is regarded by the German investigators as the chief cause of the prejudicial actions observed by them when farmyard manure or its solid constituents, were applied to the soil; and this destruction of nitrates they believe to brought about by a special organism which the manure supplies. To gain a clearer light on the subject we will therefore, in the first place, briefly consider what takes place during the process of denitrification, and what conditions are favourable to the occurrence of this action.

The Process of Denitrification.

The subject of denitrification, has been carefully investigated by many scientists during the past thirty years, with the usual result that a great deal of the work done has been already forgotten, and is now buried in the ignorance of a fresh generation of workers. This scarcely avoidable occurrence happens most frequently when as in the present case, the modern worker belongs to a different nationality from that which produced the earlier investigators. An historical treatment of the subject would perhaps be unsuitable for these pages. Prefacing, therefore, our remarks by saying that Dr. Angus Smith of Manchester, in 1867, was apparently the first to observe the destruction of nitrates with the evolution of gas in decomposing organic solutions, we will proceed to take a general view of the facts connected with denitrification.

The reduction of nitrates which occurs in solutions, or soil, containing readily oxidisable organic matter is of several distinct kinds. The reduction may be simply from nitrate to nitrite ; or it may be from nitrate to nitric oxide gas ; or to nitrous oxide gas; or, finally, to nitrogen gas. The first form of reduction does not necessarily involve any loss of nitrogen ; all the others do involve a loss of nitrogen, as the product escapes in the form of gas.

The reduction of nitrates is occasioned by various species of bacteria. That the action in question only occurs in the presence of these living organisms was first established by Meusel (1875) in the case of natural waters, and afterwards shown by Dehérain and Maquenne (1882) to hold true in the case of soils. If all living organisms are destroyed in sewage or soil—if, to use modern language, these mediums are sterilised—neither nitrification nor denitrification will occur.

Bacteria reduce nitrates by bringing about the combustion of organic matter by the oxygen of the nitrate, the temperature distinctly rising during the operation. When circumstances are favourable to the process of reduction, the amount of nitrate reduced is determined by the quantity of combustible organic matter present. The combustion of the organic matter, and the reduction of the nitrate, can take place in the absence of air in the same way as gunpowder—composed of a nitrate, charcoal, and sulphur—is capable of burning under water. In the presence of air, the oxygen which it contains. takes the place, more or less, of the oxygen of the nitrate, and the reduction of nitrate is either diminished, or the oxidation of the organic matter much increased. The whole action is quite similar to the familiar combustion of food in the animal body ; or to the combustion of organic matter which occurs in plants, and notably in those which, as in the case with fungi, are destitute of chlorophyll.

Different species of bacteria behave very differently in a mixture of a nitrate and organic matter. Many species of bacteria are incapable of reducing a nitrate, though quite capable of effecting the combustion of organic matter with free oxygen. The reduction of a nitrate to a nitrite, but not to the state of gas, is, however, a very common property of bacteria. Only a few species appear to have the power of reducing a nitrate to gas, but these species are widely distributed. Dr. P. Frankland grew thirty-two distinct species of bacteria, obtained from atmospheric dust, and from natural waters, in a very weak solution, containing peptone, sugar, and a nitrate. One-half of the species tried reduced the nitrate to nitrate. The production of gas was apparently not noted, and would be scarcely perceptible under the conditions of the experiment. In a series of experiments conducted by myself in the Rothamsted laboratory, thirty-seven distinct species of bacteria were grown in clear beef broth containing ½ per cent. of nitre, at temperatures varying fron 70° to 95° Fahr. Of these, fifteen failed to reduce the nitrate ; three effected only a small amount of reduction to nitrite while nineteen reduced the nitrate to nitrite with great energy, one of them producing gas.

Gayon and Dupetit (1886) were the first to isolate the species of bacteria reducing nitrates to gas; two organisms having this property were separated by them from sewage. The action of the more active of these organisms was most intense. Cultivated in a solution of nitre containing asparagine and a citrate, the liquid evolved its own volume of gas per day, while the temperature rose 18 ° Fahr. The action was most energetic in the absence of oxygen, and ceased when the supply of oxygen became abundant. The work carried out by these investigators at the experiment station at Bordeaux should be studied by everyone desiring to obtain a scientific view of the phenomena of denitrification.

Quite recently Burri and Stutzer (1895) have isolated denitrfying bacteria from horse dung and from straw. These organisms differ in several ways. The one obtained from straw is capable of reducing nitrates to gas in the absence of oxygen, and in the presence of much oxygen its action is hindered and finally ceases. The bacterium from horse dung developes exclusively in the presence of oxygen, but it can reduce nitrates only when associated with another organism of anaërobic character, that is, one developing in the absence of oxygen. When the two organisms are associated, no reduction takes place in the complete absence of oxygen, but the action becomes active as soon as a little oxygen is present, and when plenty of organic matter is present the process is apparently not hindered by a full supply of that gas. There is no evidence that either straw or horse dung contains only, or always, the two denitrifying organisms just described.

Soil contains an abundance of reducing organisms, including those producing nitrogen gas. When broth containing 1 per cent. of nitre is infected with a particle of surface soil, and kept in a warm place a quantity of gas bubbles containing nitrogen is produced, and the nitrate will entirely disappear. Soil treated with a 1 per cent. solution of sugar containing nitre, rapidly reduces the latter ; the gas produced contains nitrous oxide and nitrogen.

Any kind of organic matter readily oxidised by bacteria may be used to bring about the reduction of nitrates. In the trials made by various experiments, albuminoids, asparagine, starch, sugar, humus, fats, tartrates, citrates, acetates and alcohol have all proved effective for this purpose.

The presence of some nitrogenons plant food, and of phosphates, potash, and the other ash constituents of plants is of course necessary for the growth and activity of the reducing bacteria.

It is clear from what has gone before that denitrification may be expected to occur whenever a suitable mixture of nitrate and organic matter is infected by soil dust under the conditions favourable to the action. The early observations of Angus Smith in England, and of Th. Schloesing in France (1868), taught us that organic solutions, as sewage, diluted blood, tobacco juice, and sugar solutions, when undergoing fermentation or putrefaction, actively reduced nitrates, nitrous oxide and nitrogen being evolved. Whence did these mixtures obtain the bacteria necessary for this action to take place ? Nothing had been done to introduce the organism ; indeed, at the date of these observations it was not known that the action was brought about by bacteria. The answer is plain ; these organic solutions obtained the organism which reduced nitrates by ordinary contact with atmospheric air. We are now familiar with the fact that the air is the great distributor of bacteria, yeasts, and fungi, and that a sterilised solution can seldom remain a single minute in contact with ordinary air without becoming infected. In Dehérain's experiments on denitrification, soils which had been sterilised by heat, and had lost the power of reducing nitrates, were found frequently to regain this power by merely transferring them to another vessel.

Having grasped the facts now before us, we are disposed to smile when we are gravely informed that straw bears on its surface the organism reducing nitrate to nitrogen gas and that it is *in consequence of this fact* dangerous to use it as a manure for soils. It is doubtless quite true as we are informed by Wagner and others, that rye-straw, placed in water containing saltpetre, slowly reduces the nitrate present. But this result is not due to any peculiar property of straw ; the action which occurred would equally have been observed if other forms of organic matter contaminated with atmospheric dust had been made use of. Bréal, in fact, experimenting in this way has obtained similar results when using dead leaves ; the straw of wheat, maize, or haricot bean ; lucerne silage (conserve de luzerne), or maize cake. That atmospheric contamination was the source of the organisms reducing nitrates which were present in these experiments is strikingly evident in the case of the maize cake. This cake is prepared on the Continent by crushing the embryo of maize grain, which, like other embryos, is extremely rich in fat and albuminoids. Now, we cannot conceive that this embryo, embedded in the substance of the seed, naturally contains the bacterium reducing nitrates to gas. The cake must therefore have gained this organism during the process of its manufacture ; or, possibly, the organism was supplied by the air in the course of the experiment.

It is assumed by the German experimenters that the solid excrement of herbivorous animals, and especially that of the horse, is peculiarly rich in the organisms reducing the nitrogen of a nitrate to gas ; the only foundation for this supposition is, apparently the marked power of reducing nitrates possessed by these excrements. Wagner tells us that if 100 grams of horse dung are added to 1,000 grams of water, containing 5 grams of saltpetre, and the whole allowed to stand in a warm place, the nitrate will disappear in a few days, the escape of gas being shown by a brisk effervesence of the liquid. So many hasty conclusions have been arrived at during the discussion of the question before us that we must just point out that in the case of an action like denitrification, requiring the concurrence of several conditions, each of them equally essential, the activity of this action in any particular case cannot be taken as proof of a special preponderance of one of these conditions, but rather as showing that all are fully present.

There is, however, one reason which would lead us to expect that animal excrement would contain a relative abundance of the denitrifying organism. If we may assume, as we probably may, that the denitrifying bacteria present in the food passed uninjured through the intestines, it is evident that they will occur in larger proportion in the solid excrement than in the original food. If, for instance, a horse is fed on hay, and digests one-half of the food consumed, the dung will then contain twice the proportion of the denitrifying bacteria originally present in the food. The proportion of the organisms supplied by different kinds of food must vary greatly. If the bacteria are, as we assume, deposited from the atmosphere, and lie in all cases on the surface of the food, their proportion must depend largely on the extent and character of the surface, and on the length of exposure to the atmosphere. A hundred pounds of hay should contain a far greater proportion of bacteria than a hundred pounds of clean mangel or turnips. From this point of view there is thus some ground for assuming that horse excrement will be richer in denitrifying organisms than cattle excrement. Wüthrich and Freudenreich have recently attempted to estimate the relative number of bacteria present in the dung of cows fed on fresh grass, on hay alone, and on hay with potatoes or brewers' grains. They found that when nothing but hay was given the number of bacteria in the dung was far greater than with any other diet amounting indeed, to the extraordinary proportion of 165 millions per gram of excrement.

It is suggested by some who have written on the question, that the denitrifying bacteria may largely increase in numbers during the passage of the food through the intestines. Of this increase there is as yet no proof, nor does it seem very probable. The increase of an organism can only be safely assumed when the circumstances are favourable to the exercise of its particular functions ; now, the denitrifying bacteria belong to a class of organisms requiring oxygen, free or combined, to accomplish their special work, and this necessary condition is absent in the animal intestine. The bacteria which certainly flourish in the animal intestine are those which determine the march-gas fermentation of cellulose. It has been said. with great truth that the fermentation of the dung heap is simply a continuation of the fermentive processes which have commenced in the animal intestine.

Before further discussing the question before us we must turn once more to the results of former investigations, and see what are the precise conditions necessary to induce denitrification.

Schloesing (1873), in his investigation on the rate of nitrification in soil, kept various portions of the same moist, humous soil, in atmospheres in which different proportions of oxygen were constantly maintained throughout the experiment. He found that the quantity of nitrate produced in the soil steadily diminished as the proportion of oxygen in the air decreased ; when, however, no oxygen was present, denitrification took place, and the nitrates originally contained in the soil entirely disappeared. He repeated the experiment, this time adding a known amount of saltpetre to the soil. He found that such a soil placed in a vessel containing very little air, first absorbed all the oxygen present and then evolved a considerable quantity of gas, this gas contained nitrogen equivalent to the whole of that contained in the saltpetre added. The consumption of the oxygen of the air had thus determined denitrification.

The supply of atmospheric oxygen to a soil is effectually prevented if the soil is kept saturated with water ; this condition alone is sufficient to set up an energetic denitrification. In an experiment made by myself in the Rothamsted laboratory in 1880, and published in the Journal of the Agricultural Society of England in 1881 (2nd Series, Vol. xvii.,) 7lbs of dry, finely powdered loam were placed in a percolator, and thoroughly saturated with water ; the column of soil was about eight inches in depth. The nitrates naturally present having been entirely removed by the passage of water through the soil, a known quantity of nitrate of sodium was placed on the surface. After a week had elapsed a small quantity of water was placed each day on the surface of the soil, and the drainage water removed and analysed. When nitrates no longer appeared in the drainage water it was found that only 21 per cent. of the nitrate applied to the soil has been recovered ; 79 per cent. had been lost. The mode in which this loss had occurred was evident to the eye ; the column of soil. though always kept in a saturated condition, was cut across about the middle with large transverse fissures, the result of the formation of gas within the soil. In another experiment, made with the same soil under identical conditions, in which an equivalent quantity of chloride of sodium was employed, the whole of the salt applied was recovered in the drainage water, and no fissures appeared in the column of soil.

A recently published experiment by Bréal furnishes a further excellent example of the active denitrification which takes place in a soil kept saturated with water. He placed some garden soil in a percolator and consolidated it by pressure ; the column was about fifteen inches high. Water more than sufficient for saturation, was then poured upon the soil. When the water had run through, it was poured back again over the soil, and this treatment was continued for some time. The soil at the commencement of the experiment was in an active state of nitrification, and the drainage water was at first rich in nitrates, but at the end of three weeks the nitrate had entirely disappeared from the drainage water, though no water had been removed from the soil.

We have now the conditions which bring about a loss of nitrogen by denitrification plainly before us. There are needed : 1. The specific organism. 2. The presence of a nitrate and suitable organic matter. 3. Such a condition as to aëration that the supply of atmospheric oxygen shall not be in excess relatively to the supply of organic matter, 4. The usual essential conditions of bacterial growth as plant food, and a suitable temperature.

Of these conditions, the supply of organic matter is by far the most important in determining the extent to which denitrification will take place. An abundance of the special organism is of comparatively little importance ; for, if the conditions are made favourable for its growth and development, it will increase with such rapidity that the number of organisms originally present will soon become a matter of indifference. Nothing, however, will compensate for a deficiency of organic matter ; if this is small in quantity, the action will be strictly limited in extent, however large may be the supply of the specific organism This fundamental principle of the reaction has been strangely overlooked by the German investigators when interpreting the results of their experiments. They have sought to explain the denitrification in their experiments as due to the supply of additional organisms to the soil in the form of manure, when the results were really due to the supply of an excess of organic matter. We shall see presently that, taking the more correct explanation of the facts, the practical conclusions become very different from those hitherto assumed. The principle that denitrification proceeds, other things being equal, in direct proportion to the quantity of combustible organic matter present is, however, so very important that we shall quote a few more experimental illustrations of this fact before discussing the German results from the new point of view.

In Gayon and Dupetit's investigations the preponderating influence of the quantity of the organic manner present is fully recognised. The same organism placed in sewage and in chicken broth, reduced in the first instance 0.1 to 0.2 gram of nitre per litre, and in the second instance 50 grams per litre. Some experiments of my own are equally clear on the point. Two equal volumes of diluted urine were taken ; one received nitre at the rate of 1 gram per litre ; the other received both nitre and sugar, each at the rate of 5 grams per litre. Both solutions received 0.5 gram of soil to supply to the denitrifying organism. The solutions were then covered with a layer of paraffin oil to exclude air, and thus intensify the action of the organic matter, and were kept at the temperature of 70° Fahr. In the solution containing no sugar a slight evolution of gas occurred, and nitrites appeared in the liquid ; some reduction of nitrate thus took place. The action then stopped, and much of the nitrate remained permanently in the solution. In the second case, in which five times the quantity of nitre was present, accompanied by its own weight of sugar, the whole of the nitrate disappeared in eleven days. This experiment was afterwards repeated at a higher temperature, 95° Fahr. the whole of the nitrate then disappeared in four days. The presence or absence of sugar thus entirely determined the extent to which dentrification would take place. An experiment of Munro's is perhaps still more to the point, as it shows, that the presence or absence of organic matter is sufficient to determine whether nitrification or denitrification will occur. Munro was experimenting with a river water. When he added to this water an ammonium salt, active nitrification took place, the ammonia disappeared and was replaced by a nitrate. If, however, to this actively nitrifying medium he added a small quantity of a soluble tartrate, denitrification set in, and the whole of the nitric acid in the water disappeared. After a time the effect of the tartrate ceased, and the water again became a nitrifying medium. This water like ordinary soil, clearly contained both nitrifying and denitrifying organisms. In the absence of oxidisable organic matter the nitrifying organisms held command of the situation; but when organic matter was introduced the denitrifying organisms sprang into activity, and the character of the chemical changes taking place was entirely reversed.

We pass now to consider more particularly the German results.

The German Results.

The German culture experiments were made, as already mentioned, in large cylinders, the cylinders in each series containing the same weight of soil. As the object of the investigation was to ascertain the comparative value of different nitrogenous manures, applied alone or together, the quantity of each manure applied to the soil was such that each pot received the same quantity of nitrogen. *Although, however, the quantities of nitrogen applied in comparative experiments were the same, the quantities of organic matter applied were very different.* When nitrate of sodium and sulphate of ammonium were used, the manure supplied no organic matter to the soil. When urine or dried blood was made use of the supply of organic mattter was very small. With green manures (green lucerne, or young grass) the supply became much more considerable. With dung and farmyard manure the supply of organic matter became very large. In the experiments with straw the maximum supply of organic matter was reached.

The details given of the experiments are frequently too incomplete to enable us to state with perfect accuracy what was the weight of manure employed in every experiment, the mere fact that it contained so many grams of nitrogen being sometimes the only information afforded. It is possible, however, to state approximately what quantities of manure would be required to supply the unit of nitrogen adopted, and what quantities of organic matter would be contained in each dressing of manure. The data required for these calculations have been obtained from Wolff's tables when not supplied by the experimenters themselves.

Weights of Manure Supplying two Grams of Nitrogen.

	Fresh Weight. Grams.	Dry Organic Matter. Grams.
Cattle Urine	—	6-10
Dried Blood	14	12
Pasture Grass	157	31
Young Lucerne	200 ?	34 ?
Sheep Manure	200	66
Cow Dung	524	85
Horse Dung	513	103
Farmyard Manure	300-600	65-130
Rye Straw	500	409

If the results which followed the application of these manures are borne in mind, it will be seen that the return in the crop for the same quantity of nitrogen applied became, as a rule, rapidly less as the amount of organic matter associated with the nitrogen increased. Thus, in one series of Wagner's experiments, the nitrogen recovered in a crop of oats for 100 applied as manure was in the case of :

Nitrate of Sodium	77	Farm Manure (good)	8
Sulphate of Ammonium	69	" " (poor)	6
Cattle Urine	69		
Dried Blood	50	Cow Dung	2
Young Grass	43	Horse Dung	0

In two series of Maercker's experiments, also made with oats, the following were the proportions of nitrogen recovered in the crop for 100 supplied in the manure. As the nitrate of sodium gave the same return in each series of experiments, we assume that the conditions were alike throughout.

Nitrate of Sodium	- 57.5	Ox Dung	- 4.5
Sheep Dung	- 19·9	Wheat Straw	- 0
Farmyard Manure (4 kinds)	3·0-9·8		

The influence of the decomposable organic matter in a manure is twofold: it affects the process both of nitrification and of denitrification.

If the conditions within the soil are suitable for nitrification, any addition to the soil of decomposable carbonaceous matter will tend to diminish the rate at which nitrogen is oxidised, and may cause nitrification to cease altogether. The decomposition of an organic manure, and its partial oxidation, must precede its nitrification. If much of this preliminary work has to be done, the commencement of nitrification is greatly delayed; the products of the decomposition of carbonaceous matter are, indeed, inimical to nitrification.

When the quantity of organic manure applied exceeds a certain proportion, the conditions prevailing in the soil may be entirely changed, and a nitrifying medium, converted for a time into a denitrifying medium, the oxygen demanded by the decomposing organic matter being now obtained by the destruction of the nitrates in the soil. An organic manure which is effective when applied in small quantity may thus become injurious when made use of in excess.

An illustration of the decrease in efficiency which follows an increase in the quantity of an organic manure is furnished by one of Wagner's experiments: 157 grams of pasture grass were incorporated with the soil of one pot, and double this quantity, 314 grams, was applied to another pot. The return in the crop for 100 of nitrogen applied was in the first case 43, in the second 36 ; or, in other words, the crop instead of being doubled was increased by 69 per cent. by doubling the quantity of the manure. As the total amount of nitrogen assimilated with the heaviest manuring was far less than that taken up when nitrate of soda was applied, the smaller return from the green manure was clearly not due to its supplying an excess of nitrogen, but simply to the incapacity of the soil to bring this nitrogen into a condition available for the crop.

That the addition to the soil of large doses of fermentable organic matter will retard the nitrification of other easily nitrified nitrogenous manures is probably the principal reason of the ill-effect resulting in the German experiments from applying horse dung with sulphate of ammonium, with urine, and with green manures. Wagner and Maercker applied these nitrogenous manures, both alone and with the addition of dung or farmyard manure ; the following is a selection from their results. The produce given by dung alone is in every case substracted from the produce of dung with other nitrogenous manures and the remaining increase is credited to the respective manures.

Nitrogen recovered for 100 applied in Manure.

1.—Wagner's Results.

	Manures applied alone	Manures with Horse Dung
Nitrate of Sodium	77	52
Sulphate of Ammonium	69	50
Cattle Urine	69	40
Pasture Grass	43	20

2.—Maercker's Results.

	Manures applied alone	Manures with Farmyard Manure
Nitrate of Sodium	55	35
Sulphate of Ammonium	37	31
Cow Urine	29	22

Wagner employed in the above experiments, 2 grams of nitrogen as nitrogenous manure, with, or without, 2 grams of nitrogen as horse dung. Maercker used ·75 gram of nitrogen as nitrogenous manure, with or without 1·5 gram of nitrogen as farmyard manure.

The German investigators are doubtless right in attributing the decrease in the return from nitrate of sodium, when mixed with dung or farmyard manure, to the destruction of the nitrate occasioned by the latter manures, but Wagner will not admit that the decrease in the return from ammonia, urine, or grass is due to the diminished rate of nitrification of these manures brought about by their mixture with much organic matter. His argument is peculiar. He says : we cannot explain the depressing action of the dung when applied with urine or grass as due to any hindrance in the conversion of their nitrogen into ammonia, because the yield of ammonium salts also suffers under these circumstances : and we cannot explain the depression in the case of ammonium salts as due to want of nitrification, as the nitrates applied equally show the injurious effects of the dung. Might we not add, with as much justice : we cannot explain the action of dung on nitrates as due to denitrification, as the dung occasions an equal depression where no nitrates have been applied ? This mode of argument is valueless : all it can possibly prove is that a single explanation will not suffice for all the results before us.

It is generally assumed by the German investigators that denitrification is a sufficient explanation of all the results obtained ; it is apparently supposed that the ammonia, urine, and grass have nitrified in the soil just as usual, and that the nitrate produced has heen destroyed by the dung. But it is proved in the course of the German investigations that the reducing action of the dung is greatest immediately after its application to the soil, and gradually diminishes with the lapse of time. We have, then, the conditions producing denitrification set up most actively at the first, and we may well ask—How can nitrification take place under these circumstances ? That nitrification will eventually set in is most true, but then the conditions producing dentrification will have diminished, or entirely ceased. That nitrification and denitrification can occur simultaneously in the same place has yet to be proved, (1) till this is done we must assume that nitrification is considerably retarded by the addition to the soil of large quantities of fermentable organic matter.

It is only right to add that the simultaneous occurence of nitrification and denitrification is not accepted by all the German investigators as a sufficient explanation of the diminished return from ammonium salts, urine, etc., when these manures are mixed with dung. Pfeiffer believes that an evolution of nitrogen from ammonia, due to its partial oxidation, takes place in the soil under the circumstances in question; and that the considerable loss of nitrogen which occurs in an aërated dung heap is due to the same action, which he assumes to be brought about by bacteria. This view is at present little more than a supposition, but it indicates that the explanation first mentioned is by no means regarded as satisfactory.

When considering the action of large applications of organic manure, both in retarding nitrification and in setting up denitrification, we must of course bear in mind that all kinds of organic matter have not an equal effect, and that mere quantity will not alone determine the result. When, instead of fresh horse dung, Wagner used black, humified manure, which have been frequently turned over during four months, the injurious effect on the action of nitrate of sodium almost disappeared. The return from 100 of nitrogen in nitrate of sodium was now 73, and from 100 of nitrogen in cattle urine 63, (2) instead of 52 and 40, respectively, when fresh horse dung was employed. Maercker also observed that if horse dung was applied to the soil two months before the nitrate of sodium, its denitrifying action was scarcely perceived. This

(1) In some of the recent German analyses of farmyard manure considerable quantities of nitrates are mentioned. In a small experimental mass it may happen that the conditions suitable for nitrification may in the course of time occur, but an ordinary dung heap seems the most unlikely situation for the nitrifying process. The mode of determining the nitrates is not always mentioned, but, in one paper, boiling the extract of the manure with aluminum and soda is stated to be the method employed; this must give far too high results. Schloesing's method of estimation as nitrate oxide gas would give accurate results. Reduction to ammonia with a copper-zinc couple, and distillation with magnesia, would also give fair results.

(2) A hasty reader of Wagner's paper would come to the conclusion that the return of nitrogen in the crop was in this instance 39 and 34 per cent. respectively, these being the numbers printed in the table; they are obtained by dividing the nitrogen in the increase by the total nitrogen applied to the pot. This mode of reckoning fails, however, to show the return yielded by the nitrate of sodium or urine, which is the point in question. To give one example: 2 grams of nitrogen in the form of humified horse dung gave an increase of ·097 gram of nitrogen in the crop; 2 grams of nitrogen as humified horse dung, plus 2 grams in the form of nitrate of sodium, gave an increase in crop of 1·548 gram of nitrogen. The return from 2 grams of nitrogen as *nitrate of sodium* was thus 1·548—·097=1·451 gram or 72·55 per cent. The ill-effects of mixture with dung are much exaggerated by the mode of calculation adopted in Wagner's tables; in his text, however, the true proportions will usually be found.

result is not obviously explainable if we assume that the denitrifying action of fresh horse dung in the soil is to be attributed to the organisms which the manure supplies, for there is no reason to suppose that these organisms would die in a soil which naturally contains them ; but the result is at once understood if we grasp the fact that denitrification is determined by the presence of *fermentable* organic matter.

Several results which greatly puzzled the German investigators appear capable of explanation, if we regard them from the point of view just taken. Thus, Wagner found that when dung was preserved by the addition of superphosphate, or kainit, it possessed a greater denitrifying power than when these substances were omitted. His temperature determinations, in fact, show that these substances decreased the fermentation in the manure heap.

The much better results obtained by the German experiments from sheep manure than from horse or cattle manure are apparently to be explained by the fact that the sheep manure contain a much greater proportion of easily nitrifiable nitrogenous matter, and a distinctly smaller proportion of organic matter per unit of nitrogen. The German investigators are fully alive to the importance of the first point, but give no weight to the second. The far smaller denitrifying power of sheep manure is, however, quite in accordance with its much smaller proportion of fermentable organic matter per unit of nitrogen. Its comparative freedom from denitrifying action certainly does not support the idea that this action is due to the presence of a special organism derived from the animal intestine, for in this respect sheep dung must stand on a par with the horse or cow dung.

Attempts to destroy the denitrifying organisms in dung and thus alter its action on nitrates, have met with no success. Wagner sifted a quantity of horse dung, and destroyed the living organisms in one portion by treatment with bisulphide of carbon. After removal of the bisulphide, the denitrifying power of the treated horse dung was compared with that of the untreated. It was of course expected that, the denitrifying organism having been destroyed, the treated horse dung would be found comparatively harmless when applied to the soil along with nitrate of sodium or other nitrogenous manure. To the surprise of the experimenter, however, the treated manure proved more injurious that the untreated. We could not have an experiment showing more conclusively that the presence or absence of organisms in the manure is a matter of indifference so long as the necessary organisms are present in the soil. (1)

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(1) In Maercker's Second Report, which has come to hand after the above was written, experiments are described in which wheat and oat straw were soaked for two days in 1 per cent. sulphuric acid, with a view of destroying the denitrifying organisms present. The straw thus treated was found, however, when mixed with soil, to reduce the yield of nitrate of sodium to the same extent as the untreated straw. Two other germicides were tried, with a similar failure of result. Straw sterilised by steam had a worse effect on crops than unsteamed straw; the prejudicial effect in this instance is considered by Maercker as due to the formation of acid humus. All attempts to prove that the depressing action of straw and horse dung is due to the organisms which they contain have thus failed.

If we have by this time made good our contention that the injurious action of fresh farmyard manure observed by the German experimenters is due to the fermentable organic matter which it contains and is generally in proportion to its amount, we have next to ask : What proportions of manure to soil were used in German experiments. If these proportions were the same as those employed in ordinary agriculture, then our farmers may expect to meet with the same results when they employ farmyard manure under similar circumstances. If, however, far more of this manure was applied to the soil in the German pot experiments than is used in practical agriculture, we must clearly take the German results simply as illustrations of the properties of farmyard manure, and not as examples of what we have to expect in practice. Organic matter in the soil acts, in fact, in an injurious manner only when it is of such kind and quantity that it changes the character of the soil from an oxidising to a deoxidising medium.

For our present purpose we may assume that the depth of soil turned over by the plough—the quantity in fact with which a dressing of farmyard manure would be mixed in practice—will weigh, when dry, 1,000 tons per acre. It follows that an ordinary dressing of 10 tons of manure per acre will amount to 1 per cent. of the soil. A farmer may now and then double this proportion, but 2 per cent. will very rarely be exceeded. In the experiments which Wagner first describes, each pot held 7,000 grams of soil, and the quantity of dung employed was about 500 grams, or 7 per cent. of the soil, representing, therefore, 70 tons per acre. In his main series of experiments the pots contained 18,500 grams of soil, but the manure was only incorporated with the upper portion, 15 cm. in depth. The surface area of the soil is mentioned in this case ; we are thus able to state that his ordinary dressing of dung, 500 grams, was equivalent to 40 tons per acre, incorporated with about six inches of soil ; this amount was doubled in a few instances. In experiments on denitrification, in which no crop was grown, the dung employed amounted to 10, 18 and 20 per cent. of the soil. Maercker does not give the details of his experiments so fully as Wagner, but from one sentence it would appear that his pots held 6,000 grams of soil. His unit of nitrogen is larger than Wagner's so that about 600 grams represents his ordinary application of dung, which thus amounted to 10 per cent. of the soil, or 100 tons per acre. In some of his trials with farmyard manure the dressing was three times this amount.

It is, then, quite evident that the quantities of dung mixed with the soil in the German experiments were far in excess of the amounts commonly employed by a farmer and that a great delay of the process of nitrification, and a production of actively denitrifying conditions, was only what might naturally be expected under the circumstances of the experiments, and is no proof that the same actions will occur to the same extent in ordinary arable farming.

That the farmyard manure was used to great disadvantage in the pot experiments we have just described is indirectly admitted by Wagner, for at the commencement of his paper he tells us that his former experiments have shown that, *under the conditions which occur in practice* 25lb. of the nitrogen contained in farmyard manure may be expected to be on an average recovered in the crop for 100lb. applied to the land. He also quotes field experiments by J. Kühn in which 24 per cent. of the nitrogen of farmyard manure was recovered in the crop. Yet in the experiments on the action of dung and farmyard manure, which he proceeds to describe, the fresh dung in every case but one yields a crop below that given by the unmanured soil, while farmyard manure gives an average return of only 5 per cent. of its nitrogen in the produce. The conditions of the experiments were thus clearly not such as to allow these manures to be employed to advantage, and the results obtained cannot be taken as indicating what may be expected to happen in the ordinary use of farmyard manure in the field. (1)

The results obtained by Wagner have naturally excited attention in France, and experiments on the subject, also conducted in pots, have been made by Pagnoul at the Experiment Station of Pas de Calais (1895). His pots were large, containing 25,000 grams of soil, and the quantity of horse dung employed was 500 grams, or 2 per cent. One set of pots remained six weeks without seed and was then sown with

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1 In Maercker's later experiments, just published, much better results were obtained from the use of farmyard manure in pot cultures.

He experimented with 45 kinds of manure, the history and composition of which we are fully given. Applied at the rate of one gram of nitrogen per 6,000 grams of soil, which, omitting the sheep manures, was equivalent to 17-61 tons of manure per acre, he obtained from 38 samples the following results:—

4 decreased the yield of nitrogen in the crop.
7 yielded in increase less than 5 per cent of their nitrogen.
8 " " " 5-10 per cent of their nitrogen.
7 " " " 10-15 " " "
7 " " " 15-20 " " "
5 " " " over 20 " " "

In the last group, one manure yielded 37·4 per cent. its nitrogen in the increased crop which it produced. As a rule, the most nitrogenous manures, of which consequently, the smallest weight was applied, gave the best return.

When Maercker used smaller quantities than before of farmyard manure and straw, with nitrate, the depressing effect of the farmyard manure practically disappeared, but that of the straw, was still very marked. The return of nitrogen in the crop for 100 applied as nitrate of sodium was—

Nitrate alone	66·6	Nitrate with horse dung	57·2
" with cow manure	66·0	" " oat straw	23·0
" " sheep manure	62·7	" " wheat straw	21.8

The farmyard manure was used at the rate of 3·3 per cent. of the soil or 33 tons per acre. The straw was half this weight, but nevertheless supplied the soil with considerably more organic matter than the farmyard manure.

These new results appear to be in accordance with the views we have expressed above. Maercker does not relinquish in the least his belief in the preponderating influence of the organisms present upon the results obtained; when any specimen of farmyard manure gives results better or worse than its analyses would indicate, he at once assumes that this is due to the absence or abundance of the denitrifying organism.

grass. A second set was sown with mustard two weeks after the addition of the manures. The weight of crops harvested was as follows:—

	Grass Grams.	Mustard Grams.
Nitrate of sodium	184	234
Nitrate of sodium with horse dung	251	357
Sulphate of ammonium	182	69
Sulphate of ammonium with horse dung	190	229

These few experiments leave much to be desired; but it at all events appears that with a more moderate application of dung, amounting to about 20 tons per acre, the return obtained from nitrate of sodium and sulphate of ammonium is not decreased, indeed, in every instance the dung has itself contributed to the increase of crop.

Rothamsted Results bearing on the Question.

The field experiments at Rothamsted furnish abundant examples of the action of farmyard manure on various crops, and also of the after-effect of residues of the manure remaining in the soil. The alteration in the character of the soil by the continued use of farmyard manure, and the relative production of nitrates in manured and unmanured land, are also well shown in these experiments. Keeping, however, to the points before us, we shall here simply inquire what have been the results of the Rothamsted experiments on the employment of farmyard manure with nitrate of sodium, and with other nitrogenous manures ; and what have been the results of the application of straw in conjunction with nitrogenous manures.

The practical question whether farmyard manure can be used econonomically with artificial manures is one of great importance to the farmer, and can only be satisfactorily settled by field experiments. The irregularities of field experiments are, however, very great, and the most potent cause of irregularity, namely, the great variety in the seasons, and especially the wholly variable and uncertain distribution of rain, is unfortunately beyond the control of the experimenter, and assumes its greatest proportion where large quantities of manure have been applied. It is necessary therefore, to take the average result of many years if trustworthy conclusions are to be drawn from field experiments.

In the field devoted to the culture of roots at Rothamsted a considerable portion of the land has received annually for many years 14 tons of farmyard manure per acre. One-half of this land has received in addition 3½ cwt. of superphosphate each year. These two farmyard manure plots are each divided into five portions, one receiving no further manure, the others cross-dressed respectively with nitrate of sodium, sulphate of ammonium, rape cake, and sulphate of ammonium with rape-cake. Each cross-dressing supplies a known quantity of nitrogen. What has been the effect of these cross-dressings ?

From a practical point of view the farmer will be content to ascertain what increased weight of roots has been obtained by the use of each cross dressing, and to compare the value of the roots with the cost of the artificial manure producing them. To obtain an exact knowledge of the return yielded by the artificial manures when employed with farmyard manure we must, however, go a step further, and ascertain what proportion of the nitrogen of the artificial manure has been recovered in the crop. It is the more necessary to do this, as a heavily manured root crop is harvested in different seasons in very different stages of maturity, and an immature crop, which an unfavourable season has prevented from forming a large weight of root, may yet contain in root and leaf almost as great a quantity of nitrogen, and furnish consequently almost as large a return for the nitrogen applied, as that which would have been realised in a season of greater production of roots. The less mature root is in fact more nitrogenous than the perfect root rich in sugar and the green leaf far more nitrogenous than the root which it is its function to produce.

Determinations of nitrogen were made at Rothamsted in the roots of all the plots of mangel-wurzel receiving farmyard manure during the five years 1878-82. The amount of nitrogen in the leaf when the roots were taken up was not determined, but the weight of the leaves, and the amount of dry matter which they contained, were recorded. Determinations of nitrogen were, however, made during these years in the leaves of a series of other plots in the field receiving the same cross dressings. By assuming that the dry matter of the leaves from the farmyard manure plots contained the same percentage of nitrogen as was found during the same years in the leaves of plots receiving the same cross-dressing we may arrive very nearly at the total nitrogen contents of the farmyard manure crops. In a later year, we shall presently mention, the amount of nitrogen in both roots and leaves of all the mangel plots receiving the farmyard manure was actually determined.

Sir J. B. Lawes and Sir J. H. Gilbert have most kindly placed at my disposal the results of the calculation we have just described. In the the table on p. 32 will be found the average results of the farmyard manure plots during six years, 1878-83. In calculating the nitrogen contained in the roots of 1883 the average percentages of nitrogen in the roots during the preceeding five years have been employed.

Before considering the results it will be well to mention in what manner the manures were applied during the years in question. At Rothamsted the mangels are grown "on the ridge." During the years in question the whole of the manures, save the dung, were sown broadcast, and harrowed in before the application of the farmyard manure; the only exception being that the superphosphate was occasionally sown afterwards by drill on the top of the ridge. The cross-dressings having been thus applied, furrows were opened, and the farmyard manure was placed in the furrow; the land was then bouted, the furrow being converted into a ridge, along the top of which the seed was dibbled.

The application of the nitrate of sodium at such an early date, and before the farmyard manure, is clearly not what would now be recommended in the light of recent knowledge, and we shall see presently that this mode of proceeding has in later years been altered; but even with this disadvantage the returns yielded by nitrate of sodium and ammonium salts applied with farmyard manure are seen to be remarkably good.

EXPERIMENTS ON MANGEL-WURZEL IN BARNFIELD, ROTHAMSTEAD. MEAN RESULTS OF SIX YEARS, 1878-83.

Plot.	Standard Manures.		Standard Manures only.		STANDARD MANURES WITH CROSS-DRESSINGS AS UNDER:															
					Nitrate of Sodium, 86lb. Nitrogen.				Ammonium Salts 86lb. Nitrogen.				Rape-Cake, 98lb. Nitrogen.				Ammonium Salts, etc. Rape-cake, 184lb nitrogen			
					Actual result		Increase by Cross-dressing.		Actual result		Increase by Cross-dressing.		Actual result		Increase by Cross-dressing.		Actual result		Increase by Cross-dressing.	
			PRODUCE PER ACRE.																	
			tons.	cwt.	tons.	cwt.	tons.	cwt.	tons.	cwt.	tons.	cwt.	tons.	cwt	tons.	cwt.	tons.	cwt.	tons.	cwt.
1	Farmyard Manure, 14 tons.	Roots	14	17	20	6	5	9	20	4	5	7	21	9	6	12	23	2	8	5
		Leaves	2	13	3	13	1	0	4	19	2	6	3	15	1	2	5	15	3	2
		Total	17	10	23	19	6	9	25	3	7	13	25	4	7	14	28	17	11	7
2	Farmyard Manure, 14 tons. Supherphosphate 3½ cwt.	Roots	14	16	22	7	7	11	20	0	5	4	21	7	6	11	22	18	8	2
		Leaves	2	8	4	6	1	18	5	4	2	16	3	15	1	7	5	17	3	9
		Total	17	4	26	13	9	9	25	4	8	0	25	2	7	18	28	15	11	11
			NITROGEN PER ACRE.																	
			lb.		lb.		lb.		lb.		lb.		lb.		lb.		lb.		lb.	
1	Farmyard Mannre 14 tons.	Roots	53·8		92.5		38 7		90·7		36·9		93·0		39 2		116·9		63·1	
		Leaves	17·4		24·8		7·4		30·4		13 0		24·6		7 2		43·8		26·4	
		Total	71·2		117·8		46·1		121·1		49 9		117·6		46·4		160·7		89·5	

NITROGEN PER ACRE.—(*Continued.*)

2	Farmyard Manure, 14 tons. Superphosphate 3½ cwt.		lb.	lb	lb.	lb.	lb.	lb.	lb.	lb.	lb.
		Roots	53·4	100·2	46·8	92·3	38·9	93·5	40·1	118·8	65·4
		Leaves	15·4	27·9	12·5	34·4	19·0	25·0	9·6	43·4	28·0
		Total	68·8	128·1	59·3	126·7	57·9	118·5	49·7	162·2	93·4

NITROGEN RECOVERED IN INCREASE OF CROP PER 100 IN CROSS-DRESSING.

1	Farmyard Manure 14 tons.		per cent.	per cent.	per cent.	per cwt.
		Roots - -	45·0	42·9	40·0	34·3
		Leaves - -	8 6	15·1	7·3	14·3
		Total -	53·6	58·0	47·8	48·6
2	Farmyard Manure, 14 tons. Superphosphate 3½ cwt.	Roots - -	54·4	45·2	40·9	35·5
		Leaves - -	14·5	22·1	9·8	15·2
		Total - -	68·9	67·8	50·7	50·7

Wagner mentions, at the commencement of this paper that, under the conditions of practical agriculture, 55 per cent. of the nitrogen of nitrate of sodium may be expected to be recovered in the crop. In the pot experiments we have earlier mentioned the return has varied from 55 to 77 per cent. In the Rothamsted field experiments with barley, nearly 60 per cent. of the nitrogen of a moderate dressing of nitrate of sodium has been on an average recovered in the increased produce where a liberal amount of ash constituents has been supplied. Sulphate of ammonium Wagner finds to give on an average one-tenth less return than nitrate of sodium for the same amount of nitrogen applied. Bearing these facts in mind, the percentage of nitrogen recovered in the increase of crop by the use of nitrate of sodium and sulphate of ammonium in the mangel experiments appears quite satisfactory. The nitrate of sodium employed as a cross-dressing is utilised to the extent of 53.6 per cent where 14 tons of farmyard manure are applied, and the utilisation reaches 68.9 per cent. where superphosphate is also employed. With ammonium salts, the utilisation under these two conditions is respectively 58.0 and 67.3 per cent. It will be observed that although superphosphate and farmyard manure give no greater crop of roots than farm yard nanure alone, yet, when nitrate or ammonia is used in addition, the presence of the superphosphate produces a considerably greater increase of crop. The supply of phosphates becomes insufficient only when the supply of nitrogen is increased. We shall see presently that still bette. results were obtained when potash was supplied as well as phosphatesr The cross-dressing of rape-cake has been utilised to the extent of 47.3 and 50.7 per cent. without, and with superphosphate. As the rape-cake itself supplies both phosphates and potash, the effect of additional superphosphate is here little perceived. The very heavy cross-dressing of ammonium salts and rape-cake, supplying 184 lb. of nitrogen per acre, is utilised to the extent of 48.6 and 50.7 per cent. under the conditions already mentioned.

It may fairly be objected that the return for the nitrogen applied is exaggerated in the statement just made, as, in fact, all the mangel leaves from every plot are returned to the soil. To estimate the influence of this return of the mangel leaves on the results before us we need to know what proportion of the nitrogen in mangel leaves spread on the soil in November may be expected to appear in next year's crop of mangels. If we assume that one-quarter of the nitrogen in the leaves will reappear in the next year's crop, we shall probably be making a liberal concession to the objection urged. In using this correction we have to deduct from the average amount of nitrogen in the increase by nitrate of sodium, or other cross-dressing, one-quarter of the average nitrogen in the leaf ; the remainder will then, according to our assumption, represent more nearly the amount of nitrogen derived from the cross-dressing. The difference made by this alteration in the calculation depends on the proportion of leaf to root usual on the different plots ; the alteration in the figures is quite small where nitrate of sodium is the cross-dressing, and becomes much more considerable where ammonium salts, and especially ammonium salts and rape-cake are applied.

Nitrogen recovered in increase of mangel crop per 100 applied at cross-dressing on dung, after deducting from the increase one-quarter of the average nitrogen in the leaves.

CROSS-DRESSINGS.

Plot	Nitrate of Sodium, 86lb. nitrogen.	Ammonium Salts, 86lb. nitrogen.	Rape-cake 96lb. nitrogen.	Ammonium Salts. etc., Rape-cake 184lb. nitrogen.
	per cent.	per cent.	per cent.	per cent.
1	51·5	54·3	45·5	45·1
2	65·3	61·9	48·3	47·0

These corrected estimates still show a very good return from the use of nitrate of sodium and ammonium salts when applied to land receiving farmyard manure; this is especially the case on plot 2, where superphosphate was used.

In the figures just given we have had to use an approximate estimate of the nitrogen in the leaves in the absence of actual determinations; we may, however, arrive at a practical conclusion as to the efficacy of nitrates, etc., when applied with farmyard manure, without taking the leaves at all into consideration. Below is a comparison of the average return of nitrogen in the mangel roots only given by nitrate of sodium, ammonium salts, and rape-cake, when used both with and without farmyard manure. It is clear that if the nitrogen of these three manures is utilised to the same extent under the two conditions named, we shall have good ground for concluding that the farmyard manure has had no prejudicial influence upon their action. The figures given are the average for the same six years already mentioned.

STANDARD MANURES.	CROSS-DRESSINGS.			
	Nitrate of Sodium.	Ammonium Salts.	Rape-cake.	Ammonium Salts and Rape-cake.
NITROGEN RECOVERED IN INCREASE OF ROOTS FOR 100 IN CROSS-DRESSING.				
Farmyard manure and superphospate	54·4	45·2	40·9	35·5
Superphosphate and potassium sulphate	58·1	44·5	51·8	45·5
LEAF TO 1,000 OF ROOT.				
Farmyard manure and supherphosphate	193	260	176	255
Superphosphate and potassium sulphate	169	186	148	235

It will be seen that when nitrate of sodium, or ammonium salts, were applied to land manured with superphosphate and sulphate of potassium, the increase in the quantity of nitrogen in the roots by the addition of these manures was practically the same as was obtained when these cross-dressings were applied to land receiving farmyard manure ; the 14 tons of farmyard manure had thus no depressing effect on the action of the nitrate or ammonia. That the leaves, if taken into account, would not alter this conclusion is shown by the fact that the proportion of leaf is greatest in every case on the farmyard manure plot ; the proportion of nitrogen recovered in the crop would thus be more increased on this plot than on the other, if the nitrogen in the leaf was taken into account. Where rape-cake is used with the farmyard manure we do not get so good a return in the roots as where the rape-cake is used without dung ; with 2,000lb. of rape-cake and 14 tons of farmyard manure we apparently reach an amount of organic manure in excess of what can be economically employed in an average season.

Notwithstanding the excellent utilisation of the nitrogen of the nitrate of sodium or ammonium salts when applied with dung to mangels, the increased weight of crop obtained from these cross-dressings is by no means so great as when the same cross-dressings are applied without farmyard manure. Thus the increase in root and leaf yielded by the nitrate of sodium on the farmyard manure and superphosphate plot was 9 tons 9 cwt., and that yielded by the ammonium salts 8 tons; while, without farmyard manure, the increase from similar dressings applied to land receiving superphosphate and sulphate of potassium was respectively 14 tons 5 cwt. and 11 tons 19 cwt. This considerable difference is due to the fact that nitrate of sodium or ammonium salts give a smaller, but much more nitrogenous increase when applied to dunged land than when applied to land receiving no other nitrogenous manure. The fact is of considerable practical importance to the farmer, but it has nothing to do with the question before us, which is: Does farmyard manure interfere with the assimilation of nitrogen from other manures ? That a smaller return is obtained in crop, per unit of nitrogen, as the supply of nitrogenous manure is increased is a fact sufficiently familiar to the agriculturist.

Since 1895 some alterations have been made in the mangel field at Rothamsted; 500 lb. of sulphate of potassium per acre are now applied to plot 2; and since 1896, 450 lb. of basic slag have been applied to this plot instead of superphosphate. The supply of ash constituents is thus made far more complete, and opportunity is given for the heavier dressings of nitrogenous manure to display their greatest effect.

The mode of applying the manures has also been changed. In 1896 and 1897 the basic slag, sulphate of potassium, and rape-cake were broadcast towards the end of April, and ploughed in ; furrows were then opened, the dung applied, and the land thrown into ridges. Seed was drilled the first week in May. The nitrate of sodium and ammonium salts were applied as a top-dressing in July, being distributed along each side of the drills. In 1896 the top-dressing took place on July 7th, in 1897 on July 20th. The lateness of the application in 1897 was due to the drought in that season. When nitrogenous manures have been applied too late, a large proportion of leaf to root is found when the crop is taken up, time not having being allowed for root formation.

In the crops grown with farmyard manure in 1897 the nitrogen has been determined both in root and leaf. For the crop grown in 1896 the nitrogen in the root is known, and the weight of the leaf ; the percentage of nitrogen in the leaf is assumed to be the same as in corresponding experiments. The results of these two years have been kindly supplied by Sir J. B. Lawes and Sir J. H. Gilbert ; they will be found on p. 38.

As soon as we deal with the results of individual seasons we encounter the irregularities inseparable from field experiments. In the results before us more than one of the applications of nitrogenous manure has apparently yielded double the return of nitrogen in the crop in 1897 than it did in 1896 ; this is notably the case where rape-cake has been applied. The increased utilisation of the manures in 1897 is but little shown by the weight of crop per acre ; the severe drought of July and August arrested the development of the mangels. and when taken up in November they contained an undue proportion of leaf, the materials accumulated in which had not had sufficient time to bring about the elaboration of sugar, and the construction of a larger root.

Taking the mean of the figures at the bottom of the table, where a correction is made for the effect of the leaves left on the land in the previous season, we have the following proportions of nitrogen recovered in the increase of produce for 100 supplied in the undermentioned manures, applied as cross-dressings on dunged land, with and without the addition of basic slag and sulphate of potassium.

	Nitrate of Sodium 86lb. nitrogen.	Ammonium Salts 86lb nitrogen.	Rape-cake 96lb nitrogen.	Ammonium Salts and Rape-cake 184lb
Farmyard manure alone	81·9	59·7	58·9	39·3
" " with slag and potash	95 9	77·8	58·7	49·5

Comparing these figures with those previously given, we especially notice the increased return from the nitrate, due doubtless, to its application later in the season. The farmer must not, however, apply the nitrate too late, as happened in the present case, for nitrogenous leaves will be no compensation to him for the lack of roots. The higher return given by nitrate of sodium than by the other manures is doubtless in part due to the soda supplied ; in the mangel-field, the plot receiving soda and magnesia, in addition to potash and phosphates, is the one giving the highest return, excepting the two plots manured with farmyard manure.

It is now, I think, clear that under the conditions in which farmyard manure is employed in the mangel field at Rothamsted the

EXPERIMENTS ON MANGEL-WURZEL IN BARNFIELD, ROTHAMSTED. SEASONS 1896 & 1897.

Year.	Plot.	Standard Manures.	Standard Manures only.			STANDARD MANURES WITH CROSS-DRESSINGS AS UNDER:															
						Nitrate of Sodium, 86lb. Nitrogen.				Ammonium Salts 86lb. Nitrogen.				Rape-Cake, 98lb. Nitrogen.				Ammonium Salts, etc. Rape-cake, 184lb nitrogen			
						Actual result		Increase by Cross-dressing.		Actual result		Increase by Cross-dressing.		Actual result		Increase by Cross-dressing.		Actual result		Increase by Cross-dressing.	
			PRODUCE PER ACRE.																		
				tons.	cwt.	tons.	cwt.	tons.	cwt.	tons.	cwt.	tons.	cwt.	tons.	cwt.	tons.	cwt.	tons.	cwt.	tons.	cwt.
1896	1	Farmyard Manure.	Roots	18	11	27	18	9	7	19	3	0	12	19	3	0	12	19	13	1	2
			Leaves	4	0	6	2	2	2	4	17	0	17	4	10	0	10	5	4	1	4
			Total	22	11	34	0	11	9	24	0	1	9	23	13	1	2	24	17	2	6
	2	Farmyard Manure, basic slag and potash.	Roots	21	7	31	0	9	13	24	4	2	17	22	5	0	18	23	18	2	11
			Leaves	4	3	7	0	2	17	6	0	1	17	4	17	0	14	6	5	2	2
			Total	25	10	38	0	12	10	30	4	4	14	27	2	1	12	30	3	4	13
1897	1	Farmyard Manure	Roots	15	16	25	6	9	10	19	5	3	9	20	6	4	10	20	4	4	8
			Leaves	4	4	8	6	4	2	7	9	3	5	7	10	3	6	8	7	4	3
			Total	20	0	33	12	13	12	26	14	6	14	27	16	7	16	28	11	8	11
	2	Farmyard manure, basic slag and potash.	Roots	17	5	27	1	9	16	23	3	5	18	22	6	5	1	25	4	7	19
			Leaves	3	19	8	13	4	14	7	10	3	11	7	7	3	8	8	14	4	15
			Total	21	4	35	14	14	10	30	13	9	9	29	13	8	9	33	18	12	14

NITROGEN PER ACRE.

				lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
1896	1	Farmyard Manure.	Roots	74·1	117·6	43 5	97·3	23·2	103·5	29·4	106·8	82·7
			Leaves	23·5	38·7	15·2	36·5	13·0	32·5	9·0	42·2	18·7
			Total	97·6	156·3	58·7	133·8	36·2	136·0	38·4	149·0	51·4
	2	Farmyard Manure, basic slag and potash.	Roots	85·5	146 1	60 6	135·0	49·5	125 6	40·1	139·7	54·2
			Leaves	26·0	44·8	18·8	40·3	14·3	34·5	8·5	47·8	21·8
			Total	111·5	190 9	79·4	175·3	63·8	160·1	48·6	187·5	76·0
1897	1	Farmyard Manure	Roots	66·3	125·4	59 1	97·9	31·6	116·3	50·0	117 3	51·0
			Leaves	24·7	52·9	28·2	63·9	39·2	56·3	31·6	73 5	48·8
			Total	91 0	178·3	87·3	161·8	70·8	172 6	81·6	190·8	99·8
	2	Farmyard manure, basic slag and potash.	Roots	71·3	131·7	60·4	118·8	47·5	114·4	43 1	140·8	69·5
			Leaves	24·9	55·6	30·7	52·2	27·3	52·4	27·5	69·3	44·4
			Total	96 2	187·3	91·1	71·0	74·8	166·8	70.6	210·1	113·9

NITROGEN RECOVERED PER 100 IN CROSS-DRESSING.

				per cent.	per cent.	per cent.	per cent.
1896	1	Farmyard Manure.	Roots - -	50·6	26 9	30 0	17·8
			Leaves - -	17 6	15·1	9·2	10 2
			Total crop -	68 2	42·0	39·2	28·0
	2	Farmyard Manure, basic slag and potash.	Roots - -	70·4	57·6	40·9	29·5
			Leaves - -	21·9	16·6	8·7	11·8
			Total crop -	92.3	74·2	49·6	41 8

NITROGEN RECOVERED PER 100 IN CROSS-DRESSING.—(*Continued.*)

	1	Farmyard Manure	Roots Leaves	per cent. 68·7 32·8	per cent. 36·7 45 6	per cent. 51·0 32·3	per cent. 27 7 26.5
1897			Total crop	101·5	82·3	83·3	54·2
	3	Farmyard manure, basic slag, and potash.	Roots Leaves	70·2 35·7	55·2 31·8	44·0 28·1	37·8 21 1
1896			Total crop	105·9	87·0	72·1	61·9
			DITTO, ONE QUARTER NITROGEN IN PREVIOUS LEAVES DEDUCTED.				
	1	Farmyard Manure.		per cent.	per cent.	per cent.	per cent.
1896			Total crop	66·6	40·9	36·8	26·9
	2	Farmyard Manure slag and potash.	Total crop	91·3	72 8	47·4	40·0
	1	Farmyard Manure					
1897			Total Crop	97·1	78·5	80·9	51·7
	2	Farmyard Manure, slag and potash	Total crop	100·5	82·8	70·0	58·9

addition of a dressing of nitrate of sodium is attended with a good return for the additional nitrogen applied ; this fact is shown by the earlier results when the nitrate was applied before the dung ; it is shown still more in the later experiments, when the nitrate was applied as a top-dressing to the young plants, and when the supply of potash to the crop was at the same time increased. The amount of farmyard manure employed in the Rothamsted field is a moderate quantity, and we must not therefore conclude that no deterioration in the action of nitrate of sodium will take place where much larger quantities of dung are made use of. The danger of denitrification reaching considerable proportions will increase as the amount of fermentable organic matter in the soil increases, and will be much aggravated by a wet condition of the land. The horticulturist who employs dung in large quantities is much more likely to suffer from denitrification than the farmer.

The mode in which farmyard manure is applied, and the extent to which it is incorporated with the soil, must have some influence upon its action. When farmyard manure is ploughed in, it is not intimately mixed with the whole soil, as in a pot experiment, but is left in a succession of layers separated by unmanured soil. When roots are grown on the ridge system, the farmyard manure is confined to the centre of the ridge. In either case the denitrifying zone is limited in extent, and does not include the whole of the soil penetrated by the roots. There is clearly much scope for careful enquiry as to the most proficable method of employing dung with other manures.

We now turn to the experiments made at Rothamsted with straw.

During twelve years, 1868-79, the straw of the preceding year's crop was applied to one-half of certain plots in the experimental wheat field. None of these plots received nitrate, but nearly all of them ammonium salts. We will take as our first illustration Plot 7, which receives a complete supply of ash constituents, with 400 lb. per acre of ammonium salts, supplying 86 lb. of nitrogen.

During sixteen years before the straw was applied the average total produce of the two halves of Plot 7 was, for 7a, 6,339 lb. and for 7b. 6,412 lb. per acre per annum, or a difference in favour of 7b, of 73 lb. During the twelve years, 1868-79, the straw of the previous season, amounting on an average to about 3,000 lb. per acre, was cut into chaff, spread on Plot 7a, and ploughed in during October. The other manures, including the ammonium salts, were applied at the same time in ten years out of the twelve; in the other two years the ammonium salts were applied as a top-dressing in the spring. During the twelve years in which straw was applied the average produce of 7a, was 4,973 lb. and of 7b, 5,185 lb., or a difference in favour of 7b of 212 lb. ; from this we may deduct 73 lb., representing the original superiority of 7b. We have thus an annual loss by the use of straw amounting to 139 lb per acre, diminishing the produce of Plot 7a by 2.7 per cent.

On Plots 6 and 8, also receiving a full supply of ash constituents, with 200 lb. and 600 lb. respectively of ammonium salts, the return of the straw, carried out in the same manner as just mentioned, occasioned, in the case of 6a an average diminution of 38 lb. of total produce, and in the case of 8a an average increase of 128 lb. of total produce, allowing in every case for the original difference between the two halves of the plots. The influence of the straw in diminishing the effect of the ammonium salts is thus altogether doubtful.

In the experiments on permanent grass, the addition of 2,000lb. of cut wheat straw to a complete manuring with ash constituents and ammonium salts has apparently increased the annual produce of hay by 7¾ cwt. on an average of forty years, 1856-95. In this experiment the straw is applied to the land in January, and the ammonium salts in February and March.

The results furnished by the field experiments at Rothamsted, both with farmyard manure and straw, do not thus substantiate the conclusions of the German experimenters ; the results obtained by the latter were due to the special conditions of their experiments, and especially to the large quantities of dung or straw which they employed.

Apart from the subject of denitrification, there are many facts of great practical value which are taught by the German experiments we have had under consideration. Persons unfamiliar with the method of pot experiments are apt to disregard the results obtained in this way ; it is foolish to do so. Pot-culture, with the opportunity it gives of maintaining exact experimental conditions, is, indeed, the only trustworthy method for the solution of many questions.

One fact which comes into great prominence in the German experiments is that ordinary farmyard manure is valueless as food for plants until it is nitrified ; this is surely the only conclusion we can draw from the want of action of the manure when applied in large quantities in the pot experiments. In the light of these results the economy of large dressings of farmyard manure becomes very questionable.

The conditions most suitable for the nitrification of considerable masses of organic matter deserve attention. Dehérain's few experiments on the subject are very suggestive. He mixed 100 parts of ordinary dry soil with 5, 10, 15, 20 and 25 parts of water ; placed these mixtures in a saturated atmosphere, so as to preserve unchanged the proportion of water added ; and at the end of ninety days determined the quantity of nitric acid produced. A similar experiment was made with soil with which 2 per cent of farmyard manure had been mixed. The results found were as under :—

Water added to 100 soil.	Nitric acid formed per million of soil.	
	Natural Soil.	Soil with Farmyard Manure.
5	250	270
10	260	360
15	270	490
20	290	290
25	380	220

We see, then, that while nitrification proceeded more energetically in the natural soil with each increase in the amount of water added, up to 25 per 100, this was not the case when farmyard manure, equivalent to 20 tons per acre was present. In the case of the manured soil, much the best result was obtained with 15 of water per 100 of soil. With 20 of water per 100 of soil there was no benefit from the addition of the manure ; and when the water reached 25 per cent. the soil contained much less nitric acid than if no farmyard manure had been applied ; denitrification had clearly been active in this case. Dehérain's results were not free from irregularities, and deserve careful repetition ; they are, however, quite consistent with the general ideas as to the most suitable conditions for the nitrification of organic matter furnished by the prolonged experience gained in France as to the most profitable way of managing artificial nitre beds, which in that country were kept under cover. These beds consisted of heaps of organic matter undergoing nitrification. The proportion of water present was found to be of great importance. As nitrification advanced this proportion was carefully diminished. If this precaution was neglected very little nitre was finally obtained. We should judge, therefore, that moderately dry soils are those most likely to yield a profitable return with farmyard manure.

The immense difference between the manurial value of the solid and liquid excrements of animals is shown in a striking manner in the German experiments; and the analysis of the dung, and of the farmyard manure which they employed, showed that there effect on crops was plainly connected with the proportion of soluble and active nitrogenous matter which they contained. The original voidings of the animal have a far greater manurial value than the final product of the manure heap which the farmer carries to his fields. In the whole progress from the stables to the field the loss of nitrogen is going on, this loss falling on the most valuable constituent of the manure, and resulting finally in a residue of comparatively inert matter (1). Maercker estimates the loss of nitrogen in the ordinary preparation of farmyard manure as equal to 45 lb. per beast in one year. One practical conclusion from these statements is the economy of feeding animals *on the land* whenever practicable. The whole subject of the economic preparation and preservation of farmyard manure is being actively investigated in Germany.

R. Warington,

Harpenden, Herts.

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(1) It is unfortunate that the Germans use the term "albuminoid nitrogen" for all forms of insoluble nitrogenous matter, and thus favour the idea that albuminoid nitrogen has but little manurial value. One has only to remember that the whole of the nitrogen in dried blood, fish manure, powdered horn, and oil-cakes is in this condition to see the falsity of such a notion. The albuminoids of fresh dung (chiefly nuclein) are specially insoluble, as they have resisted the process of digestion. The insoluble nitrogenous matter of humified manure cannot with any propreity be called albuminoid ; it falls in the same analytical class as albuminoids simply by virtue of its insolubility.

NOTES ON INTERESTING CONTRIBUTIONS.

Kikuyu Clover, (Trifolium Johnsoni, Oliver.)

Sir W. T. Dyer, Director of the R. Gardens, Kew, sends seeds of a white clover collected by Mr. A. White in the Kikuyu district of the British East African Protectorate. Mr. Whyte states that it was gathered in rich short pastures at an elevation 6,500 feet, and that he believes it will prove most useful in other tropical and sub-tropical countries. It is nearly allied to the white or "Dutch" clover (Trifolium repens) which grows wild in the Blue Mountains of Jamaica.

Soudan Water Lily.

Sir W. T. Dyer also sends seeds of a large Water Lily from Bahr el Zerat in the Soudan, the flowers of which are said to be eight inches in diameter.

Bergamont Orange. (Citrus Aurantium, var. Bergamia, W. and A.)

Messrs. Damman, of Naples, forwarded a small case of Bergamot Oranges. A consignment in a former year was unsuccessful, as not a seed grew. We have also had seeds from Kew in the dry state which did not germinate. The seed evidently cannot last long. If unsuccessful, growing plants will be imported. Mr. J. C. Sawer, author of "Odorographia, a Natural History of Raw Materials and Drugs used in the Perfume Industry," wrote to the Director of Public Gardens some time ago that this variety of Citrus should be cultivated in preference to any other, as the essential oil of the rind was very valuable.

Juniperus communis (Juniper.)

Seeds received from Messrs. Damman. This Juniper grows in Europe, N. Africa, N. Asia, and N. America. The oil distilled from the unripe fruit is used medicinally, as it possesses carminative, stimulant, and diuretic properties. Formerly the berries were used as a spice in food. "A spirit of which wormwood was an ingredient, was obtained from them by fermentation and distillation. This spirit called in French 'Genièvre' became known in English as 'Geneva' a name subsequently contracted into 'Gin.'" It is said that the famous quality of Westphalian hams is partly obtained through their being subjected to the smoke of juniper wood.

Erythea edulis.

This Fan Palm is native on the island of Guadalupe off the coast of California; seeds received from Messrs. Reasoner, Florida. It attains a height of 40 feet with bunches of fruit 6 feet in length and weighing 50lbs. The fruits are as large as plums, and the outer portion is edible.

JAMAICA CHALK.

By F. Watts, F.I.C., etc., Government Chemist, Jamaica.

In connection with the question of the production of citrate of lime, it is interesting to note that carbonate of lime suitable for the manufacture may be procured in many parts of Jamaica where lime-stone abounds. For this purpose the material should be in a friable condition so that it may be reduced to the state of a fine powder without much labour it should also be free from notable quantities of impurities such as Magnesia, Iron, Alumina and earthy matters.

Analyses have been made of two samples to ascertain their suitability for this purpose, the results are as follows :—

Analyses of Jamaica Chalk.

	I.	II.
Carbonate of Lime	94·51	91·55
Carbonate of Magnesia	·59	·36
Oxides of Iron and Alumina	traces only	·11
Earthy matter insoluble in acid	3·51	2·00
Water	·63	4·69
Undetermined loss	·76	1·29
	100·00	100·00

No. I.—Is a specimen of compact friable chalk, almost perfectly white in colour, obtained from a site on Chalky Hill Road, about four miles from St. Ann's Bay, at an elevation of about 600 feet.

No. II.—Is a friable chalk, less compact than I. of a pale cream colour, obtained on road from Papine Corner to Hall's Delight

No doubt these samples represent the character of numerous similar deposits widely scattered over the island.

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ADDITIONS AND CONTRIBUTIONS TO THE DEPARTMENT.

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Contributions from Prof, P. H. Rolfs State Experiment Station, Lake City, Columbia. [Author]
Contributions from A. D. Selby, Columbus Horticultural Society [Author]
Contributions from Botanical Department, Iowa Coll Agr. [Authors]
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The Grass and Grain Joint Worm Flies.
A Study in Insect Parasitism, No 5.
Revision of the Tachinidæ of America North of Mexico No. 7.
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Exhibition, Chicago Ill. 1893. No. 31.
Reports of Observation and Experiments. No. 4, 14, 22, 23, and 32.
An Enumeration of the Published Synopsis, Catalogue and Lists of North American Insects No. 19.
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The Pediculi and Mallophaga affecting Man and the Lower Animals. No. 7.
The Imported Elm-leaf Beetle. No. 6 (2nd Series.)
General Index to the Seven Vols. of Insect Life 1888-1895. Washington 1897.
Circulars;—No. 2 (2nd Series) No. 36.

SEEDS.

From Botanic Garden, Saharanpur.

Ziyphus Xylopyrus
Kydia calycina
Ipomeae sp
Blumea sp.
Albizzia procera
Coix lachryma
Terminalia Arjuna
Withania somniferum
Diospyros tomentosa
Smilax maculata
Alangium Lamarkii
Bignoniaceæ sp.
Hymenodictyon excelsum
Lagerstroemia parviflora
Dioscorea Diemona
Erycibe paniculata
Solanum indicum
Vernonia cinerea
Compositæ sp
Holarrhena antidysenterica
Apocynaceæ sp.
Diospyros tomentosa
Clausena pentaphylla
Caesalpinia sepiaria
Adenanthera pavonina
Sterculia sp
Zizyphus Jujuba
Jasminum pubescens
Diospyros Melanoxylon
Phœnix acaulis
Smilax sp.
Stereosperum chelonoides
Randia dumetorum
Combretum Vanun
Flacourtia Ramontchi
Odina Wodier
Stephegyne parvifolia
Zizyphus rugosa
Smilax macrophylla
Spatholobus Roxburghii
Indigofera pulchella
Woodfordia floribunda
Solanum sp.
Semecarpus Anacardium
Vitex canescens
Randia uliginosa
Sagittaria sagittifolia
Ardisia humilis
Crozophora plicata
Ehretia acuminata
Maesia indica
Leonotis nepetaefolia
Corchorus capsularis
Nicotiana Tabacum
Clerodendron phlomoides
Terminalia Chebula
Glycosmis pentaphylla
Ochna pumilio
Premna latifolia var mucronata

From Messrs. F. Sander & Co. St. Albans, England.

Carduus tauricus
Platycerium sp.
Delphinium, mixed
Scabiosa atropurpurea
Clematis paniculata
Dracaena Draco
Streptocarpus
Amaryllis sp.
Bambusa sp.
Caryota mitus
Begonia glaucophylla
Bertolonia, mixed
Mimosa pudica
Digitalis vars.

From Commissioner Imperial Department of Agriculture. Barbados.

Eucalyptus tereticornis

From Mrs. Munn, Strawberry Hill.

Melangene (Garden Egg)

[Issued 6th April 1899]

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] APRIL, 1899. Vol. VI. Part IV.

BACTERIA IN THE DAIRY.

Minor industries in their total volume are of immense importance to the welfare and happiness of every country.

During the year 1897-98 the Collector General reports that of Butter and its substitutes there were 884,624 lbs. imported into Jamaica valued at £26,325; of Condensed Milk 39,006 cases valued at £28,662; of Cheese 253,581 lbs. valued at £6,340; that is, the value of imported Dairy products amounted to £61,327.

In the days when cattle were bred principally as draught animals for sugar estates, it did not pay the pen-keeper to attend to Dairy work, but times have changed, and the Dairy business is assuming importance. Those who take it up, will only be able to compete with the imported articles by keeping themselves abreast with the scientific advances of the day.

Attention has already been called in the Bulletin to the importance of bacteria in the dairy, and the following pages taken from the Annual Reports of the Agricultural Experiment Station, Storrs, Connecticut for 1894, 1895, deal with the commercial importance of a particular bacterium, which is now distributed from the station to dairies, and has the effect of imparting a delicious aroma and flavour to butter, besides preventing the growth of hurtful bacteria, and improving its keeping qualities.

1. By Prof. Awater.

Bacteria in Milk.

Bacteria or microbes, as they are often called, abound in air, water, and soil, in animal and vegetable substances, and in living plants and animals. They are extremely minute and multiply with wonderful rapidity wherever the circumstances are favourable. Cold hinders their development. When heated long enough at the temperature of boiling water they are killed, but their spores, which correspond to seeds, may endure even this temperature for some time, though higher heat kills them speedily.

Bacteria grow with the greatest readiness in milk and cream. Hence they collect in milk and cream exposed to the air, and multiply rapidly.

A large number of different species of bacteria are found in milk and cream. Different species have different effects. Many of them sour and curdle milk at some temperature. A few induce changes that render milk alkaline with or without the formation of a curd. When a curd is formed, it differs in character with different species of bacteria. The souring of milk is more complex than has been supposed ; and while without much doubt souring always depends upon the action of bacteria, any one of a number of species, or several combined, may be the cause.

The longer a specimen of milk has been exposed to the action of bacteria, other things being equal, the greater will be the number of bacteria present. Hence it follows that cream will usually contain a very large number. The presence of these organisms, so far from being injurious, is of a positive advantage to the butter maker, since it is by their action that cream is " ripened."

Vessels in which milk and cream are to be kept are a great source of contamination by bacteria. The latter gather upon the sides and in the joints, and develop in the minute portions of milk, grease, or other matters from which it is difficult to free the walls of the vessels completely by washing.

Two important points in the handling of milk and cream are brought out by these considerations :

First.—The importance of keeping milk, so far as possible free from bacteria by the exercise of the greatest cleanliness.

Second.—The importance of cooling milk immediately after it is drawn from the cow in order to prevent the souring as long as possible.

Bacteria in Cream.

Besides the ordinary souring of milk, there are many other changes which are produced by bacteria, as the ripening of cream, the ripening of cheese, butter becoming rancid and others less common.

The chief object of the ripening of cream is to produce the butter aroma and flavour which, though very evanescent, control the price of the butter. This aroma and flavour the butter-maker owes to the bacteria; for by their growth the materials in the cream are decomposed and the compounds formed which produce the flavours and odours of high quality butter.

Different species of bacteria vary much as to the flavours which they produce, some inducing good, some extra fine, and others a very poor quality of butter. A majority of our common dairy species produce good, but not the highest quality of butter. Up to the present time the butter-maker has had no means of controlling the species in his cream, but has had to use those furnished him by the farmer. The bacteriologist can isolate and obtain in pure cultures the species of bacteria which produce the best flavoured butter. He can then furnish them to the creameries to use as starters in cream ripening.

Bacillus No. 41.

Among the food products exhibited at the World's Fair in Chicago, was a can of so-called preserved milk from Uruguay, which on testing was found to have been inadequately sterilised so that it was somewhat decomposed. Mr. W. M. Esten, of Middletown, was at the Fair in charge of an exhibit of the bacteria of milk, prepared by Prof. Conn and shown as part of the Experiment Station exhibit of the U.S. Department of Agriculture. The milk was placed in Mr. Esten's hands for bacteriological examination. He isolated several species of bacteria and took them to Middletown, where they were further investigated by Prof. Conn, who was then engaged in the study of a considerable number of species, found by him in specimens of milk obtained in and near Middletown. The tests of the Uruguay species were begun in the autumn of 1893. In December of that year it was found that one of the species, which had been designated for convenience during the process of the investigation as No. 41, produced such an effect in the ripening of cream that the butter from the cream was pronounced by experts as having the flavour of the best June butter. It is an interesting circumstance that this bacillus, which has proved of so great practical value, should have come from a specimen of milk from the other side of the world, and that the accident by which the milk had been improperly prepared for preservation should have resulted in so useful a discovery.

The investigations by Prof. Conn have been carried on at Wesleyan University in the biological laboratory, of which he has charge.

II. By Prof. H. W. Conn.

Experiments in Ripening Cream with Bacillus No. 41.

The organism, while forming an acid in its growth in milk, is not to be regarded as one of the milk-souring organisms. Milk under its influence becomes acid, but the acid production is quite slight and the milk, under no condition, becomes curdled. Even when growing at a warm temperature the milk remains limpid for weeks finally becoming somewhat brownish. After cultivation of the organism for a year or more in the laboratory, its acid producing powers seem to be somewhat greater than at first.

This organism has proved the best of all of the many species of bacteria thus far studied in its effect upon cream in ripening.

METHOD OF EXPERIMENT.

It may be well first to explain the method of experiment which has been found after considerable trial to be, all things considered, the most satisfactory.

When experiments in the creamery or elsewhere are desired, the procedure is as follows : There is first placed in an ordinary flask a half pint of milk, and this is sterilized by discontinuous steaming for three or four successive days. This sterilized milk is inoculated with a small amount of the Bacillus No. 41, and the culture thus made is allowed to grow at about 23 ° C. (74 ° F.) for a couple of days. The object of this growth is merely to increase the number of bacteria and thus make a larger inoculation in the creamery possible. After two days' growth the culture is sent to the creamery and the rest of the experiment is performed there by the butter-maker.

A lot of cream, amounting to six or eight quarts, is placed in a metal vessel and pasteurized, by being put into a tub of water into which steam is allowed to run. The temperature of the cream is allowed to rise to about 69 ° C. (156 ° F.) and to remain there for some ten minutes. The cream vessel is then removed and placed in cold water and cooled as rapidly as possible. When the temperature has fallen to about 23 ° C. (74 ° F.) the milk culture of the bacillus above described is poured into it and is thoroughly mixed with it by stirring. The vessel is then covered and placed in the ripening room of the creamery for two days, at the end of which time the cream is churned and the buttermilk reserved for further use. The object of this ripening of a lot of six quarts of cream is to increase the number of bacteria in order that a large and strong culture may be obtained for use in the large vat of cream in the creamery. The buttermilk from the churning of the six quarts of cream is then inoculated into the day's cream as soon as the cream is placed in the vat for ripening. The cream in the large vat receives no preliminary treatment, the prepared milk being poured into it directly. The cream is then allowed to ripen at a normal temperature for about twenty-four hours and churned as usual. Before the churning two or three gallons of the ripened cream is set aside to be added to the next day's cream collection to insure a continuation of the process. In this way the ripening is continued day after day, a small amount of each day's churning being set aside for the next day's inoculation, and the process is continued as long as the good effects of the original culture are seen. In the series of experiments which were instituted it was found that the effect of the first culture could be kept up in this way from three to six weeks, after which a new pure culture from the bacteriological laboratory was needed.

It will be noticed in these experiments that in practical use the cream of each day's gathering is not pasteurized nor treated in any way to insure removal of the bacteria which chanced to be in it. It may seem strange that under these conditions the addition of a pure culture would have decided effect upon the ripening of the cream. The explanation of the matter seems, however, to be simple. As is well known, a properly ripened cream needs to be slightly acid in order to give the flavour which is usually desired. Now Bacillus No. 41 does not produce sufficient acid to give this flavour, and in laboratory experiments with strictly pure cultures upon pasteurized cream it is found that the flavour of the butter is somewhat too flat. The cream as is ordinarily collected for the creamery contains organisms which render it acid, and when, therefore No 41 is added to the ordinary cream the effect of this culture is enhanced by the acid produced by the organisms already present. There is thus obtained a cream which is acid and also influenced by the peculiar effects of No. 41. Moreover, the culture bacteria were always added in excess. By cultivating as above described for several days in larger lots of cream, and by adding the day's collection of cream two or three gallons of buttermilk or ripened cream, the number of bacteria of Bacillus No. 41 added to the lot of cream was so great that their effects were plainly noticeable, in spite of the presence of the other species of bacteria which were in the cream as originally collected.

Results of the Inoculation.

In a long series of experiments the effect of the method of inoculation above described was always uniform and as follows : The first lot of cream, six or eight quarts, give a butter which was moderately good, containing a somewhat pleasant flavour, but not quite the typical flavour desired. The first churning in the large lot of butter from the ordinary cream vat gave butter slightly superior to that in the small churning. Then, on each day for several successive churnings, the quality of the butter improved. For perhaps one or two days it was a little difficult to say that the artificial culture had produced much of an improvement,the butter having about its ordinary flavour But after two or three days there began to be noticed a pleasant added flavour which was not there at first and after several days' churning this added flavour became very pronounced and noticeable to all who examined the butter. This delicate, exquisite flavour now continued and remained in the butter of each day's churning for some time, the length of time varying with, at present unknown conditions. If the flavour began to deteriorate it could be immediately restored by the addition of a new culture from the laboratory by the same method above described, and there is thus no difficulty in constantly maintaining this flavour in the butter.

The general results in the creamery at Cromwell where most of these experiments have been performed, have been as follows : The experiments began in November 1893, and there was noticed an immediate improvement in the butter. These experiments have been continued constantly with the exception of the months of July, August and September, until the present time and with uniform results. During this time pure cultures have been sent to the creamery upon many different occasions and have been used according to the above method. In each case there was an improvement in the butter, and the experiment was continued for three, four, five and six weeks, until the butter-maker noticed a distinct deterioration in the quality of his butter. Then a new culture was sent to the creamery which immediately restored the quality of the butter.

At four distinct periods the butter from the creamery was sent to an expert for rating, together with a lot of butter made from half of the same cream of the same day, but without the artificial inoculation. In every case where the butter was thus sent, the butter made by the artificial culture was rated higher than the butter made without it. It was marked from four to fifteen points on a scale of 100, ahead of the normal butter, the improvement being chiefly in the flavour. In one case the inoculated butter was 18 points ahead of the uninoculated butter. In another case three lots were sent to the expert, one made with a culture of Bacillus No. 41, a second made with the artificial culture sold by Carl Hansen's dairy company, and a third lot by a combination of Bacillus No. 41 and Carl Hansen's ferment. The butter made from Bacillus No. 41 rated highest, 95 points, the combination next 83 points, and Carl Hansen's lowest. In addition to the rating by the butter expert the butter was in all cases carefully examined by individuals who were more or less connoisseurs of proper butter flavour, and in each instance the butter made by the artificial culture was rated as better than that made without such culture. In most of these tests the individual examining the butter had no knowledge of the experiment.

Perhaps the most satisfactory experiment of all was one made early in June. June butter, as is well known, is in flavour about the best that is produced during the year, and the effect of Bacillus No. 41 upon June butter was therefore especially interesting. Early in June, when the amount of cream collected by the creamery was very large, two large vats full of cream were collected. One of these was inoculated with No. 41 and the other was uninoculated. They were then allowed to stand in the same room at the same temperature for the same length of time to ripen, and were subsequently churned. The effect of No. 41 even here was exceptionally striking. Both lots of cream produced, as was to be expected, an excellent quality of butter, but No. 41 had an aroma more pronounced and more agreeable than that of the butter made without the inoculation. In both taste and odour the butter made by inoculation was decidedly superior to that made without it. This butter was submitted for testing to a large number of persons, and no one had the slightest hesitancy in deciding that No. 41 made the superior quality of butter. It was most strikingly noticed just as soon as the wrapper was taken from the butter, the pleasant aroma of the inoculated butter filling the nostrils at once, while the uninoculated butter did not possess this decidedly pleasant aroma and taste.

The general result of experiments thus carried on now for at least twelve months in the Cromwell creamery, has been that this artificial culture uniformly improves the value of the butter. The effect of the pure culture is seen best after two or three days' ripening, and lasts from three to six weeks, but by the constant use of the culture it may be kept up indefinitely.

Mr. E. D. Hammond, the superintendent of the Cromwell creamery, has put into my hands the following letter, indicative of the experiments carried on in his creamery:

December 20th, 1894.

H. W. Conn:

My dear Sir:—In reply to yours of the 19th I will say that we have used your culture the past year, with the exception of the summer months when you were away and we could not get it. There can be no doubt as to its producing butter of a superior and uniform quality. In every instance where we have taken a quantity of cream, thoroughly mixed, and divided it into two parts, and have treated one in the usual way and have inoculated the other with the culture, and have sent the product to an expert to be judged, the culture has scored the highest. It produces a fine, sweet flavour which leaves a most pleasing taste in the mouth. For the sweet butter trade it is decidedly superior.

Yours truly,

E. D. Hammond.

It was, of course, desirable that these results should be confirmed in other places, and for this reason the culture has been used in several localities. These experiments have been as follows :

One lot of the culture was sent to Mr. George M. Whitaker of West Dudley, Mass. The creamery of which he is president was making at the time the highest quality of butter, which commanded a very high price in the Boston markets. The culture sent was broken in the journey and only a small amount of it reached the creamery. It was, however, used by Mr. Beck, the butter-maker of the creamery, and his statement was that he noticed a decided improvement in the quality of his butter as the result of it. Owing to the distance and the consequent difficulty of furnishing the culture at this creamery, the experiments were not continued, only one churning being made with the culture.

A culture of the bacteria was sent to Mr. Hollister Sage, Superintendent of the creamery at Stepney Depot, Conn. The culture sent to this place for necessary reasons, was not a culture in milk, but an ordinary bacteria culture on agar-agar, and required the use of certain bacteriological methods in its practical application to cream. Mr. Sage, however, seemed to have no difficulty in making use of it as directed, and reported, after the proper length of time, that he had noticed a decided and pleasant flavour in his butter, which was not there before and which gave it an enhanced value.

Up to this point the experiments had been practically confined to Middletown and the immediate vicinity. It was of course very desirable that they should be repeated in other localities and by other persons, in order to determine whether the effect was local only, and to what extent other creameries besides the Cromwell creamery would be benefited by the use of Bacillus No. 41. During the last three months therefore, arrangements have been made by which the organism has been used in other States. These experiments have now been made in the States of

Indiana, in the creamery of R. W. Furness, Indianapolis. In Pennsylvania the organism has been introduced into some thirty-five different creameries through the assistance of Mr. John Jamison, a large commission merchant of Philadelphia. In Iowa it has also been introduced into twenty-eight creameries controlled by Wm. Beard & Sons, commission merchants in Decorah, Iowa. The experiments in this large number of creameries have been most rigid. In many cases a lot of cream has been divided into two portions, one of which has been inoculated and the other not, the resulting butter being compared carefully. In some instances the organism has been inoculated into old cream which had acquired considerable odour by standing. In several instances it has been used in creameries in which the quality of the butter has not been first-class, and in others it has been used in creameries of the highest grade, whose butter commanded high market prices. In two instances it has been used in creameries which were at the time troubled with an undesirable flavour due to what is known as "frost weed." The butter made in the various creameries has been submitted for testing to experts, who in some cases knew of the experiments, and in others knew nothing of them. The butter made by the use of the culture was kept in the creamery side by side with the ordinary butter to test its keeping property. In short, the greatest variety of tests have been tried in this large series of creameries to determine whether the organism really possesses in other localities the valuable property that it has appeared to possess in the experiments conducted in Connecticut.

The results of these experiments have been highly satisfactory and to me somewhat snrprising, in spite of my belief in the value of the organism in butter-making. With a single exception none of this large series of creameries has failed to report an improvement in their butter. The creamery which did not find such improvement was reported as failing to have proper care for cleanliness in its butter-making process, and the failure to find an improvement has not therefore been thought to be significant. All other creameries in this large number of over 60 have found an improvement in their butter, sometimes appearing at once, and in other cases appearing after a few days' use of the artificial inoculation.

So uniform have been the results of the use of this organism that it must be regarded now as beyond the reach of experimentation, and Bacillus No. 41 takes its rank as a species of organism whose artificial use in the ripening of cream will produce a striking improvement in the flavour of the butter. The effect of the culture upon the various grades of butter is not exactly what might have been expected, and I have been considerably surprised the eby. When the experiments were begun I had supposed it probably that the use of the artificial culture might improve a poor quality of butter but was very doubtful whether it would have any effect, at least any advantageous effect, upon first-class butter. Experiments, however, has shown that the organism appears to be of decided value even in first class creameries. As already mentioned, the effect of the organism appears to be to add to the butter an especially delicate aroma and taste, and this delicate aroma and taste is added equally to butter of a poor grade and medium grade, or to butter of the very highest quality. In the light of the present experiments, therefore, it appears that all grades of butter may be somewhat improved by the use of artificial cultures.

Another matter of some interest is the fact that Bacillus No. 41 is not a milk souring organism. The " ripening " of cream is in many places called the " souring " of cream, and it has been supposed by all experimenters hitherto that the souring was identical with the ripening. For this reason all of the species of bacteria which have hitherto been used in ripening cream have been acid producing organisms. Experimenters have not thought it worth while to investigate whether or not the aroma of butter might not be due to species of organisms that do not normally sour the cream. Bacillus No. 41, while it produces a very slight acid reaction, does not sour cream, and it belongs therefore, to an entirely different class of organism from those hitherto used. This is especially interesting as indicating that probably the aroma of the butter is entirely distinct from the souring of the cream and may be produced either by acid organisms or by organisms that do not produce acid.

In one other respect Bacillus No. 41 appears to show itself as decidedly more advantageous in practical use than the organisms hitherto used. As will be seen above no previous treatment of the cream is needed in order that Bacillus No. 41 may produce its appropriate results. This of course, greatly simplifies the use of the organism and makes it much more probable that artificial inoculation of cream for ripening may in the future become a somewhat universal process. So long as butter-makers are obliged to heat their cream before artificial inoculation, in order to destroy bacteria already present in it, so long will they hesitate about adopting any form of artifical inoculation. When however, the butter can be improved from three to eighteen points by the simple addition of the culture of the proper species, the use of the organism becomes decidedly easier. When first undertaking these experiments, I was extremely incredulous as to the likelihood that artificial ripening of cream would ever be very common among butter-makers. Having, however, seen what good results can accrue to all grades of butter by the simple addition of a culture to the cream, I am now prepared to believe that the artificial ripening of cream will have a growing popularity among the butter-makers of this country.

THE WOODPECKER.

Attention has been drawn to the loss to which Cocoa planters in the Castleton Garden district are subject through the Woodpecker.

The Woodpecker is on the list of birds that are protected by law during the whole year. Under Law 32 of 1885 it is forbidden to kill, wound or take these birds at any time, and their eggs are also protected.

It feeds not only on seeds and berries but on insects as well, and and it is as an insectivorous bird that it is placed under protection.

Gosse in his " Birds of Jamaica," says:—" This is among the commonest of Jamaican birds, being abundant in all situations, from the shores to the summits......... ... His food is not confined to boring larvæ; the large red ants, so common in the woods, I have found numerous in his stomach; and at other times, hard strong seeds enclosed in a scarlet pulpy skin. In March we sometimes find him filled with the white pulp and oval seeds of the soursop. He is said to feed on the beautiful cherries (Cordia collococca) which in brilliant bunches are ripe at the same season; and I have seen him engaged in picking off the pretty crimson berries, that hang like clusters of minature grapes from the fiddlewood (Citherexylum). Sometimes he extracts the pulp of the orange, having cut a hole through the rind; and mangoes he eats in the Autumn. He does damage to the sugar-cane, by chiselling away the woody exterior, and sucking out the juice, and gets shot for this feat by the owners."

No complaints have so far been received from Orange growers that the Woodpecker damages Citrus fruits, but the extract from Gosse suggests that there is danger, and attention should be directed to this point by those interested in the industry.

Information is however to hand that it has acquired a taste for Cocoa-beans, and that while rats destroy only ripe pods, the Woodpecker attacks the pods in all stages of growth, causing the destruction of thousands of pods every season.

Correspondence is invited from planters on the following points :—

What districts of the island suffer through the Woodpecker ?

What kind of damage is done ?

What amount of loss is suffered ?

At what seasons of the year is damage done ?

What kinds of insects, fruits, seeds, etc., does it feed on ?

Is the good done by destruction of insects more than counterbalanced by the loss of fruit ?

Is it wise to protect the bird at all ?

If so, is it necessary to protect it all the year round ?

Or is a close season required only during a part of the year ?

Is it feasible to allow it to be killed in certain districts only, and protected in the rest of the island ?

TESTS OF SOME NEW VARIETIES OF SUGAR CANES.

By F. Watts, F.I.C., Government Analytical and Agricultural Chemist

In October 1896, Mr. R. Craig of Danks Savoy procured from Hope Gardens ten varieties of sugar cane ; these were planted in nursery beds on somewhat stony land of the estate. On August 28th 1297 these canes were cut and used for planting the field on which the following experiment was conducted ; both tops and lower joints of the canes were used for planting. The trial plots had each an area of one forty-fourth of an acre and the canes were planted in rows 6ft. apart and 2½ feet apart in the row. The soil, a friable loam, was in good condition ; no manure was used. The piece of land employed is in a somewhat shady place screened by a hill from any rapid circulation of air.

At the request of Mr. Craig analyses of the juice were made : in order to effect this appliances were taken to the property and the analyses were made in the boiling house at Danks. It must be pointed out that the specific gravities of the various samples of juice were taken by means of a Beaumé's hydrometer, hence no high degree of accuracy can be claimed for the figures representing total solids and purity. Cane sugar and glucose were determined in the usual manner.

The canes were cut, weighed and crushed and the analyses were made on February 1st and 2nd, 1899.

In the following table the canes are arranged in the order of the yield of cane sugar in the juice per acre; the table shows the weight of canes per acre, the gallons of juice, the percentage of juice expressed by the mill, the composition of the juice, the number of pounds of cane sugar (unmanufactured) contained in the juice from an acre, together with the proportion of rotten or "rum" canes.

A sample of 2nd Ratoon Caledonian Queen canes from the ordinary crop of the Estate was examined at the same time for purposes of comparison.

It will be observed that the saccharine richness of the juice in every case is exceedingly low while the proportion of glucose is very high : in only two cases, China and No. 78, does the cane sugar rise as high as 1·4 pounds per gallon, while in one instance Po-a-ole it is below 1 pound. It is difficult to account for these anomalous figures; at first sight they are suggestive of unripe canes, but it will be seen that the canes were over 17 months old : on the other hand it does not seem probable that the low saccharine richness and high glucose is due to over ripeness for the canes were juicy and in no way dried. The season during which they were growing was pronounced a good one. Probably the situation with insufficient sun and air may be held to account largely for the poor quality of the juice. It is thought probable that if grown in a more sunny position these canes would give much richer juice, as they have done in other countries. It is to be regretted that there was not a plot of Caledonian Queen cane, the character of which is locally well known, planted in this same field.

Of these canes, six are referred to in the analyses made by Mr. Bowrey and published in this Bulletin, October 1897, pp. 227-231. Those are 81. 78, 95, 115 Po-a-ole and 74. In the case of three of the varieties the quantity of cane sugar per gallon of juice agrees very closely with the figures now given ; these are 81. 78 and Po-a-ole, in the last case the comparison being made with Po-a-ole 2nd Ratoons in Mr. Bowrey's table. In the other three cases Mr. Bowrey's analyses show larger amounts cane sugar which would give support to the view that those three varieties 95, 115 and 74, particularly the first two, will yield rich juice under favourable conditions.

The weight of cane yielded by some of the plots was very great, the greatest weight being given by No. 116 viz. 146,168 pounds, or over 68 tons consequently the yield of sugar per acre is also large in spite of the low quality of juice, but with the muscovado process, boiling the sugar in open pans, the process of manufacture would be unsatisfactory ; indeed it is doubtful whether some of the samples of juice would yield syrup which would granulate in the coolers.

The following notes were made of the condition of the canes in the fields.

No. 116—Kept well, arrowed freely first week in January 1898.

81—Badly laid, heavy top, much prickle on leaf, sheath arrowed first week in January.

China—Low, scrubly and tangled, arrowed second week in December, 1897.

78—A very upright cane ; sound ; did not arrow.

95—Suckered heavily, many unsound canes, arrowed third week in December, 1897.

102—Upright cane, arrowed first week in December, 1897.

89—Cane very much tangled, arrowed heavily first week in December, 1897.

115—Upright cane, arrowed second week in December, 1897.

Po-a-ole—Badly laid, arrowed third week in December, 1897.

74—Cane with heavy trash and many suckers : badly rotted. Did not arrow.

Rind fungus (Trichosphæria sacchari) was found in many cases, No. 74 was closely attacked by the Weevil Borer (Sphenophorus sacchari.) In this connection it is important to note that the crop canes of the Estate, chiefly Caledonian Queen, were very free from fungoid and insect parasites: amongst the canes in this mill yard it required some little search to discover a "bored" cane, one that had been attacked by the Moth Borer so common in Barbados, the Leeward and Windward Islands: no evidence of rind fungus was seen in the Caledonian Queen canes.

TABLE I.

CANES GROWN EXPERIMENTALLY ON DANK'S ESTATE—CHAPELTON.

Name.	Weight of Canes per acre. pounds.	Gallons of Juice.	Beaumé.	Crushing per cent. on wt of Canes.	Cane Sugar pounds per gallon of Juice.	Composition of Juice, per cent by weight. Total Solids.	Cane Sugar.	Glucose.	Non Sugar.	Glucose Ratio.	Purity.	Cane Sugar in Juice lbs. per acre.	Rotten or Rum Canes per cent. on sound.
116	146,168	9,893	7·6	72·7	1·153	13·4	10·94	2·06	·40	18·8	81·6	11,405	6·3
81	146,124	9,857	7·6	71·1	1·145	13·4	10·86	2·15	·89	19·9	79·2	11,290	5·4
China	98,340	6,851	8·5	73·9	1·464	15·0	13·80	1·39	—	10·1	92·0	10,030	8·8
78	94,424	6,281	8·5	70·6	1·448	15·0	13·65	1·27	·08	9·3	86·3	9,095	1·6
95	117,656	8,183	7·2	73·2	1·138	12·9	10·81	1·44	·65	13·3	83·8	9,305	24·2
102	105,996	7,346	7·8	73·2	1·254	13·8	11·87	1·58	·35	13·3	86·0	9,212	13·9
89	99,352	6,895	7·5	69·4	1·238	13·2	11·75	1·38	·07	11·7	89·0	8,554	12·8
115	106.436	6,974	7·7	69·2	1·160	13·7	10·75	1·97	·98	17·9	78·5	8,097	12·4
Po-a-ole	119,152	8,276	7·5	72·6	·928	11·5	8·86	2·52	·12	28·4	77·0	7,674	32·7
74	79,904	5,486	7·5	72·2	1·188	13·2	11·22	1·76	·22	15·7	67·5	6,487	54·1
Caledonian Queen 2nd Ratoons.	48.048	2,888	10·5	64·6	1·886	18·6	17·52	·41	·67	2·7	94·2	5,438	none

This single series of experiments with these varieties should by no means be considered as final. It is probable that much better results might be obtained on a different site. The large proportion of rotten cane in some of the varieties is a most serious matter, particularly when the great loss sustained by some of the West Indian Colonies is remembered. Hitherto the canes of Jamaica have been free from serious pests.

Specimens of the canes were sent to Kingston; when those were examined at the end of about eight weeks indications of Rind fungus, (*Trichosphaeria*,) were found on many of them. It is uncertain what significance attaches to this manifestation of Rind fungus during the process of drying which the canes have undergone, but it is well to place the observations on record. The following table indicates the conditions of the canes after being kept for about eight weeks.

Signs of Rind Fungus on canes, about 8 weeks after being cut.

102—Extensive.
116—Extensive.
81—Moderately extensive.
95—Fairly marked.
115—Fairly marked.
78—Fairly marked.
China—Slight.
74—Free from visible signs.
89—Free " " "
Po-a-ole—Free " " "

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ADDITIONS AND CONTRIBUTIONS TO THE DEPARTMENT.

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SEEDS.

From Messrs. Reasoner Bros. Florida.
Erythea edulis
Melia azedarach var. umbraculiformis.
Prunus carolinana.
From Messrs. Dammann & Co., Italy.
Juniperus communis.
From Botanical Gardens, British Guiana.
Pritchardia, Dwarf sp.
From Thos. P. Roxburgh, Esq.
Grevillea robusta.
Eucalyptus Globulus.
From Royol Gardens, Kew.
Trifolium Johnsoni, Oliv. (Kikuyu Clover)
Soudan Water Lily.
From J. V. Calder, Esq.
Erythrina umbrosa (Bois Immortelle)

WOOD.

From B. S. Gosset, Esq.
Bauhinia variegata

[Issued 1st May, 1899.]

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] MAY, 1899. Vol. VI Part VI.

JAMAICA DOGWOOD.

Proximate Analysis of the Bark of Piscidia Erythrina, Linn.

By Herman Berberich, P.D.

Piscidia Erythrina, or Jamaica Dogwood, belongs to the natural order Leguminosae, and is a native of the West India Islands.

A fluid extract of the bark was several years ago introduced to the notice of the medical profession, and it is stated by physicians to be a direct sedative, producing narcotic effects, which are refreshing, and not followed, as in the case of opium, by hyperaemia of the brain, nausea and general nervous disturbance. It is said to be also of value in bronchitis, asthma, spasms of the muscles, due to flunctional causes, chorea, tetanus, and especially in toothache, to relieve pain.

By treating the fluid extract of the bark with slaked lime, Edward Hart* obtained a crystalline substance which he considered to be the active principle of the bark. The crystals separated on the sides and bottom of the flask after the mixture had stood for two or three days. They were accompanied by a resinous subtance. The crystals were purified by recrystallization from alcohol, and were finally obtained in a nearly colourless condition. After repeated recrystallization from alcohol, the substance was obtained in the form of small, yellowish crystals, which under the microscope, appeared to consist of four-or six-sided prisms. The same investigator further described the crystals as "insoluble in water; slightly soluble in cold, much more in boiling alcohol; only slightly soluble in ether; easily soluble in benzene and chloroform. It is dissolved by strong hydrochloric acid, and sulphuric acid, but reprecipitated apparently unchanged by dilution with water. Fehling's solution failed to detect

* American Chem. Journal, 1883, p. 39 ; Therapeutic Gazette, 1883, pp. 97, 98.

glucose or sucrose. The alcoholic solution is neutral to litmus paper. Alcoholic lead acetate solution does not produce a precipitate." The crystals melted at 192 ° C. An elementary analysis of them led to the formula, $C_{29} H_{24} O_8$. They were named *piscidia*.

The work of the present writer consists of a proximate analysis of the bark and a special search for the principle called piscidia. The approximate analysis was conducted according to the scheme of Dragendorff. The material was used in No. 40 powder. The percentages stated are for the air-dry bark.

	Per cent.
Petroleum ether extract :	
Caoutchouc, saponifiable wax and fat, etc.	0·61
Ether extract:	
Glucose, saccharose, resin, piscidia, etc.	0·86
Absolute alcohol extract :	
Glucose, saccharose, resin, etc.	0·51
Water extract:	
Mucilaginous and albuminous substances, 14.78 per cent.; dextrin, 3·38 per cent.; saccharose, 1.20 per cent., etc	22·43
Alkaline water (2 per cent. NaOH solution) extract:	
Mucilaginous and albuminous substances, 1·28 per cent., etc.	4·40
Acidulated water (1 per cent. HCl solution) extract :	
Pararabin, 1·35 per cent.	4·00
Starch	1·34
Moisture	9·25
Ash :	
Potassium, sodium, calcium, magnesium, chlorine and phosphoric oxide	10·55
Cellulose and undetermined substances	46·05
Total	100·00

Tannin was not found. The acidulated water extract contained calcium phosphate but not calcium oxalate.

After completing the proximate analysis a special search was made for the principle piscidia. The method used by Hart was followed. For this purpose a fluid extract was made by exhausting 500 grammes of the bark with an alcohol of 78 per cent. strength. The extract was concentrated by distilling off the alcohol until about 100cc. of liquid remained in the flask. This liquid was poured into a beaker containing 30 grammes of quicklime, which had been previously slaked with enough water to make a thick paste. The milk of lime and concentrated extract were intimately mixed, the mixture allowed to stand in a warm place for a half hour, then strained, and the residue pressed. The liquid was then filtered through paper to obtain it in a clear condition.

Water was now added to the clear filtrate until the latter was rendered slightly turbid. The liquid was then set aside for crystallization to take place. After two or three days crystals separated upon the sides and bottom of the beaker. They were accompanied by a resinous substance from which they were purified by recrystallization from alcohol. By adding water to the mother-liquor from these crystals, a second crop, still more impure, was obtained. These crystals posesssed all of the properties assigned to piscidia by Hart.—(*American Journal of Pharmacy.*)

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PEPPERS OR CHILLIES.

Pod peppers or Capsicums, the fruits of *Capsicum annuum* and allied species, are a well known spice and condiment. They are an indispensable ingredient in curries and are largely consumed in the fresh and dried state and in pickles. Some forms of Capsicums known as Bell peppers are entirely free from the acrid and burning pungency so characteristic of these fruits, and may be eaten cooked as a vegetable or in salads.

Chillies, Bird or Guinea Peppers the fruits of the shrubby *Capsicum minimum* (usually much smaller than the preceding) grow generally in tropical countries. These are in chief demand in commerce. When thoroughly dried and pounded, and afterwards passed through a hand mill and shifted, they are the principal source of the well-known Cayenne pepper.

It is estimated that about 100 tons of dried chillies are annually received into England from the West Indies and the East and West coasts of Africa. The price at which they are sold appears to be liable to considerable fluctuation. In April 1899, " fair red Zanzibar sold at 29s. 6d. : and good red Japan sold at 33s. 6d. to 34s. per cwt." A sample of capsicums grown in the West Indies, dull and uneven in colour, were valued at 20s. per cwt. What is evidently required is an article bright in colour, even in quality, and possessing great pungency.

Zanzibar Chillies.

In the *Kew Bulletin* (1892, p. 88) the following information respecting chillies was given in an article on the Agricultural Resources of Zanzibar, contributed by Sir John Kirk.

" The small red peppers or chillies are largely grown in the more dry and rocky part of the island, where the upheaved coral presents a honeycombed surface, that favours the accumulation of rich soil in the crevices. The pods are picked when ripe, sundried and packed in mat bags made of the split frond of the *Hyphaene* palm for shipment. This is an industry that has sprung up within the last 30 years."

Zanzibar chillies, as they appear in the market in a dry state, are small, red, thin, carrot-shaped fruits about an inch in length.

The following further particulars are contained in a Report on the Spice and other Cultivation of Zanzibar and Pemba (F. O. Report, 1892 Misc. Series, No. 226) :—

"The pepper plant growing in the island is *Capsicum minimum*, usually termed the 'shrubby capsicum,' and producing the bird's-eye chillies forming the basis of cayenne pepper. This is to be found in a small degree in every shamba, but the principal source from which the annual exports are derived is the eastern side of Zanzibar, and the cultivation here is chiefly in the hands of the Wahadinu people.

"Judging from observations made during my brief visit to this portion of the island, east of Dunga, the chillie cultivation struck me as being of a very scattered nature, generally small isolated patches from half to one or two acres in extent, and combined with tobacco, tomato, pumpkins, &c. I regret my inability to quote the annual total exports, but I believe they are large, and an undoubted source of revenue. As the chillie is, as yet, the only product of any value grown in this less favoured portion of the island, I consider that this cultivation could be extended, and that a little fostering care might be productive of much advantage. It is a cultivation easily carried on, and calling for no special trouble or skill, and the returns are certain and profitable. At present the people are so blind to their own interests as to purposely depreciate the value of this product. I understand through fear of possible shortage by theft on the way down, owners actually damp the chillies before dispatching, and it is often necessary, on their reaching the Government Customs godowns, to dry them as quickly as is possible as the only chance of saving them.

"Another variety of pepper (? *Capsicum annuum*) bearing a larger red and yellow pod is also cultivated, but the produce from this is all consumed locally."

The latest account of Zanzibar chillies is contained in the Report of Mr. Consul Cave on the Trade and Commerce of Zanzibar for the year 1897 (Foreign Office, 1898, No. 2129 Annual Series) :—"The production of Chillies has risen from 16,336 frasilas in 1896 to 17,698 frasilas in 1897, an increase of 77,670 lbs. The average price was 2 dol. 37c. per frasila as against 2 dol. 57c. per frasila during the previous year.* A better price than this could doubtless be obtained for Zanzibar produce if a little more care and attention were devoted to its cultivation and harvesting, but up to the present time it has been allowed to grow almost wild on the coral outcrop which covers the eastern portion of the island, and the slight personal discomfort which attends the handling of pods prevents the native from exercising any care in its picking and subsequent preparation for market. Attempts have lately been made to obtain a better sample on ground which has been specially cleared and prepared for the purpose, but the results are not yet to hand."

* A frasila = 35 lbs. avoir.

Japanese Chillies.

In a note on Recent Additions to the Museum of the Pharmaceutical Society (*Pharm. Journal*, Dec. 11, 1897), Mr. E. M. Holmes, F.L.S., furnished the following interesting particulars at an evening meeting of the Society, respecting Japanese and other Chillies.

"During the last three or four years there has been in commerce a very bright red variety of *Capsicum minimum*, Roxb. (*C. fastigiatum*, Bl.) said to be imported from Japan. In consequence of its clean, bright, and attractive appearance it has commanded a higher price than other varieties. Mr. J. C. Umney has recently directed my attention to the fact that this variety is less pungent than the Sierra Leone and Zanzibar varieties, although far superior to them in colour. On further inquiry I find that this fact is well known to drug and spice brokers. Mr. Umney points out that when an alcoholic tincture of the Japanese and Zanzibar varieties are respectively diluted with about 14 parts of water, the former gives a much clearer solution than the latter, indicating less oily matter. All the bright red Cayenne pepper until recently in commerce is said to have been imported from Natal in that state. The entire pod pepper imported from Natal is a variety of *Capsicum annuum*, much larger than the chillies, and of a dark red colour and very pungent, whereas the powdered Japanese and Natal Cayenne peppers placed side by side are indistinguishable in point of colour. The other principal varieties of chillies at present in English commerce are, I am informed, those of Sierra Leone and Zanzibar, the former being of a yellowish-red tint, and the latter of a dull, dark red, and often of inferior quality, containing badly-dried fruits, stalks and foreign matter, but both are more pungent than the Japanese kind. The latter is, however, quite pungent enough for most people, although perhaps unsuitable, by reason of its lesser pungency, for medicinal purposes, as an outward application, etc. I am indebted to Mr. Young, of the firm of Messrs. Dalton and Young, for information concerning the different commercial varieties and for specimens illustrating them. My object in directing attention to these commercial varieties is to point out to students and to retail chemists that there are often differences in the qualities and appearance of the same drug, which are worthy of careful observation, not only from a scientific, but also from a commercial point of view. Nepal Cayenne pepper is made from a small variety of *Capsicum annuum*, and is remarkable for its violet odour. Neither this kind nor the Zanzibar gives a red, but a brownish, powder.

The following comments on Mr. Holmes' paper were made at the meeting by Mr MacEwan:—

"The subject of cayenne pepper was interesting to many chemists quite apart from medicinal purposes, probably more capsicum being sold for feeding birds than for any other purpose. The pepper used in that way was tasteless, and seemed to contain a large amount of fatty matter. It was dark in colour, and the object was to heighten the colour of the feathers. It was supposed to come from *Capsicum annuum*, and he should much like to know where it came from. It was only supplied by two or three houses, and attempts by others to obtain it had not been very successful. There was no doubt that the pepper as used was an untreated product. The late Dr. Brady, on his return from Japan, passing through Vienna, came across a comparatively tasteless pepper, which caused considerable discussion at the time, as there was a large amount of it on the market, but the substance had been pretty much lost sight of since. He thought it would well repay inquiry, as very little had been done on the subject of peppers since Dr. Thresh dealt with it about 18 years ago."

According to a writer in Spons' *Encyclopædia*, Div. V., p. 1803 :—

" Several varieties of *C. annuum* have little or no pungency ; one of these is abundantly grown in Hungary, forming the paprika of the Magyárs. Another variety, cultivated in Spain, is imported into this country in powder for giving to canaries, to improve the colour of their feathers. The Nepal capsicums, which have an odour and flavour resembling orris-root, are the most esteemed as a condiment."

South American Peppers.

The following interesting account of the use of peppers in South America appeared in the *Saturday Review* of the 15th September, 1886 :—

" *Aji-aji.*—Pepper of peppers is the meaning of this compound Quichuan word, and both word and thing are largely distributed over South America, extending from the Bibo-Bio in the south to the Atrato in the north ; it is also found in the dialects of the Gran Chaco ; in Aymara, in Andaqui, among the Agricultural Indians of Chocò, the mining Indians of Potosi, and the Cerro de Pasco. . . . ."

" There are two kinds of aji ; but there is only one way of preparing it. The best is that which is made from the greatest variety of peppers. The pods of these are taken when fresh, stripped of their seeds, and ground into a paste of the consistence of fresh spring butter. The paste is put into a small, well-dried gourd, prepared on purpose, of the size and shape of a well grown orange.* The gourd, when thus charged, is then coated with a layer of well-tempered clay, and placed in the sun to dry, or to ripen, as the simple people who prepare it say in their own tongue. By the time when the clay is well baked, the pulp or paste within has been dried into a fine yellow powder, and is then fit for use. Many people, ignorant of this fine art of the Incas, have supposed, quite naturally, that these aji-laden gourds, with their exqusite flavour and refined taste, were some uncommon and little-known natural fruits. The other method of preparing aji is to grind the seeds with the pods, which simply adds great pungency to the pepper, and is always used in the preparation of maize or Indian corn, which is boiled in its own husk with much aji, and surpasses in flavour and pleasantness any vegetable curry of the East. The gourds of aji,

* Specimens of these gourds are in the Kew Museum labelled "Gourds used in Chile for holding red pepper 'aji' (*Capsicum* spp.), from Mr. H. F. Stahlschmidt, 1885."

when thoroughly ripe, are cleansed of their coating of clay, tied up in suitable leaves, well secured by the fibre of the aloe, and much resemble when ready for market reeves of large onions, a dozen gourds making up one reeve of aji. The cost of these in the good old times was fifteen pence for a dozen gourds; what the price may be now is only known on the exchange. Time was when some of the old families of the interior who had passed their lives in ignorance of railways, daily newspapers, and quotations of the state of the markets, had their own special way of preparing aji, mixing with it some delicately scented bark ground to powder, or other salutary substance known only to the reticent Indian. From such houses no visitor was ever allowed to take his departure without carrying with him a supply of the latest-made aji ; no traveller went to the capital or any of the coast towns but he carried with him some of this excellent pepper as a present to the archbishop or bishop of the diocese, the ladies of Santa Rosa, or the good Fathers who once a year went long journeys to baptise the children, marry their parents, and otherwise maintain the influence and authority of the Church in the remote parts of the earth. But even this good custom is fast dying out."—(*Kew Bulletin.*)

:o:

VEGETABLE SOAP.

By Dr. Anthony Robinson. *

The Coratoe or Curaça (as Dr. Browne calls it in p. 199 of his Natural History of Jamaica) is a species of the Agave. [A. Morrisii, Bak.] There are but few plants more common than this in Jamaica, where it grows naturally upon the most barren rocky hills, and is so generally well known to the inhabitants of this island, as to render a botanical description unnecessary.

The Vegetable Soap mentioned in my petition to the honourable house of assembly, and with some of which sundry experiments were tried before a committee thereof, is prepared from the leaves of this plant.

The lower leaves of the moderate grown plants may be cut off for use, without injury to the other parts ; but care must be taken not to cut off so great a quantity as to prevent the plants from flowering or vegetating, for by such means, the planter will never be able to increase his stock.

The plant blossoms in the spring, and the whole top of many of them is then covered with a number of little plants, which are to be carefully gathered as the stem withers, and planted in the fissures of the rocks where there is some soil, and at a proper distance, making allowance for the spreading of the plants which when arrived at maturity, expand 14 or 15 feet.

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* From the "Columbian Magazine," January, 1798. Published in Kingston, Jamaica.

Or they may be planted in the worst savannah soil, where the prickly pears and such like plants are usually found.

When the leaves are cut off for use, the most expeditious way of obtaining the juice, is by passing them singly with the point foremost through the rollers of a common cane mill, and straining it through an hair cloth, crocus, or coarse blanket.

The leaves after being pressed and the juice strained, in this manner, may be strained and soaked in water a few days and then dried, cleansed, and the fibres manufactured into ropes for plantation use.

In places where the convenience of cane mills cannot be had, proper hand mills with two or more rollers of Lignum Vitæ or other hard wood, may be erected at a very trifling expense.

Where these are not erected, the juice may be obtained for the use of private families, by cutting the leaves in pieces and bruising them with a heavy pestle in a wooden mortar, and then pressing the bruised pieces in a cassava or other press, or finally with hands, if other means are wanting.

The juice being thus extracted and strained may be inspissated by three several processes.

The first, by common concoction in a copper, tin, or iron vessel over a small fire, frequently stirring the liquor during the operation, to prevent its burning which it will be apt to do without proper care, and thereby loose somewhat of its detersive quality.

The second, is by coction in Balneo Mariae. For example, put the extracted juice into a tache or boiler, and place the tache or boiler within one of the largest coppers upon a trivet or other support, in such a manner so as to prevent the tache or boiler from touching the sides or bottom of the copper. Put such proportion of water into the copper that in case of ebullition, it may not flow into the tache or boiler and mix with the juice. Let the water in the copper boil with a brisk fire, and continue the process until the juice in the tache is gradually brought to a due consistence ; by this method of preparation it will be effectually secured from burning.

The third method is by insolation, or exposing the juice after straining in a large shallow receiver of wood or metal of any kind, to the action of the sun and breeze. The Soap prepared in this manner, is found to be the most detergent.

When the juice or extract is by either of the preceding methods brought to a due consistence, it may be manufactured into balls of the size of common wash balls, dried in the shade and kept for use, and to prevent them sticking together, or to the hands, nothing is more proper than the fine ashes of the lye tub, which may be found on most estates, or may be prepared occasionally, being first dried and sifted.

A caution must be used, never to compound the extract with tallow or any other unctious materials, for any mixture of that kind will render it much less efficacious.

December 17th, 1767.

THE ELENGI TREE.

MIMUSOPS ELENGI, LINN.

The Elengi is a large tree, a native of India and Malaya. It is often cultivated in India on account of its ornamental appearance and its fragrant flowers.

The flowers contain a volatile oil, and, when distilled, yield a sweet-scented water which is esteemed by the natives as a perfume, and is sometimes employed as a stimulant. Dried, they are used for stuffing pillows. It is reported that " a snuff made from the dried and powdered flowers is used in a disease common to Bengal, called ahwah. The symtoms of this disease are strong fever, headache and pain in the neck, shoulders, and other parts of the body. The powdered flowers induce a copious defluxion from the nose, and relieve the pain in the head."

The unripe berries are astringent and are chewed for fixing loose teeth. The ripe berries are sweetish and astringent, and have been known to cure chronic dysentery. A preserve is sometimes made of them.

From the seeds a fixed oil is expressed, used for culinary purposes, for burning, and medicinally. Reduced to a paste, the seeds are used to form suppositories in cases of obstinate constipation.

The wood is close and even-grained, taking a good polish—weight about 60 lbs per cubic foot. It is employed in house-building, for cart shafts and cabinet work, and is said to last for fifty years.

A decoction of the bark makes an astringent gargle.

This tree is very nearly allied to Naseberry Bullet Tree, and is also related to the Naseberry and Star Apple. All along to the family Sapotaceae. (See Dictionary of Economic Products of India, Watt).

:o:

RUBBER.

SOME RECENT DEVELOPMENTS IN RUBBER-CULTIVATION.

During a trip of several months through the old rubber-producing regions of Central America and the northern states of South America, I found a great interest in Rubber cultivation, and preparations were being made to start very considerable undertakings, particularly in the British West Indies, where the fact that rubber never has been indigenous to those islands is not considered in the enthusiasm of the people.* On the island of Trinidad I found this enthusiasm increased, to a substantial boom. Rubber seeds were selling at five cents each and young trees were wanted at fifty cents, though owners were refusing to sell

* The Milk-withe of Jamaica (Forsteronia floribunda) yields an excellent rubber. See Bulletin, July, 1894. [Ed. Bulletin, Bot. Dept.]

year-old trees about two feet high for less than a dollar a piece. It was reported that two English companies were about to begin operation in Trinidad and were proposing to invest a combined capital of $5,000,000 while private enterprise would probably bring $2,000,000 more to the island, making a total $7,000,000 prospective capital to be invested in that one locality. Other islands were becoming interested. In Grenada seeds were in demand, with the prospect that a very considerable acreage will be set out.

The most interesting point under discussion in relation to rubber-planting in the British West Indies is a series of experiments now being carried on in London and Trinidad, by which it is proposed to secure rubber from year-old trees of the *Castilloa elastica*. It has been found that seeds sown broadcast over a prepared field will yield an abundant crop of young trees, which at about a year old can be cut and sent to a factory where, with ordinary machinery operating a simple process, 8 per cent. of fine rubber can be extracted from the young shoots. This can be done in the laboratory. It is claimed that the process is a simple one, that but little machinery is necessary, and that in the future the world's rubber supply will be secured from an annual crop of young trees sown on cultivated estates, and not from remote forests as at pre-sent. A series of experiments has shown the young tree contains about 8 per cent. of rubber, which would at present prices return an estimated profit of $200 to $400 per acre. The extraction of rubber from young shoots has been accomplished chemically in the laboratory, but whether it can be applied to economic production of rubber on a large scale remains to be seen.

Castilloa elastica will grow almost anywhere, but it will yield a profitable flow of milk only under favourable conditions, and these conditions are dependent on the geological formations and topographical features surrounding the trees. To form an opinion in regard to these matters requires an economic geologist of some skill, and because of this fact the greatest losses will be made, for, as it is in mining and kindred enterprises requiring technical skill, uninformed people always consider themselves competent to judge, and most of them will have no use for the trained observer. As rubber-trees will grow almost anywhere, and as the period of waiting before a crop can be expected is a long one, the success that some will make, afford an example on which to secure money and lose it, to the profit of promoters and their associates who will claim to be thoroughly posted and to control lands that fulfill every requirement.

By forestry cultivation I mean the care of rubber trees in their natural forests, assisting nature to reproduce them; by husbandry I mean the cultivation of rubber-trees in plantations and an attempt to force them under conditions different from their natural surroundings.

Opinions in regard to suitable rubber lands vary to an unusual extent. This is because many observers have noted one species of rubber-producing tree and its special surroundings, but have never noted all the conditions common to the several species. In America rubber is mostly produced from *Castilloa elastica*, and several species of ***Hevea*** each of which is found under quite distinct surroundings. As a result general opinions on rubber lands, are three times differently expressed. One man will feel assured that rubber to be successful must be planted on land that is inundated a few feet at least once a year; another will say that low ground near a wet swampy country is the only available locality; while still another will talk of the medium upland country as the most promising.

These are widely different opinions, yet each is correct. Some species of *Hevea* do best on low ground that is subject to slight annual floods. Other species of the tree thrive over low, rich woodlands just beyond the reach of floods. *Castilloa elastica* does well on the foot hills wherever there is a rich, clean soil and abundant water. It is also found in low swampy ground, but amid such surroundings does not yield as fine rubber as in the healthier localities.

Rubber is taken from a number of trees and vines, but the species that I have noted. yield the commercial suppliess of America; of these *Castilloa elastica* is of the most interest to people who think of planting, because it does well on healthy ground where a man from the temperate regions can expect to live and see his trees develop.

The proper land should be clean, rich, and abundantly watered, with a good drainage. Such lands give the best returns. The trees grow abundantly on low unhealthy lands, but do not yield so good a quality of rubber, for which reason if one proposes to cultivate, it is well to have the best, and on this much will depend, for it will have an important bearing on results. Of the two methods of cultivation that are being tried little has been done with forestry as yet, but the few experiments made have been almost universally successful and promise important developments for the future. Husbandry so far has not been a great success, and in many places rubber trees have been carefully planted and tended for a long term of years but have not given any returns, though it is claimed that some of the trees are twenty to forty years old.

The claims in favour of husbandry are that a great number of trees can be planted on one acre, and that all are within easy reach, while better returns can be expected from cultivation than from the natural conditions of the forest. It must be borne in mind, however, that *Castilloa elastica* is a tree of the shade, and that the flow of sap, and not beautiful proportions or an abundant yield of fruit is the object sought. Another important point is that the tree has a comparatively tender bark in the shady woods, which in an open cultivation becomes much heavier as a protection against the sun and dry air at the expense of the flow of sap, and the provisions of nature which permit the tree to grow anywhere defeat the objects of a planter and makes rubber-cultivation a doubtful undertaking. Hence in many cases the thousands of dollars that are being invested in such enterprises will be the source of grievous disappointment. On the other hand, a careful selection of a run of forest property where rubber-trees reproduce themselves naturally, must yield returns that will surprise even the most sanguine expectations.

Castilloa elastica reproduces itself freely. It has been compared to the pine—a slow-growing tree which does not propagate itself rapidly. It should however be compared with the chestnut of our northern forests. If a stretch of well-situated land were allowed to grow up wild here at the north, it is certain there would be a fair proportion of chestnut-trees that would probably come up on the property. If, besides these natural results one or two camps were established on the place and a few men were kept working about through the woods planting chestnuts and looking after the trees, it is certain that the care and attention would result in a heavy percentage in favour of the planter. Similar results can be expected in the tropical forest, using the same methods but substituting the care of rubber-trees for the chestnut-trees that I have taken as an illustration.

I have noted strong evidence in the tropical forests that rubber-trees will reproduce themselves whenever the locality is naturally adapted to such reproduction, and with a little care such as could be given by three to ten men according to the size of the property taken in hand the results will be beyond the most sanguine expectations. The great question is to secure a good run of healthy forest land in a suitable location. This being done but little more is required. A few ordinary labouring men and the investment of a small amount each year will after a time return thousands annually. In the forests the rubber-tree can be relied on to produce an abundant flow of sap. In open cultivation it must protect itself from the sun and dry air, and the results are doubtful, though some well-situated plantations will certainly yield bountifully. Another important point is that forest land is cheap in most rubber countries, and it is no object to secure a maximum yield from a given amount of land. The object should be a minimum cost of production without regard to the amount of land employed.

After having travelled through all the desirable rubber regions in Central America and northern South America, I am satisfied that suitable tropical forests which can be had now at a low price—often for a few cents an acre—present an opportunity for the profitable employment of capital such as has seldom been offered in the world's history, but the serious point is to secure the proper land. Those who acquire it will have more than they expect, but natural rubber lands are not to be had by simply making a chance location. Though the tree will grow almost anywhere, it is only the most favoured spots that will yield those spontaneous returns that are so very profitable. It is fair to state that if people go to taking up tropical forests promiscuously ten will be disappointed to every one who secures a prize.—*Indiarubber World.*

NOTES ON INTERESTING CONTRIBUTIONS.

Parmentiera cereifera, Seem. "Candle Tree." Plants of this interesting tree have been received from Mr. E. Campbell, Curator of the Botanic Station in British Honduras.

On the Isthmus of Panama this tree, according to the *Treasury of Botany*, is called the Candle Tree or Palo de Velas, because its fruits, often 4 feet long, have the appearance of yellow wax-candles suspended from the stems and older branches of the trees. "The fruits have a peculiar apple-like smell which communicates itself in some degree to the cattle fattened with them, but which disappears if a few days previous to killing, the food is changed." There are two other species, natives of Mexico, the fruits of which are also edible. Parmentiera is nearly allied to the genus Jacaranda, which is so ornamental on account of its bunches of blue or violet coloured flowers and finely divided leaves, natives of South America. Both belong to the family Bignoniaceæ. The flowers of Parmentiera have a corolla which is almost bell-shaped and of a white or greenish colour.

The genus is named after the French botanist Aug. Parmentier who did so much for economic botany.

Mr. Campbell also sent plants of :—

Cochlospermum hibiscoides, Kunth, a native of Mexico, a tree with large yellow flowers. The generic name refers to the shell-like form of the seeds; and the specific name, meaning hibiscus-like, refers to the shape of the flower. It is nearly allied to the Annotto shrub, both belonging to the family Bixineæ. There is a coloured plate in Biologia Centrali-Americana.

Pentapetes phœnicea, Linn, a native of the East Indies. This is an annual growing from two to five feet high, with large red flowers which open at noon, and close at the following dawn. It belongs to the same family as Kola and Cocoa,—Sterculiaceae.

Hirtella dodecandra, DC., a native of Mexico, belonging to the same genus as a native Jamaica tree, H. triandra, Sw., and nearly allied to the Coco-Plum. Family—Rosaceae.

Palms and other plants, natives of Honduras, were also received.

Socratea exorrhiza, H. Wendl. Seeds received from Dr. Morris.

Dr. A. R. Wallace, in his "Palms of the Amazon," describes this palm as "curious and beautiful."

"It reaches fifty or sixty feet in height, with the stem moderately thick and very smooth, there being scarcely any rings or scars left by the fallen leaves.

The leaves are large and pinnate, with the leaflets triangular and very deeply notched, standing out at different angles with the midrib. The leaves curve over gracefully, and the character and aspect of the foliage is very different from that of most other palms. The column formed by the sheathing leaf-stalks is swollen at the base and of a deep green colour.

The spadices are three or four in number, growing rather upwards from the stem below the leaf-column. They are small and simply branched, and bear small oval red fruits about the size of a damson, the outer pulp of which is bitter and only eaten by some birds.

But what most strikes attention in this tree, and renders it so peculiar, is, that the roots are almost entirely above ground. They spring out from the stem, each one at a higher point than the last, and extend diagonally downwards till they approach the ground, when they often divide into many rootlets, each of which secures itself in the soil. As fresh ones spring out from the stem, those below become rotten and die off ; and it is not an uncommon thing to see a lofty tree supported entirely by three or four roots, so that a person may walk erect beneath them, or stand with a tree seventy feet high growing immediately over his head.

In the forests where these trees grow, numbers of young plants of every age may be seen, all minature copies of their parents, except that they seldom possess more than three legs, which gives them a strange and almost ludicrous appearance.

The wood of these trees is very hard on the outside, but soft and pithy within. It splits easily and very straight, and is much used for forming the floors of canoes, the ceilings of houses, shelves, seats, and various other purposes. Perfectly straight laths are more readily made from it than from any other wood, and they are so hard and durable as to serve for fish-weirs, corals for turtles and for harpoons. The air-roots are covered with tubercular prickles, and are used by some Indians to grate their mandiocca (cassava).

This species grows in swamps or marshy ground in the virgin forest, not in the tide-flooded lands on the river banks." It was formerly associated with the old genus Iriartea from which it may, however, at once be distinguished according to the "Treasury of Botany," by being very bitter in every part. This property disqualifies the leaves from being eaten as 'cabbage,' and in Central America has obtained for these palms the name of Palmas amargas, in contradistinction to the different species of Iriartea, which are termed there Palmas dulces, and are used as food.

Grevillea robusta, Cunningham, according to Von Mueller, is a stately lawn-tree, indigenous to the subtropical parts of East-Australia, rising to 150 feet, of rather rapid growth, and resisting drought in a remarkable degree; hence one of the most eligible trees, even for desert-culture, though naturally a silvan plant. The wood is elastic and durable, valued particularly for staves of casks, also for furniture, and for interior work in houses. The richly developed golden-yellow trusses of flowers attract honey-sucking birds and bees through several months of the year. The seeds are copiously produced and germinate rapidly. Rate of growth in Victoria, 20-30 feet in 20 years. In Ceylon it attained a stem-circumference of 5 feet in eight years. In India it flourishes at alevations from 2,000 to 7,000 feet, and is chosen as a favourite tree for lines of shady walks. In Jamaica it does equally well at sea-level, and at 5,000 feet.

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Seeds.

From Supt. Bot. Gard. Mysore.
Spathodea campanulata.
From Commissioner, Imperial Dept. Agri. West Indies.
Talauma Plumieri
From Vilmorin—Andrieux & Co., Paris.
Papaver somniferum.
Verbena hybrida
Petunia hybrida.
Salvia.
Antirrhinum majus var,
Coreopsis tinctoria.
Godetia nana.
Dianthus sinensis.
Coreopsis hybrida
Gaillardia picta.
Zinnia elegans.
Chrysanthemum coronarium.
Tropæolum majus.
Impatiens Balsamina.
Celosia cristata.
Phlox Drummondii.
Reseda odorata pyramidalis grandiflora.
From J. V. Calder, Esq.
Erythrina umbrosa (Bois Immortelle)
From A. Geo. Heron, Esq.—Cross Keys.
Papaw.
From Dr. Stubbs, Louisiana.
Velvet Bean (Mucuna pruriens, var utilis.)
From W. Jekyll Esq.—Robertsfield.
Hibiscus elatus (Mahoe.)

Plants.

From Bot. Station, British Honduras.
28 Native and other plants.

[Issued 26th May, 1899.]

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] JUNE, 1899. Vol. VI Part VI

METHODS OF PREPARING RUBBER.

By R. H. Biffen. *

So much has been written within the last few years on the subject of indiarubber, the sources of our supply, and the possibility of acclimatizing the best-yielding trees in our colonies, that at first sight it may appear that there is little more to be said. A study of the methods in use for preparing rubber from the latex, or milk, may however be of use to many interested in the formation of plantations, especially if some attention is paid at the same time to the inaccurate statements made in some recent publications, which apparently have disregarded the valuable series of papers on the subject contained in our one journal devoted to economic botany, the "Kew Bulletin".

The methods in use at present are either the out-come of the limited experience of uncivilised peoples, or the application of experiments made without paying due attention to what is known of the chemical constitution and physical properties of latex. As a good example of the latter we may take the experiments of Morisse** who found that coagulation was brought about in the latex of Hevea by the addition of alcohol, phenol, hydrochloric acid, nitric acid, sulphuric acid, calcium chloride, ferric chloride, corrosive sublimate, etc. As the outcome of these experiments a mixture of phenol in alcoholic solution, and dilute sulphuric acid was recommended as a coagulating agent.

The latex is, as a general rule, a thick, white fluid, composed of small particles of rubber in suspension in a clear watery solution of various substances. Unfortunately, only the latex of a few trees has, as yet, been chemically examined when fresh.

* Journal of Society of Arts.

** Seeligman, Lamy, et Falconnet ; " La Caoutchouc et la Guttapercha, Paris, 1896, p. 68.

The analysis of the latex of Hevea brasiliensis shows that it contains :—

Rubber	32 per cent.
Proteid matter	2 3 ,, ,,
Calcium and sodium salts	9·7 ,, ,,
Resin	traces
Water	55 to 56 per cent.

It is slightly alkaline to litmus paper. †

The presence of albumin, globulin, and other proteids, has been demonstrated by Green * in some other rubber-yielding latices.

As a general rule all these substances are to be found in rubber as it is at present prepared, often with others added to bring about coagulation of the latex, and accidentally or intentionally added impurities such as bark and clay. In all cases the percentage of impurities is large, how large we shall see later, and when it is remembered that some cause a rapid deterioration of the rubber, it is obviously much to the interest of those connected with the industry that a method of preparation should be adopted which would minimize them or ensure their absence.

I propose now to consider a few of the better known varieties of rubber.

Para Rubber is the product of Hevea brasiliensis, a tree which thrives in many parts of the Amazon valley, British Guiana, etc. As pointed out by Churchill** in his consular report, there is no danger of this source of supply becoming exhausted, though this is the frequent cry of companies formed for rubber-planting, usually fated for an ephemeral existence. The tapping is done with considerable care by the natives, and even should a district become exhausted, in a few years a fresh supply of trees springs up. From the planters' point of view Brazil is hardly a suitable country, for the climate is bad, it is difficult to obtain labour, and the exchange is *liable* to endless variations. The trees have, however, been introduced into Ceylon, where small plantations exist, and into other colonies‡.

The method of preparing the rubber has been so frequently described that repetition is needless ; but a "translation of a valuable article on rubber of the Orinoco" ‖ has received so much attention of late that it requires some examination. One of its most striking errors is the following :—"As the juice contains a considerable quantity of water, the preparation of rubber consists essentially in separating the former from the latter, which is performed by evaporating the water by means of a heating process or obtaining its coagulation by certain chemical processes. Although the last system is more rapid, they prefer the former, as they pretend that the rubber thus obtained is of a superior quality—a supposition devoid of all reason."

† "Le Caoutchouc," etc., p. 94.
* Green, "Proc. Roy. Soc.," 1886. p. 28.
** "Kew Bulletin," 1898, p. 242.
‡ "Kew Bulletin," 1893, p. 159.
‖ "Trinidad Bulletin," 1893, No. 18, and 1897, p. 36

As I have already had occasion to show,‡ this statement is incorrect, for the heating continues for too short a time ; (" the rubber " *is not* " dried in a few minutes ") to evaporate off some 50 per cent. of water, and further there is no loss of weight until the clot begins to contract and squeeze out water. Neither is " the supposition devoid of all reason," for it is a well-known fact that the smoked rubber is far preferable to that obtained by chemical processes. A comparison of the prices of " Para fine " and " sernamby " should be sufficient proof of this. Why it is so, may be made clearer from the following experiment. At the end of a day's work I had several litres of latex left, to which an equal volume of water had been added, which would not keep over night without coagulating. To this a small quantity of acetic acid was added, and in a short time the *whole of it* had formed a stiff curd. On pressing and drying, a portion of the water exuded from this mass of sernamby, but it still remained full of cavities, and the proteid matter in it quickly decomposed, so that ultimately a stinking, inflated mass was obtained.

If this latex had been coagulated by smoking it would have yielded a wet rubber, but the subsequent decomposition of proteids would not have set in, for the creosote contained in the smoke would have acted as an antiseptic and prevented decomposition, as it does when meat is preserved by smoking.

Then again we find, " the rubber thus prepared (by smoking) acquires a darkish colour, due to the particles of coal which adhere to the outer skin. Some people believe that this tends to improve it, but such is not the case, for it is thus impregnated with impurity."§ Now when these " bottles " of rubber are cut across, the fresh, laminated surfaces are a silvery grey colour, and as each layer is exposed to the same extent to the action of the smoke it is difficult to account for the outer layers only being so coloured. The freshly cut surfaces however soon darken and become black in turn, so that the explanation of oxidation seems far more probable, especially when taken in conjunction with the fact that smoke is white * and not black,† for the nuts are simply dry-distilled and not actually burnt. If the smoke of these heated urucuri nuts is condensed, it forms two layers of liquid in the receiver, one a clear limpid solution consisting mainly of acetic acid, the other, darker in colour, of creosote.

The hot vapour of acetic acid brings about the coagulation of the proteids of the latex, as may easily be proved by direct experiment.

A solution of alum is said to be in use for preparing rubber in some parts of the Amazon valley. Morisse** states that alum solution has no effect upon the latex of Hevea species however.

The loss in the factories on making up Parà rubber is as follows‖ : (1) Parà fine, 10 to 15 per cent. ; (2) Entre-fine, the carelessly smoked pieces, 15 to 20 per cent. ; (3) Sernamby, rubber pulled from the cuts

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‡ Biffen, " Anns. Bot." 1898, p. 165.
§ " Trinidad Bulletin." 1897, p. 38.
* Compare the plate on page 757 of the " Journ. Soc. Arts," 1898.
† " Trinidad Bulletin," 1897, p. 37.
** " Le Caoutchouc," &c., p. 67.
‖ " Le Caoutchouc," &c., p. 75.

on the tree and cups, coagulated by being allowed to stand, etc., 20 to 40 per cent. From these data we may safely conclude that the smoking method of preparation is by far the best in use at present, a view which will be further strengthened when we compare the losses on making up other sorts of rubber.

Ceara Rubber is the product of *Manihot Glaziovii*, a tree growing chiefly in the highlands of the State of Ceara, Brazil. Cross is responsible for most of the descriptions of the locality in which it grows, but as his experience of it appears to have been limited to Pacatuba, in which place its habitat is far from typical, they are not very accurate. He records it as growing at an elevation of 200 feet above sea level, among granite boulders, in a country whose dryness was indicated by the fact that "ferns, weeds, grasses and mosses" were absent. True, it does grow among granite boulders, in the scantiest of soil in such localities, but it is more at home in the mountains, up to a height of 3,500 feet, and even more, where there is an abundant rainfall. These facts will serve to show the wide range of conditions the tree will put up with, and were it not for the smallness of its yield (1 to 3 lbs per annum) it would be invaluable for introducing into many of our colonies. Coagulation is brought about either by smoking, as on the Amazons, or by simply allowing the latex to dry on the tree trunks or soil.

The latter methods are objectionable, as the rubber invariably contains pieces of bark or grit.

It may also be prepared by churning the latex, and pressing the resulting clots. The method is not to be recommended though, for even if the clots are cut into thin slices and exposed to the heavy pressure of a mandiocca press a considerable percentage of water remains in its cavities, and decomposition sets in, but not to the same extent as in "Cearà scrap."

Although so impure, it commands a price usually second only to "Parà fine." The loss is from 20 to 25 per cent., which, in inferior qualities, may even amount to 55 per cent.

Mangabeira rubber also comes from Cearà. It is the product of *Hancornia speciosa*, a dwarf tree with somewhat the habit of a birch. The rubber is prepared by the addition of an excess of salt to the latex, or by Strauss' method of adding alum. Even after thirty days' drying in the sun it is spongy and full of cavities of liquid. As might be expected, the loss on purification is enormous, amounting to from 40 to 60 per cent.

By this method of coagulating with chemical reagents it is impossible to get rid of the coagulated proteid matter, to say nothing of the greater part of the water. Morellet's† remark that "le procédé Strauss est ingénieux, mais les résultats de son application sont mauvais" may well be applied to all these chemical methods, and the sooner the search for coagulating agents is abandoned the better.

The only other American rubber of importance, at present, is yielded by *Castilloa elastica*. It appears on the market in a number of different forms under the names of Mexican, Nicaraguan, etc. As far as we know *C. elastica* is the only species of the genus yielding rubber, for the *C. Markhamia* of Collins turns out to be a *Perebea* species.‡

The latex is obtained in a rough and ready fashion by hacking a spiral channel from the crown of the tree to the ground, or by making great gashes with a machete.

Collins § has recommended a timber-scoring knife for tapping, and since then most writers have followed his lead. On experimenting with one, I found it was practically useless, as little latex exuded, possibly owing to the closure of the vessels by the drag of its edge. Stabbing with a broad-bladed knife, or with a chisel as practised in Ceylon,§ gives good result without much damage to the tree. In the previously mentioned article in the "Trinidad Bulletin" (1898), there is some slight confusion as to the localities suitable for the growth of *Castilloa*. In one place (p. 122), "it will scarcely thrive in regions that are not equally suited to *Hevea spp*," which (p. 130) grow " on land which is periodically inundated, even to a depth of five feet." Then (p. 121), "the tree (*Castilloa*) avoids marshy or boggy land, and manifests a preference for warm deep loam, or sandy soil." The latter statement is the correct one.

The most general method of preparation in Mexico is to add an extract of the leaves and stem of the moon-flower (*Ipomoea bona-nox*), and allow the mixture to stand over-night. The floating clot which forms is then pressed to remove some of the water.¶ As in all these cases of preparation by "wet" methods the rubber contains large quantities of water, it loses from twelve to thirty per cent. on drying. Another method is in use in Nicaragua.*° The latex is mixed with about three parts of water, and allowed to stand over-night, when the rubber comes to the surface in particles which do not unite to form a solid mass. The water is then drained off from below, and the rubber particles are mixed with a fresh supply of water, and the process is again repeated. The particles are then brought into a solid mass by pressure. The latest account of this method is apparently given by Hart, in an article on the "Coagulation of Rubber,"** who appears to have rediscovered it. I quote it in full as I may be mistaken. "After the addition of water the mixture is well shaken; the globules of rubber (having a lighter specific gravity than the albumenoids and proteids [*sic*] contained in the latex) will float quickly to the surface. It is found moreover that on the addition of further volumes of water and the removal of albumenoid liquors from below the floating rubber, the globules rise much more quickly to the surface."

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‡ "Kew Bulletin," 1887, xxviii p. 13, *cf.* "Trinidad Bulletin," 1898, p. 21.
§ Collins "Report on Caoutchouc."
‖ "Royal Botanical Gardens, Ceylon," 1898; Ser. I., No. 4, p. 30
¶ Belt, "Naturalist in Nicaragua," p. 33. Morris, "Colony of British Honduras," p. 76.
*° "Le Caoutchouc," &c., p. 62. "Kew Bulletin," 1887, xxviii., p. 16.
** "Trinidad Bulletin." 1898, p. 131.

The following criticism of this "creaming" process is given in "Le Caoutchouc et la Gutta Percha":—"Ce mode de prèparation est bien rudimentaire et ne peut fournir qu'un produit de qualitè infèrieure, qui perd souvent plus de 50 per cent, surtout lorsqu'il fraîchement préparé." †

Recently there has been some talk of extracting rubber from leaves and twigs by means of solvents, as has been done in the case of gutta-percha. A description of this latter process may therefore be of interest. It originated in the smallness of the yield of the *Isonandra gutta* trees, a tree from 25 to 30 years old, only giving 1·3 lbs of gutta percha when felled. The explanation of this fact is to be found in the work of De Bary, ‡ who showed that the laticiferous system of the tree, consisted of short, closed sacs. This the being the case, a great many would remain unopened, and thus a considerable per-centage of the gutta-percha would remain in the bark. As the demand for gutta-percha has been large, and the supply has been obtained by felling the trees, they have become almost extinct. §

Serullas proposes to utilise the leaves and twigs of the shoots from the old butts to extract the gum from. They are dried, treated with caustic potash to destroy colouring matters, and treated with solvent for gutta-percha. The solvent is then distilled off and may be used again and again.

Rather more than 1lb. of gutta-percha is said to be yielded by 30 lbs. of chopped up fresh leaves and twigs. ‖

For several reasons I do not think this process could profitably be applied to the preparation of rubber. The most important of these are (1) on gathering the leaves and twigs there would be an immense loss of latex, and (2) stripping trees of their foliage (the part which builds up their food supply) invariably kills them.

The direction in which research work should tend, I venture to think, is to prepare rubber free from the other constituents of latex, so that among other things, freight and customs charges on these impurities may be avoided.

Now it has been shown conclusively that the chemical constitution of latex varies with its source, so that it is improbable that any one reagent can be found capable of coagulating any given latex. Thus from the fact that acetic acid coagulates the latex of certain Hevea species, it cannot be argued that it will coagulate the latex of a Kicksia species.

Then expert opinions, as we have seen, show that the preparation of rubber by these chemical means is not satisfactory, for the product is far from pure.

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† "Le Caoutchouc." &c., p. 62.
‡ "Comp. Anat. Phan. and Ferns," p. 151.
§ Serullas." "Kew Bulletin," 1891, ccxiii., 230.
‖ "Kew Bulletin," 1891 ccxiv., p. 231.

I have recently succeeded, however, in preparing pure rubber by a physical process, and so demonstrated that chemical methods are not necessary. This is effected by centrifugalising the latex in a special form of separating machine, when the rubber particles, which have a smaller specific gravity than the medium in which they are suspended, are thrown out of the bowl in an almost dry state. They may then be converted into a solid mass by slight pressure, or by draining off the small quantity of water which remains with a porous tile. So prepared, the rubber forms a translucent mass, free from its usual smell and from all danger of decomposition.

The merits and demerits of this mode of preparation must rest entirely with me, but I cannot be responsible for any statements made in Trinidad, where a copy of my experimental machine was recently exhibited without my consent or knowledge.

:o:

GINSENG.

ARALIA GINSENG, Baill. and ARALIA QUINQUEFOLIA, Decne. and Planch.

As correspondents frequently send quotations of the market price of Ginseng, and ask for information about it,—what it is, whether it will grow in Jamaica, etc., the following notes are set down on the subject.

Mrs. Bishop's description in her recent work on "Korea" may first be taken :—

" Panax Ginseng or quinquefolium, is, as its name imports, a panacea. No one can be in the Far East for many days without hearing of this root and its virtues. No drug in the British Pharmacopoeia rivals with us the estimation in which this is held by the Chinese. It is a tonic, a febrifuge, a stomachic, the very elixir of life, taken spasmodically or regularly in Chinese wine by most Chinese who can afford it. It is one of the most valuable articles which Korea exports, and one great source of its revenue. In the steamer in which I left Chemulpo, there was a consignment of it worth $140,000. But valuable as the cultivated root is, it is nothing to the value of the wild, which grows in northern Korea, a single specimen of which has been sold for £40. It is chiefly found in the Kang-ge Mountains ; but it is rare, and the search so often ends in failure, that the common people credit it with magical properties, and believe that only men of pure lives can find it.

" The Ginseng season was at its height. People talked, thought and dreamed Ginseng, for the risks of its 6 or 7 years' growth were over, and the root was actually in the factory. I went to several Ginseng farms and also saw the different stages of the manufacturing process and received the same impression as in Siberia, that if industry were lucrative, and the Korean were sure of his wages, he would be an industrious and even a thrifty person.

" All round Song-do are carefully fenced farms on which Ginseng is grown with great care and exquisite neatness on beds 18 inches wide, 2 feet high, and neatly bordered with slates. It is sown in April, transplanted in the following spring, and again in three years into specially prepared ground, not recently cultivated, and which has not been used for Ginseng culture for seven years. Up to the second year the plant has only two leaves. In the fourth year it is 6 inches high with four leaves standing out at right angles from the stalk. It reaches maturity in the 6th or 7th year. During its growth it is sheltered from both wind and sun by well made reed roofs with blinds which are raised and lowered as may be required. When the root is taken, it is known as "white Ginseng," and is bought by merchants who get it "manufactured," about 3¼ catties of the fresh root making one cattie of red or commercial Ginseng. The grower pays a tax of 20 cents. per cattie, and the merchant 16 dollars a cattie for the root as received from the manufacturer.

"The annual time of manufacture depends on orders given by the Government. The growers and merchants make the most profits when the date is early. Only two manufacturers are licensed, and 150 growers. The quantity to be manufactured is also limited. In 1895 it was 15,000 catties of red Ginseng and 3,000 of "beards." The terms "beards" and "tails" are used to denote different parts of the root, which eventually has a grotesque resemblance to a headless man! It is possible that this likeness is the source of some of the almost miraculous virtues which are attributed to it. Everything about the factories is scrupulously clean, and would do credit to European management. The row of houses used by what we should call the excisemen are well-built and comfortable. There are two officials sent from Seoul by the Agricultural Department for the "season" with four policemen and two attendants, whose expenses are paid by the manufacturers, and each step of the manufacture and the egress of the workmen are carefully watched. Mr. Yi was sent by the Customs to make special enquiries in connection with the revenue derived.

"Ginseng is steamed for 24 hours in large earthen jars over iron pots built into furnaces, and is then partially dried in a room kept at a high temperature by charcoal. The final drying is effected by exposing the roots in elevated flat baskets to the rays of the bright winter sun. The human resemblance survives these processes, but afterwards the "beards" and "tails" used chiefly in Korea, are cut off, and the trunk from 3 to 4 inches long, looks like a piece of clouded amber. These trunks are carefully picked over, and being classified according to size are neatly packed in small oblong baskets containing about 5 catties each, 12 or 14 of these being packed in a basket, which is waterproof and matted, and stamped and sealed by the Agricultural Department as ready for exportation. A basket, according to quality is worth from $14,000 to $20,000. In a good season the grower makes about 15 times his outlay. Ginseng was a Royal monopoly, but times have changed. This medicine which has such a high and apparently partially deserved reputation throughout the Far East, does not suit Europeans and is of little account with European doctors."

This is the only description ever published of the method of curing or manufacture of Ginseng in Korea.

A Bulletin* on "American Ginseng: its commercial history, protection, and cultivation" collected by J. V. Nash under the direction of Professor Coville, was issued by the U. S. Department of Agriculture in 1895. It brings out the facts that the wholesale price of American Ginseng has steadily increased from 52 cents. per pound in 1858 to somewhat more than $3 per pound in 1893, and that the value of the export for the past decade has amounted to between $600,000 to $1,000,000 per year. The report also points out that the natural supply is now rapidly decreasing and that its extermination, if present conditions continue, is inevitable.

The Chinese Ginseng grows principally between the 39th and 47th degrees of north latitude, and the American plant has much the same range, but extends further south along the mountains. It is therefore, doubtful whether it will succeed in Jamaica except perhaps in the forests of the highest mountains ; but the Department has imported some roots and seeds from Mr. George Stanton, the most successful grower in the United States for the purpose of experiment.

There appear to be four grades of Ginseng in commerce. The most highly prized is the "Imperial Ginseng," found in Manchuria, worth from $40 to $200 per pound. The Korean Ginseng is next in quality, fetching from $15 to $35 per pound. The third grade includes that grown in China on the borders of Korea, and the American product. The last and poorest quality is the Japanese Ginseng. The value of the two latter grades, varies from $1 to $10 per pound. Both Chinese and Koreans are so jealous of interference in this valuable trade that no one has ever succeeded in obtaining seeds or plants from either of those countries.

The Chinese plant is *Aralia Ginseng*, the North American is a different species—*Aralia quinquefolia.* They are sometimes classed under the genus Panax as *P. Ginseng* and *P. quinquefolium.*

TALAUMA PLUMIERII, DC.

Seeds received from Dr. Morris. This tree is a native of Dominica, St. Lucia, Martinique and Guadeloupe. It grows to a considerable height—80 feet, and resembles Magnolia grandiflora, to which it is very nearly allied. The flowers are large, white, and sweet scented. The leaves and branches are aromatic, and together with the bark, buds and seeds are said to be endowed with medicinal virtues.

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* No. 16. Division of Botany.

CINCHONA BARK AND QUININE.

By C. M. & C. Woodhouse.

REPORT FOR 1898.

Few articles of commerce have ever been depreciated so much in value in consequence of overproduction as have cinchona bark and quinine.

The following statistics, taken from the Board of Trade Returns, give some idea of the extent of the fall in values :—

		Imported into U. K. lb.	Valued at £
1878	.	6.131,552	658,228
1881	.	14,024,304	1,812,501
1886	.	16,281,104	801.353
1891	.	11,933,712	250,697
1896	.	3.952,592	61,578
1898	.	5,143.040	98,132

The above figures are manifestly only approximate, as whilst the supplies in 1879 mainly consisted of Columbian barks with an analysis of rather under 2 per cent of quinine, the Ceylon and East Indian barks were considerably richer, and contained an average 2 to 3 per cent., whilst the average per centage in Java barks has of late been over 5 per cent.

Mr. Clements Markham, in his book on Peruvian bark, states that the sources of supply of bark to the London market from all parts of the world from June, 1879, to June 1880, were :—

	lb.
From Columbia . .	6,002,000
do India and Ceylon .	1,172,000
do South America (except Columbia)	959.000
do *Java . .	70.000
do Jamaica . about .	21,000
	8,224,000

* To the Amsterdam market.

In addition about 1,000,000 lb. South American were shipped direct to the United States.

The highest price ever paid for Bark in the London market was in 1877. when some renewed Officinalis bark from the Nilgiri Plantations was sold at 15s 8d per lb; supposing that this parcel to have contained 6 per cent of crystallised Sulphate of Quinine, the value of the unit would have been at that time over 2s 6d per lb ! as late, however, as the year 1880 considerable quanties of Bark were sold about 2s per unit per lb. From that time the market has been steadily declining until the lowest point was reached in January, 1897, when the Public Sales in Holland sold at an average unit of 2·12 cents per ½-kilo (equivalent to under ½d per lb). In 1877 " *Howard's*" Quinine (in bottles) was sold at

15s per oz.; on the 31st December, 1878, their quotation was 12s 6d per oz., on 31st December, 1886, 2s 6d per oz., falling by degrees, in sympathy with Bark, till the lowest point was touched in 1897, when business was done at 10d per oz.; at this time sales of German Quinine (best marks) were made at 7½d to 8d per oz.;—the lowest price on record.

The cause of this great depreciation in value is not far to seek; in 1880 the discovery of Cuprea Bark from the United States of Colombia, large quantities of which were imported in the years 1880 to 1885, gave the first shock to the market, but it was the enormous supplies shipped from Ceylon (these in the year 1886 reached their maximum of 15,000,000 lb,) which after first destroying the South American Trade, brought prices down so low that it was no long profitable to ship, and in most of the Ceylon Estates the Bark was uprooted and Tea was planted instead. The exports from British India have never reached more than 4,000,000lb., and here as in Ceylon, planters have generally (except on a few estates in the Travancore district) given up its cultivation. Java, however, owing to the superior quality of its Bark, has been able to hold its own, and exports have steadily increased until now it has practically the control of the market.

The present statistical position is we think a strong one, the Imports and Exports of bark in United Kingdom and Holland for the three years 1896-98 compare with the previous three years as follows :

	1896-98. Eng. lb.	1893-95. Eng. lb.
IMPORTS		
into U. K.	11,853,000	18,723,000
" Holland	31,649,000	28,899,000
Total ..	43,502,000	47,622,000
EXPORTS		
from U. K. ..	8,777,000	18,029,000
" Holland ..	34,491,000	21,555,000
	43,268,000	39,584,000
Left for English and Amsterdam quinine Manufacturers and for replenishing Stocks	234,000	8,038,000

thus showing that, even the increased supplies received in 1898, consumption has of late practically overtaken production. (It is worthy of note that the Exports from Holland during 1896-98 exceed the Imports by nearly 3,000,000 lb.) This probability is further confirmed by the statistics of quinine; thus we find the Exports of quinine and quinine salts from Germany during the same periods were :—

	1896-98. oz.	1893-96. oz.
Total ..	22,900,000	15,306,000

As regards the prospects of supplies in the future, we have seen that shipments from Java, if maintained as at present, are barely sufficient for consumption, even when supplemented as they were last year by larger imports from British India and Bolivia. But advices from India state there is very little bark left there, and shipments will show a large falling-off in future.

Quinine is more or less a war article, and is a necessity for troops fighting in the tropics or in marshy districts. With the enterprise shown of late years by most nations in securing colonies in Africa, etc., and with the sudden opening up of China by railways, etc., it seems probable that the consumption of quinine is more likely to increase than to diminish, and should any extraordinary demand arise, it is difficult to see where supplies of bark are to come from unless Java planters continued to extend their plantations on a large scale at a time when the market was most depressed, which we think is hardly probable. Of course, any great rise in prices would induce planters all over the world to grow Bark, but it would be some years before any large supplies would be available, and in the meantime prices might be forced up considerably.

The market has been for the last year or so in a sensitive state; in 1897 a slight falling off in shipments from Java caused a rise in the value of the unit from under ½d per lb. to 1½d per lb., and though prices have since declined to about 1d. per unit, the circumstances of a small Dutch sale being advertised for the 16th inst, coupled with advice of moderate shipments from Java for January, have brought speculators into the market for Quinine, and prices have advanced about 20 per cent., from 10½d per ounce to 1s. 0½d. per ounce.

To sum up, it appears that consumption has at last overtaken production, and increased shipments from Java will be required to supply manufacturers and make up for expected deficiency from British India and Ceylon, and in any case we fancy the days of Quinine selling below 1s. per oz. are numbered, and we think it is safe to prophesy that the average value of the unit during the next three years will be above the average of 1896-1898.

30, Mincing Lane, 9th Feb., 1899.

[*Tropical Agriculturist.*]

BUDDING TAPE.

The following recipe for making budding-wax has been found useful :—

To every pound of bees-wax, add a lump of rosin the size of an egg, and 1½ table-spoonfull of raw linseed oil. Boil and then dip the tape in.

THE IMPORTATION OF COLONIAL PRODUCE.

By E. M. Holmes, Curator of the Museum of the Pharmaceutical Society of Great Britain. *

I take the opportunity offered by the extensive colonial and foreign circulation of Journal to direct the attention of pharmacists and others who reside abroad or in the British Colonies to a few facts which bear an important relation to the sale of colonial products in this country.

1. *Drugs*.—It is absolutely necessary, in order to avoid loss, to be well informed as to the state of the large European markets, especially London, Liverpool, Hamburg, and New York, etc. As an instance I may point to the genuine or Pernambuco jaborandi, *Pilocarpus jaborandi*, which is now, I am told, realising 7s or 8s per lb., against 1s 6d per lb. for the Rio Janeiro jaborandi, *P. pinnatifolium*; Pernambuco jaborandi, which is now the only official kind, having partially disappeared from the market. The reason of this is that, when the genuine jaborandi was last sent to this country, the market was overstocked with the Rio Janeiro kind, and there were no buyers for the genuine, except at a price that entailed a decided loss on the exporters. Consequently, the exporters having lost money, sent no more, and the drug gets scarcer and scarcer and the price goes up. Drugs are not like provisions. There is not room for an unlimited supply, and the export to European Markets, if it is not to entail loss upon the producer and exporter, must bear a direct relation to the state of the market. But it is to the interest of the buyers to buy cheaply, and early information is not likely to be obtainable except through colonial agents in Europe, paid to look after the interests of their respective colonies.

2. *New Vegetable Remedies*.—Frequently specimens of native remedies are sent home on speculation, without any details as to their botanical source and in very small quantities. Under these circumstances it is useless to hope that they will receive attention. It requires at least 14 lb. or 28 lb. of the material to ascertain if any definite active principle is present, and unless the drug possesses decided properties and differs from other drugs already in use in its remedial effects, it is not likely to be experimented with. Thus, pure bitters, simple purgatives, or emetics are not needed ; but remedies that are known to be actually of service in skin diseases, malarial fevers, or zymotic diseases (and which do not owe their properties to the hot water in which they are administered), might receive a trial if sent in sufficient quantity and if a portion of the plant having leaves, flower, and fruit be sent with them for identification. Medical men are chary of trying remedies of which nothing but the native name and use is known. It may, therefore, be taken as a rule that not less than 28 lb to 1 cwt. is worth sending for a trial.

3. *Drugs other than Medicines*.—Gums, resins, oils, fats, dye woods tanning materials, and other economic products, if sent over in the form of samples of 14 lb. or more, should be sent with full information as to

* Letter to the Pharmaceutical Journal.

possible regularity of supply, and uniformity, or otherwise of quality. Thus, on offering a new fat or oil to a soap boiler, the first enquiry will be : "Can I get this by the ton ? and is there a regular supply to be had ? It will not pay me to introduce a new article to the public and when a demand is created to find there is no supply." With respect to gums, it should be recognised that it pays the exporter to sort the gum into qualities where labour is cheap ; a uniform white gum fetching a much better price in proportion than a mixed or dirty product.

4. *Packing.*—Doubtless in tropical climates there is some difficulty in drying drugs properly, so as to avoid mouldiness. It must be recognised however, that the value depends very largely on proper drying There should be no difficulty in drying many drugs under the roof of a dwelling where the air is hot and a current can be easily established and where the drug is protected from the heavy dew. Many drugs, such as coca leaves, lose much of their alkaloid if packed before being properly dried. The question of packing fruits also is one of the great importance to colonists. Thus, Jamaica oranges packed unassorted in boxes, even if of very superior quality, will fetch only a very inferior price, for the reason that the wholesale fruiterer cannot see inside the barrels, and thus has to buy so to speak, "a pig in a poke." But oranges that are packed of uniform size and quality, each in tissue paper, a definite number in a box of definite size, with air spaces between the box and boards and protected by transverse ribs from crushing, and thus allowing circulation of air, will, he knows, pay him to buy, because he can see something of their state and knows what each contains. In other words, the exporter who wishes to ensure a profitable transaction must first learn the requirements of the market to which he sends them, and must keep himself as well informed as possible as to the state of repletion or depletion of the stock in the market.

THE WOODPECKER.

A note on the Woodpecker attacking Cocoa pods and Oranges was published in the Bulletin for April, page 58 ; and correspondence was invited to ascertain the extent to which Cocoa and Orange planters suffer.

Information has been received that the Woodpecker attacks Oranges in the Port Royal Mountains.

A correspondent near Priestman's River writes as follows :— "With regard to Woodpeckers : every Cocoa planter in this district suffers from their depredations.

"They cut a hole in the pod, take out the beans, and bite them in two. They do this damage at all seasons of the year, but not quite so much now that they are nesting. They eat crickets, etc., sour-sop, orange seeds, etc.

"I think it would be wise to protect them only during a short season. One man informs me that he once had to resort to poisoning them."

Contributions and Additions.

LIBRARY.

Europe.

British Isles.

Chemist and Druggist, April 22, 29. [Editor.]
Garden, April, 22, 29. [Purchased.]
Gardeners' Chronicle, April, 22, 29. [Purchased.]
Journal of Botany, May. [Purchased.]
Nature, April, 20. 27. Purchased.]
Pharmaceutical Journal, April, 22, 29. [Editor.]
Produce World, May, [Editor.]
Sugar, April. [Editor.]
International Sugar Journal, May. [Editor.]
W. Indian and Com. Advertiser, May. [Editor.]

France.

Sucrerie, indigène et coloniale, April 25, May 2. [Editor.]

Germany.

Tropenpflanzer, May. [Editor.]

Switzerland.

Bulletin de l'Herbier Boissier, April. [Conservateur.]

Asia.

India.

Planting Opinion, April, 1, 8. [Editor.]
Madras, Agri. Hort. Soc., July, Sept., 1898. [Secretary.]

Ceylon.

Times of Ceylon, April 5, 13. [Editor.]
Tropical Agriculturist, April. [Purchased.]

Straits Settlements.

Report Bot. Gard. for the year 1898. [Director.]

Java.

Proefstation, W. Java. Med. No. 38. [Director.]

Africa.

Cape of Good Hope, Agri. Journ. March. [Editor.]
Central African Times, March 11. [Editor.]
Report on Station Agronomique, Mauritius, 1897. [Hon W. T. A. Edwards.]

West Indies.

Jamaica.

Journal, Jamaica Agri Soc., May. [Secretary.]
The Concise Agri. Guide : [Messrs. Reeves & Lopez.]

Trinidad.

Bot. Garden Bulletin, April. [Superintendent.]
Proc. of Agri. Soc., April 11. [Secretary.]

Windward Islands.

Report Bot. Gard., St. Lucia, 1897. [Curator.]

Martinique.

Bulletin Agricole, March. [Committee.]

British North America.

Montreal.

Pharmaceutical Journal, May. [Editor.]

Toronto.

The Gametophyte of Botrychium virginianum. By E. C. Jeffrey. [Librarian.]

Ontario.

Report Entomological Society, Ontario, 1898. [Dept. of Agri.]
Report Agri. and Exp. Union, Ontario 1898. [Dept. of Agri.]
Report Fruit-growers' Association, Ontario. [Dept. of Agri.]

UNITED STATES, AMERICA.

Publications of the following Agri. Exp. Stations, U. S. A., Directors.

Arizona	30	Massachusets	60
Arkansas	65	Minnesota	61
Illinois	54 and Report	New Hampshire	59. 62.
Georgia	42	Nevada	37, 38, 39.
Geneva N. Y.,	105, 151. 152, 153, 154	New Jersey,	Report.
Kansas.	84, 85, 88	West Virginia	53, 54, 55.
Kentucky,	78, 80, 81.		

Farmers' Bulletin No. 91, Potato Diseases and their Treatment. [Dept. of Agri.]

Div. of Soil. Survey, North Amer. Fauna. No. 14. [Dept. of Agri.]

Report No. 59 Curing and Fermentation of Cigar Leaf Tobacco. [Dept. of Agri.]

Yearbook of Dept. of Agri, 1898. [Secy of Agri.]

Do. (another copy) [C. S. Farquharson.]

Trans. Mass. Hort. Society 1898. pt. 1. [Secretary.]

Papers from Rhodora and Amer. Journ of Science, Vol. vi. '98. By M. L. Fernald. [Gray Herbarium.]

American Journal of Pharmacy, May. [Editor.]

Botanical Garden, N. York, Bulletin, April. [Director.]

Botanical Gazette. Chicago. April. [Editor.]

Torrey Club Bulletin, April, May. [Editor.]

Papers presented at the Boston Meeting by Linnaean Fern Chapter, Aug., 24, 1898. [B. D. Gilbert.]

Proc. of the Amer. Acad. of Arts and Sciences. April. May. [Gray Herbarium.]

Plant World, May. [Publisher.]

Notes on the Genus Bartonia. B. L. Robinson. [Gray Herbarium.]

SOUTH AMERICA.

Boletim Inst. Agronomico. S. Paulo. Brazil. Jan. [Director.]

POLYNESIA.

Planters' Monthly, Hawaii. May. [Editor.]

SEEDS.

From Imperial Dept. Agri. West Indies.
Socratea exorhiza.

From Agri. Exp. Station Calhoun. Louisiana.
28 vars. of Pea.

From H. P. Deans Esq.
Lentil seeds.

From Jamaica Products Co., Limited
Liberian Coffee grown at Castleton, cured by Co.

From Miss Burke, Kingston.
Stephanotis.

From Supt. R. Bot. Gard.. Trinidad.
Oreodoxa oleracea.

PLANTS.

From Messrs. F. Sander & Co.. England.

Cattleya amethystoglossa.
C. sp.
Cypripedium venustum.
Eria barbata.
E. sp.
Dendrobium devonianum.
D. Dalhousieanum.
D. Wardianum.
D. nobile.
D. formosum.

[Issued 17th June 1899.]

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] JULY, 1899. Vol. VI Part VII

RICE IN JAMAICA.

The following notes have been kindly furnished by Mr. Walter Woolliscroft of George's Plain, Westmoreland. There is an article on the cultivation of Rice in India in Bulletin No. 19 for September, 1890.

" My idea in starting this industry was to persuade the people (principally relying on coolies) to grow the rice and sell to me on the Central Factory system at my mills, at a given price, that they might participate in the profits. By interesting the people in this way I thought a big business might in time be built up to the satisfaction of all parties concerned, and as a help to the parish and country by a considerable money circulation. I make advances to the growers against their cultivation, to enable those to plant that otherwise would not have the means. For the season just passed the coolies, and some creoles, had a very fair cultivation here under a special scheme of arrangement with myself. I did not mill as much of this year's rice as I had anticipated, as I found the percentage of cleaned rice too poor, which no doubt was the outcome of the long repeated plantings of old worn out seed. The quantity I milled was about 1,200 bags, or 3,800 bushels in the paddy. For this coming season I imported seed for the plants, and I am hoping for a good crop of white rice at the end of the year. I am also expecting several other varieties of seeds from India to make experiments with, as to the most suitable for the lands and the market. I am glad to say the start in the growth from the imported seed now growing is favourable. A good deal of morass land here is suitable for rice growing, but is not really first rate land for the purpose, as the water cannot be put on and taken off the land, as it really should be, for the cultivation, but all the same the planters are successful and can get a return up to 75 bushels per acre. In a couple of years time I hope to have land here under proper control as to water. The soil is good, deep and rich, such as one mostly finds in morass lands that are periodically flooded during the wet season.

" Rice planting was once tried in this parish a few years back on a somewhat large scale, but under the system of its management, there is, in my mind, no wonder at the industry having failed."

TROPICAL FRUITS IN ENGLISH MARKETS.

The following notes appeared in the " Times" last December. They show that the Banana is increasing in favour ; that the navel Orange is preferred to the Jaffa : and that pines are valuable, when well grown.

The name of the persimmon is probably new to most people in Jamaica. The fruit is a favourite one in the United States, and has been much improved lately by careful selection, and by hybridsation between the Japanese and native American species. Seedling trees have been grown at the Hill Gardens, but have not yet produced fruit. Application has been made to the United States Department of Agriculture for plants of some of the best varieties for experiment at Hope and Castleton as well as in the Hill Gardens, and a courteous reply has been received from the Department, promising some plants at the next distribution to their own Experiment Stations.

" This year the opening of the Christmas season in the fruit markets of the metropolis has been remarkable for its unusual activity. A greater quantity and variety of fresh and dried fruits have been sent in for sale than ever before, so that the supply is ample for all requirements. The fruit markets during the Christmas week are well worth seeing, and the vastly increased trade can only be properly gauged by those acquainted with the sales in every centre. Tons of nuts are coming in daily from Asiatic Turkey; grapes from Belgium, Spain, France, and the Channel Islands; pineapples from the Azores; pears from Canada; tomatoes from France, Italy, Spain, Belgium, and the Canaries; and chesnuts from Italy, France, and Spain.

" The fruit auctioneers have been selling continuously almost from morning till night. In the river the boats have come up in rapid succession, and with such cargoes that it has been no easy matter to get the fruit warehoused in time for sale. Among the new seasonable fruits which have " come to stay" is the persimmon, that glossy deep orange-hued fruit, with a large open eye, if I may term its crown, not unlike the old-fashioned English medlar in shape, which now forms one of the most striking features in the windows of the retail fruit shops. This fruit, which some people consider a great dainty, has been improved almost as wonderfully as the tomato. The best supplies just now come to us from Madeira. They are retailed as high as 4s. per dozen. Presently, when the trade has been properly developed and the fruit itself popularised among the wide circle of consumers, enormous quantities will be sent into all the English markets, from California, particularly, where the fruit is grown plentifully from the size of a plum up to that of a Baldwin apple. There is nothing fanciful about this prediction, for the fruit can be picked when just ready to commence colouring, and will travel almost any distance and colour up to perfection in transit. The tree is a native of the United States, and when ripe the fruit is very sweet. . .

"Few fruits even including the apple have made a more rapid advance in the British markets than the banana. Millions of bunches of this fruit are now sent into our ports every year and for the Christmas sales the supply this season has been exceptionally large. The banana as a retail fruit is almost useless unless it is ripe. Many years ago, before this point received the attention it does now, one or two firms in Covent-garden Market owning underground cellars fitted up with heating apparatus to colour the fruit, had the business entirely in their own hands. Then perfectly-coloured bananas made as much as 20s., 30s., and 40s. per bunch, and fortunes were realised. But the enormous supplies sent from the Canaries and Madeira have revolutionised the trade. During the past few days there has been a great scarcity of well-ripened bananas in the fruit shops, and the dealers who have cellars heated for the purpose of ripening the green bunches are cramming the heated chambers to meet the great run which has set in for ripe fruit.

"At one time hot-house pineapple culture was a paying industry in this country, but the large importations of St. Michael pines specially grown under glass for the English market completely ruined the business. Nevertheless, it is quite possible that pineapple production will be revived, and in the near future become a very extensive trade in the British Isles. The superior quality, the more delicate appearance, the exquisite fragrance and flavour which distinguish the English from the imported fruit justify this prophecy. It was not unusual ten years ago to see magnificent English hot-house pines weighing from 8lb. to 10lb. each on show in the markets, and eagerly sought after by West-end buyers. Early in the present century these fruits used to be grown pretty generally, but few English hot-house pineapples will make their appearance in the fruit shops for Christmas this year. The St. Michael pineapples this season are very plentiful. They are large and well coloured, being worth from 3s to 6s each in the markets. Of oranges the supplies are most plentiful and the quality well up to the average of previous years. The giant seedless Californian navel oranges still take the lead; oranges from Jaffa, St. Michael, Malta, and Spain, also meet with a ready sale and especially the Valencia, which is a good cheap orange for the people. As many as ten million oranges have been sold by auction in the United Kingdom in one day during the present month. Altogether the fruitmen in the markets and the retail fruiterers are having a record season, and never before has the general public been able to obtain a better supply of fruit for Christmastide."

TOBACCO FERMENTATION.

In an article in the *Tobacco World* on the cultivation of tobacco in Sumatra, after dealing with the care and labour bestowed in its cultivation, particulars of the mode of fermentation are described as follows :—

"The tobacco comes direct from the drying sheds to the one fermenting shed, which holds all the tobacco of the estate. It does not leave here until packed and ready for shipment to the European markets.

The fermentation has two purposes. The first is to insure the proper texture, glossy appearance, and colour to the leaf. It brings out the characteristic properties of the wrapper leaf, which are hardly apparent when the leaf is cut in the field. It is furthermore necessary to press the tobacco into bales so that it can be shipped in compact form.

Formerly, when dark colours for cigar wrappers were in much favour by the dealers and manufacturers, the tobacco was worked up to a very high heat in the fermenting pile ; but since lighter colours are more sought for, the fermentation has to be done more slowly and not to such a high degree of heat as formerly.

It is impossible in the space of this article to describe the process of fermentation in all its details. Experience and judgment enter into the matter so largely that only one who has had this experience can appreciate the changes which are going on in the pile, and can judge of the necessary and further treatment.

The tobacco is put into piles of three kinds, the "quality" or top leaves, bottom leaves, and ragged tobacco. The piles are built up on matting. One row is spread on the matting, the bundles being placed close together with the heads in the same direction. At the corners the leaves are spread out like a fan. In this way layer after layer is put on until the pile is from 4 to 6 feet high. When a large or rather high pile is to be made, hollow bamboo rods are inserted in the middle of the pile, in which a thermometer is placed at the end of a stick. The outer end of the bamboo has a plug of cotton, so that the temperature of the outside cannot interfere with that of the inside.

With smaller piles, and especially with trash and inferior tobaccos, simply a bamboo stick is inserted in the pile without a thermometer.

The manager, on touching the stick when it is withdrawn, judges how warm it is inside. In still smaller piles the hand is simply put in between the bundles. When the temperature rises to about 100° F. the pile is taken down, the tobacco is given a chance to cool off slightly and a new pile is put up in another place. Care is taken that bundles from the interior are placed on the outside to give those which were formerly on the outside an equal chance of fermenting. The temperature gradually goes higher until it finally attains the temperature of about 130° F., when the fermentation is stopped. The maximum temperature must not be attained too quickly, as the quality of the leaf would suffer. No statement can be made as to how often the piles should be turned over, or when this should be done, as it depends upon the condition of the tobacco, especially as to how moist it was when put into the pile."—*Cape of G. Hope Agri. Journ.*

STERILISATION OF WATER.

MM. Marmier and Abraham have studied the methods of rendering drinking water bacteriologically pure, with a view to supply such pure water to towns on an industrial scale. The municipal authorities of Lille authorised them to instal an apparatus for the production of ozone, in order to find out by experiment what was the value of that substance when applied to the purification of water by means of apparatus and methods specially devised for the purpose. Experiments made from December 10, 1898, to February 12. 1899, have already led to certain conclusions, which are set forth by A. Calmette, one of the experts appointed on the Water Commission by the town of Lille. The efficacy of the ozonising apparatus is unquestionable, and the method is superior to all others that have been tried, and is suitable for dealing with large quantities of water. The apparatus itself is sufficiently strong, and its output is regular enough to justify its use in industrial operations. All the pathogenic or saprophytic microbes met with in the waters under experiment were destroyed by passing the waters through the ozonising apparatus. A few of the Bacillus subtilis alone survived the ordeal. One only of these germs was found capable of remaining in 15 c.c. of water that had been treated with ozone in the proportion of six milligrammes per litre of air. A concentration of 9 milligrammes per litre reduces the number to 1 in every ·25 c.c. of water so treated. It is important to note, however, that the B. subtilis is harmless to man and to animals, hence the weaker concentration of ozone is sufficient for the purpose. The water, moreover, is weaker in organic matter than ordinary drinking water, and is less prone to ulterior pollution, and is more agreeable to the palate by reason of the process of aëration which it undergoes. The Water Commission has recommended the adoption of the process by the authorities of Lille.—(Annales de l'Inst.Pasteur, 13 344.) *Pharmaceutical Journal.*

USE OF FUNGI AGAINST INSECT PESTS.

A recent number of the "Cape Agricultural Journal" contains a report of an address given by Dr. Edington on the artificial use of a particular fungus, said to be parasitic to locusts, for the destruction of the latter. The results so far obtained with the fungus in question appear to be at considerable variance, some farmers stating that they have derived great benefit from its application, whilst others assert as positively that it has been of no use whatever. A great deal must of necessity depend upon the circumstances in which this, together with other such similar living-destroying agencies, are employed, and Dr. Edington, in the course of his lecture, pointed out what he considered the best methods for promoting the successful use of this fungus. If locusts can be destroyed is so simple a manner as this is described to be, the gain to the Cape farmers will be enormous, and at any rate means should be adopted so that its use may become more widely known, and more extensive trials given to it. The use of fungi for the destruction of pests is being tried in America, where the white muscardine fungus, *Sporotrichum globuliferum*, has been largely employed during the last few years to cheek the injurious over-production of the chinch-bug. Mr. Benjamin Duggar of the Cornell Agricultural Experiment Station has, however, been recently making a careful study of this organism in relation to the insect in question, and has come to the conclusion that, although it is undoubtled parasitic at times, it is not sufficiently efficient to enable it to be artificially employed with economic success. It is obvious that to obtain trustworthy data on this subject, many and very carefully conducted investigations must be carried out. It is to be hoped that Dr. Edington will be able to give the locust-problem the time and attention which it requires to enable scientific conclusions to be drawn as to the economic value of the fungus he recommends in destroying locusts.—(*Nature.*)

EXTRACTS FROM CONSULAR REPORTS.

COTTON IN THE UNITED STATES.

As inquiries are sometimes made about the prospects of a cotton industry in Jamaica, the following extracts from a Foreign Office Report may be of interest; the Report is by H. M. Consul for Charleston, Mr. Cotlogon :—

The production of another large cotton crop in the United States—the largest on record—probuced a naturally unfavourable effect on prices for this staple and also on the value of the business of this port; the total quantity of cotton received being greater than that of the previous year, while the comparative value of the same was much less. An important factor now affecting the American crop is the annual production of about 3,000,000 bales of cotton which the State of Texas alone is adding to the cotton product of the country. The total yield has also been further augmented of recent years by different methods of cultivation adopted by a smaller class of planters, whose aggregate product has been large enough to materially affect the crop and market prices. . .

During the last cotton season of 1897-98 which ends August 31, 1898, Charleston received 462,408 bales of upland cotton, which in comparison with the previous season, showed an increase of 69,218 bales; the highest price paid in this market during the year being 6⅞ c. per lb. for medium, and the lowest 5 c. for the same grade of cotton. . .

Carolina Sea Island cotton opened about the middle of October, 1897, at 18 c. per lb. for medium fine quality and gradually declined to 15 c. Extra fine qualities, however, which were sold early in the season, brought moderately fair prices, but later sales showed a heavy decline.

A considerable quantity of the crop was of inferior colour, and sold as low as 10 c. per lb.

Georgia Sea Island cotton opened at 12½ c. for extra choice, declined to 12 c., and later advanced to 12½ to 13 c. per lb.

Florida Sea Islands of the better and poorer grades were in fair demand, but there was only a limited demand for extra choice and fancy East Floridas, and about 1,500 bales remained unsold at the close of the season.

Concession for Rubber.

In the Consular Report for 1898 on Lourenço Marques, a Portugese colony in South Africa, Mr. A. C. Ross, writes :—

In the end of 1897 a monopoly was granted for the exploitation of rubber in the unoccupied lands belonging to the State within the district of Inhambane with the hope of (1) putting an end to the destructive native method of collecting rubber, viz., cutting down the vines and extracting the valuable sap by boiling, and (2) increasing the production by fresh planting. The exports of rubber from Inhambane have been going down of recent years ; in 1896, 39 tons ; 1897, 35 tons ; and for 1898, only 20 tons.

The terms of the grant are as follows :—

1. The monopoly is granted for 25 years.

2. The concessionnaires have to pay during the first seven years 50 reis per kilo of rubber exported and 75 reis during the remaining 18 years.

3. Within two years 20,000 rubber plants must have been planted on land selected by the concessionaires and the Government.

4. A rent of 200,000 reis per annum shall be paid for this land.

5. At the end of 25 years the concessionnaires may elect to hand over the plantation or retain it at the same rent as previously paid.

6. The concessionnaires are exempt from any other imposts.

A company with a capital of 30,000*l*. has been floated to work this concession, and it is confidently expected that during the present year considerable progress will be made towards the fulfilment of paragraph 3 above mentioned.

It is expressly laid down that the concession above mentioned does not prevent any person growing rubber on his own land and exporting it.

Colonial Produce in Spain.

H. M. Consul, Mr. C. A. P. Talbot, in a Report on the Trade and Commerce of Corunna for 1898, says :—

" The importation of cocoa in 1898 was 249 tons, of which 43 tons came for the first time from France, and I would observe that a market is now open for all Colonial produce in consequence of the loss of the Spanish colonies, and London merchants would do well to push business for spices, sugar, coffee, cocoa, especially the latter which enters so largely in the daily consumption of every Spanish household.

" These remarks also apply to coffee hitherto imported from Puerto Rico, whence 80 tons only came in 1898, while during the same period Belgium sent 25, France 10, Germany 20 tons, but none from Great

Britain, which is regrettable as we could supply the Spanish market on as equally favourable conditions as other countries".

Manufacture of Hardwoods.

The following shows what might be done with any or all of Jamaica hardwoods, also from Mr. Coetlogon's Report :—

The Charleston Hardwood Manufacturing Company was started on a small scale in April, 1897, for the manufacture of shuttle blocks, for use in cotton mills. The factory is now a thoroughly well equipped establishment, and is furnished with the lastest improvements ; it is run by the largest electric motor in the city, and has been pronounced by experts to be one of the best factories of its kind in the country. The first shipment made from this mill was a sample order of 8,000 shuttle blocks shipped to Liverpool, which were reported by the consignee to be the best blocks he had received from America.

The dogwood * and persimmon trees which grow freely in the Southern forests, supply a close and finely grained article for making these shuttles, and it is stated that there are orders enough now in hand to keep the factory going for five years. Although the capital of the company is quite moderate, it gives employment to numbers of hands engaged all over the lower country in cutting dogwood and persimmon trees. The labour employed at the factory in the city consists of expert hands, brought here for the purpose. As the work requires great nicety and skill, it is long before the ordinary hand can learn the business. None of the blocks made here have been sold in America, the orders having come entirely from abroad. Eight different sizes of blocks have been shipped, so far, varying from 12½ to 23 inches in length.

The wood is brought here in the rough state, in sizes of about cord wood dimensions, 2, 4, and 8 feet in length, and not less at the small end than 5 inches in diameter. It must be freed from knots and other blemishes, as the inspection is very strict.

The refuse wood from the manufactured articles make excellent fuel for use in stoves or grates. Many persons in Charleston discarded coal last year, and used in its place this rejected wood, as it is very clean making a hot fire with little ash.

There is also a factory for making shuttles at Westminster, South Carolina, which started with a capital of about 1,500 dol., and is reported to have been quite successful.

These two factories are small, but being without competitors in the State, their establishment and growth are being watched with interest on account of the benefits likely to arise from their possible future development.

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* Dogwoods of Southern United States are species of Cornus. Persimmon (the wild kind) is Diospyros Virginiana. *Ed. Bulletin.*

THE SUGAR INDUSTRY IN JAMAICA.

The following Memorandum by Mr. F. Watts, late Government Analytical and Agricultural Chemist of Jamaica, on the subject of the Sugar Industry of the Colony, has been published in the Jamaica Gazette :—

MR. F. WATTS TO THE COLONIAL SECRETARY, JAMAICA.

Barbados, May 15th, 1899.

Sir,—It has been suggested to me that it may prove of service if, on leaving Jamaica, I place before you some ideas which have occurred to me in connection with the sugar industry of the Colony.

(2) The advantages of the sugar industry to a colony are such that it appears to be highly desirable that efforts should be made to preserve this industry to Jamaica ; it is an industry with which a large section of all grades of the community is familiar, both as regards the production as well as the marketing of sugar ; it affords regular employment to a large number of people, and it is an industry for which certain districts of Jamaica are eminently suited. Should the industry once pass away from the colony its re-introduction would be a matter of extreme difficulty.

(3) At the present time the greater part of the sugar produced in Jamaica is manufactured by the old and wasteful Muscovado process in small sugar works, most of which are imperfectly equipped. Although at the moment of writing the price of sugar is higher than it has been for some years the views of those well calculated to form reliable opinions are, that the price of sugar in future years will not be substantially higher than it has been during the past decade. At these prices, and with the system and appliances in vogue in Jamaica, sugar-growing during this period has not been an attractive or remunerative business. It is highly desirable therefore that means should be found for placing the industry on a better footing if possible, and there is good reason to believe that this may be accomplished.

(4) The losses entailed by the Muscovado system of sugar making may be briefly indicated thus :—

- Loss from imperfect crushing of the canes.
- Loss due to the imperfect recovery or extraction of sugar from the juice.
- Loss due to the production of low grade sugars fit only for the refinery.

These losses are those inseparable from the manufacture of sugar in small works; they may be avoided by substituting for these small works central factories sufficiently large to permit of the introduction of machinery of the best and most economical type.

(5) Taking the losses just referred to, there are very few instances in which the actual crushing power of the Jamaica mills is accurately known. (Trials made on small lots of cane, one ton for instance, I take to be of little value.) From what I can gather I believe the crushing power varies greatly. I infer, however, that the mills in all probability do

not give more than 60 per cent. of the weight of the canes in the form of juice, whereas by the mills of a central factory, where the canes would be passed through three sets of mills in succession, the yield should be 75 per cent or over ; so that if my assumption is correct—and the planters should ascertain this for themselves—15 parts of juice remains in the canes for every 60 parts expressed, or 25 per cent.

(6) The amount of sugar extracted from the juice for every 100 parts of raw sugar therein has never been ascertained over a long period, nor for several places, in Jamaica; in Antigua, I ascertained that upwards of 80 pounds of Muscovado sugar, were extracted for every 100 pounds of raw sugar in the juice, often this figure was exceeded; there however, the conditions were dissimilar from those of Jamaica, for in Antigua no rum was made and therefore efforts were directed towards obtaining as much sugar and as little molasses as possible. In Jamaica where rum is made, there have been no special efforts to reduce the quantity of molasses, and from a very limited number of observations, I came to the conclusion that the amount of sugar extracted was very low, probably, considerably under 70 pounds from every 100 of raw sugar in the juice. Now that rum is bringing very low prices it is for the planters themselves to ascertain how far it proves remunerative to allow sugar to pass away as molasses to be converted into alcohol.

(7) With modern machinery it is possible to recover from 83 to 88 pounds of marketable sugar for every 100 pounds of raw sugar in the juice; the actual quantity will vary with the quality of the sugar made and with the quality of the juice.

(8) In Muscovado works it is difficult to control the quality and quantity of the sugar to be made, and low grade sugar alone can be made; this is only fit for the refiner and consequently always brings lower prices than sugar capable of entering directly into consumption. In factories fitted with modern appliances it is possible to produce sugar of any required character from dark refiners' sugar to white and yellow grocery sugar according to the market demands for the various grades. The quantity of sugar too is controlled; all the available sugar is extracted from the molasses and a rigid control is kept showing any losses which may occur. All these points lead to greater efficiency and economy in working.

(9) I have thus indicated in the briefest possible manner the chief defects of the Muscovado system and how these are overcome by manufacturing sugar in large factories. Recognising these points, and many others, planters have from time to time made efforts to secure factories capable of reducing the losses now experienced, they have always been met with the difficulty that such factories are large and costly affairs which must involve the combination and co-operation of several estates in order to procure their advantages. The difficulties of obtaining capital and combination have led to the abandonment of many schemes. Efforts are now being renewed to effect the necessary combination and to procure the necessary capital for more than one factory for Jamaica.

(10) To secure the advantages afforded by the best machinery it appears to be necessary to have factories capable of making not less than 3,000 or 4,000 tons of sugar and up to 10,000 tons or over, in each

season. There has been much argument as to the most economical size. Doubtless, if the factory were the only point to be considered, the larger the factory the greater the economy in working, but in most instances the capabilities of the district in which the factory is to be placed, the quantity of canes available, and the conflicting business interests of estate owners, all have to be taken into account in preparing plans for any central factory scheme. From want of correct appreciation of these local points there is often a tendency to suggest factories which may be found to be too large for the district in question. It is important to ascertain what cane supply can be actually guaranteed, or relied upon; then to design a factory capable of dealing with these canes and at the same time capable of having its capacity so increased that any reasonable development of supply may be dealt with without incurring great additional expense. The additions to the factory's capacity need not be made unless there is good ground for thinking that they will prove remunerative, whereas if a factory too large in size is erected the charges for interest and maintenance may prove fatal to profitable working.

(11) How the capital is to be procured and the amount to be provided are themes for much discussion. If the cane growers who can associate themselves together are able to provide the required capital they will be able to procure a factory for the minimum cost and will be able to work with a minimum amount of capital. Unfortunately this condition is seldom met with in the West Indies. When capital has to be procured from outside it will always be found in practice that rather more will be wanted than in the case just mentioned, and the cost of the factory itself will also be somewhat greater.

(12) If central factories are erected by outside capital, it is of the first importance to any colony that the basis of trading should be a co-operative one. If this is not the case a condition of affairs may arise whereby practically all the profits of the industry are sent away from the colony, and the final stage may be more disastrous than that now existing. Matters should be so arranged that those owning the land and growing canes participate in any advantages arising from the factory. Most modern schemes contain some provision whereby this is secured, this is usually made by providing that a portion of the cost of the factory shall be paid off out of profits, and that ultimately the factory shall become the joint property of the capitalists and the cane-growers. It will be seen that there is much scope for sound judgment in adjusting the initial cost of the factory, part of which has to be paid off out of profits, and of determining what proportions of the factory and its business shall ultimately belong to the capitalists and to the cane-growers respectively.

(13) Considerable difficulty has been experienced in ascertaining what price should be paid for canes. In Queensland and in Egypt the price is about 13/ to 14/ per ton. Where the cane-growers are ultimately to become the owners or part-owners of the factory this difficulty is minimised, for if a low price is paid for canes the larger will be the profit of the factory, and the sooner will a portion of the cost be paid off, so that the cane-growers will then own a large portion of the factory and directly share the profits. In most of the schemes recently put forward in the West Indies it has been proposed to pay about 10/ to 11/ per ton for canes delivered at the mill.

(14) Several schemes have been recently put forward whereby the investment of outside capital has been invited for the improvement of the conditions of sugar manufacture; in discussing them it is well that attention should be directed to those points which I have here only indicated in a very brief manner.

(15) In Queensland considerable impetus has been given to the sugar industry by Government aid, whereby the Government guarantees the interest upon money invested in the erection of sugar works under certain well-defined regulations. The Queensland Sugar-Works Guarantee Act was passed in 1893, and has thus only been in operation for a few years; it appears to be most carefully compiled and affords the Government ample security. In considering the desirability of introducing such a method of working into Jamaica, perhaps the first point which is worth noting is, that its successful operation should be more easily secured in a colony like Jamaica, where sugar-producing now exists as an industry of considerable magnitude, merely waiting for improvements in methods of manufacture, the canes being already in existence, than under the Queensland conditions, where the sugar industry was a comparatively new one.

(16) There is little doubt that the cost of erecting and working factories would be less with some such form of government as that provided in Queensland, than will be the case if outside capital alone is found for the undertaking.

(17) Where sugar can be grown on lands irrigated at small expense, the sugar industry ceases to be a precarious one, and should prove highly remunerative. This can be accomplished in some districts of Jamaica and here there ought to exist a thriving industry affording stability to the welfare of the colony. In addition to the districts capable of irrigation there are many other places well suited for sugar growing where central sugar factories could be erected to the advantage alike of the sugar grower and of the colony, if satisfactory means of providing capital can be found and an equitable basis of trading, as between the capitalists and cane-growers, can be secured. In all this, I see no difficulties greater than those which have to be overcome in most commercial undertakings.

I have, &c.,

Francis Watts.

NOTICES OF BOOKS.

Illustrations de la Flore du Congo.

Amongst the contributions to the Library of the Department lately presented are two parts of the first volume of "Illustrations de la Flore du Congo." It is an Atlas of Drawings (14 x 11 inches) of new species of plants with descriptions in full, published under the editorship of Messieurs Dr. de Wildeman and Th. Durand of the Brussels Botanic Garden.

This publication is part of a comprehensive work, entitled "Annales du Musée du Congo," published by order of the Secretary of State. It is divided into "Series" as follows:—

Series I.—Botany.—Illustrations of the Flora of the Congo.
Series II.—Zoology.—Materials for the Fauna of the Congo.
Series III.—Ethnography and Anthropology.

Special Series.—Monographs and works on the natural, physical, political and economic history of the basin of the Congo.

The descriptions of the plants have mostly appeared before in various publications, but the drawings which are beautifully executed, are new, and are by Mme. B. Herincq and Messieurs Ch Cuisin and A. D'Apreval.

THE SUPPLY OF CINCHONA BARK.

The report that there will be a decrease in the output of the Ceylon and Indian cinchona plantations during the present year has given rise to considerable interest in cinchona statistics in commercial circles.

Already the price of quinine has risen by 100 per cent. during the last two months, viz., to 1s 9¼d per oz., and during the same period the sales and resales of quinine have amounted to about 4,000,000 oz. Messrs. C. M. and C. Woodhouse have directed attention to the present position of cinchona and quinine in two circulars issued to those interested in this trade.

From the tables given in these circulars it appears that during the last few years the supply of cinchona has only just kept pace with the demand, and has now fallen short of it, so that a still further increase in the price of the bark and the alkaloid may be looked for. This enhanced value of cinchona may possibly lead to an extension of cinchona-planting in India, where planters have, of late years, shown a tendency to abandon it in favour of more profitable products. (*Imp. Inst. Journ.*, iv., p. 77.)

The following tables show the amounts of cinchona produced in the East Indies during the last few years and the imports into the chief cinchona-consuming countries.

EXPORTS.

	1896.	1897.	1898.
	lb.	lb.	lb.
Ceylon -	1,328,498	591,368	975,784
British E. India	754,384	816,077	3,090,000
Java - -	11,079,234	9,349,687	12,303,424

IMPORTS.

	1896.	1897.	1898.
	lb.	lb.	lb.
United Kingdom	3,952,000	2,758,000	5,143,000
Holland -	10,922,000	9,070,000	11,657,000
Germany -	7,649,000	9,279,000	7,805,000
France -	2,603,000	2,270,000	2,304,960
United States -	2,599,000	2,696,000	3,302,128

The cinchona bark, is, of course, chiefly used for the manufacture of alkaloid quinine, but it is difficult to correctly estimate the amount of quinine produced in any country, since some of the cinchona imported is used in other ways, but the following tabular statement has been given as probably representing the world's production of quinine last year. (*Chemist and Druggist*, Feb. 25. 1899.)

Germany - -	7,594,000 oz
United States -	3,333,000 "
France - -	1,424,000 "
United Kingdom -	1,500,000 "
Java and other countries	1,000,000 "

The imports of bark in the United Kingdom and Holland during the first quarter of last year amounted to 4,715,000 lb., while this year the total is only 2,789,000 lb.

The present value of English sulphate of quinine is 2s per oz., against 1s 4d. per oz. last year. (*Imp. Inst. Journ.*, v., p. 156, June, 1899.)

CINCHONA CULTIVATION IN SOUTH INDIA.

Action of the Madras Government.

Madras, May 17th.—Mr. Standen, Government Quinologist, Madras, has been deputed to visit Java to study the system of planting cinchona and manufacturing Quinine there, and will be absent for some months.

It is proposed by the Madras Government to considerably extend its cinchona plantations on the Neilgherries, and a large area has recently been cleared close to the Pykara Falls.— *Times of India.*

PEPPER CULTIVATION IN ASSAM.

The Assam Government has recently issued a note on the cultivation of black pepper in that province, with the idea of inducing the people to cultivate it extensively as a commercial product. At the present time it is only produced in sufficient quantities to supply local requirements. The pepper-vine in Assam, it appears, is generally reared on betel-nut trees, and the average yield of a single vine is said to be about three seers (40 seers=$2\frac{1}{5}$ lb.) of cured pepper. An acre of betel-nut plantation holds about 500 trees.—*Chemist and Druggist*, March 11.

ADDITIONS AND CONTRIBUTIONS TO THE DEPARTMENT.

LIBRARY.

EUROPE.

British Isles.

Botanical Magazine, May, June. [Purchased.]
British Trade Journal, May, June. [Editor.]
Chemist and Druggist, May 6, 13, 20, 27. June 3, 10. [Editor.]
Garden, May 6, 13, 20, 27. June 3, 10. [Purchased.]
Gardeners' Chronicle, May 6, 13, 20, 27. June 3, 10. [Purchased.]
Journal of Botany, June. [Purchased.]
Journal R. Colonial Institute, May, June.
Nature, May 4, 11, 18, 25. June 1, 8. [Purchased.]
Pharmaceutical Journal, May 6, 13, 20, 27. June 3, 10. [Editor.]
Produce World, June. [Editor.]
Sugar, May. [Editor.]
International Sugar Journal, June. [Editor.]
W. Indian and Com. Advertiser, June. [Editor.]

France.

Sucrerie, indigène et coloniale, May 9, 16, 23, 30, June 13, 6. [Editor.]

Germany.

Notizblatt, Berlin, Könige Bot. Garts and Museums, May. [Director.]
Tropenpflanzer, June. [Editor.]
Die Naturlichen Pflanzenfamilien, Nachtrâge zum und Gesamtregister zum, 11—IV. Teil. [Purchased.]
Symbolae Antillanae seu Fundamenta Florae Indiae Occidentalis. Vol. 1 Fasc I. II. [Purchased].

Holland.

Bulletin Koloniaal Museum ti Haarlem, April, May. [Director.]

Belgium.

Illustrations de la Flore du Congo. Vol. I. Pts. 1 and 2. [Director, Musee du congo.]

ASIA.

India.

Agricultural Ledger (Calcutta) Nos. 1, 2, and 3. 1899. [Lieut. Gov. Bengal.]
Planting Opinion, April 15, 22, 29, May 6, 13, 20. [Editor.]

Ceylon.

Times of Ceylon, April 19, 27, May 11, 17, 25. [Editor.]
Tropical Agriculturist, May. Purchased.]
The Coccidae of Ceylon. By E. E. Green. Part II. [Purchased.]

JAVA.

Proefstation E. Java. De Bemestings proeftiunen Van 189-98. [Director]

N. S. WALES.

Agri. Gazette of N. S. Wales, April. [Dept. of Agr.]

QUEENSLAND.

Queensland Agri. Journal, April, May. [Editor.]
Queensland Sugar Journal, May. [Editor.]

AFRICA.

Cape of Good Hope Agricultural Journ, April, May. [Agr. Dept.]
Central African Times, March 18, 25, April 1, 8, 15, 22, 29. [Editor.]

West Indies.

Barbados.
Agricultural Gazette and Planter's Journal, May. [Editor.]
British Guiana.
Report of Bot. Gard., 1897-98. [Superintendent.]
Jamaica.
Journal Jamaica Agri. Soc., June. [Secretary.]
Trinidad.
Proc. of Agri. Soc., May 9. Report for 1898. [Secretary.]
Windward Islands.
Met. Observations, Sept. Dec. 1898. St. Lucia. [Curator.]

British North America.

Montreal.
Pharmaceutical Journal, June. [Editor.]
Ontario.
Bureau of Industries, Bull. LXIX. [Secretary.]

United States America.

Publications of the following Agri. Exp, Stations, U. S. A. [Directors.]
Alabama 103, 104.
Geneva, N. Y. 121, 155, 156, 157, 158.
Kentucky, 1897. Report.
Michigan, 166—167, 168—169, 170—171, 172—173. Special Bull. 11 and 12 New Jersey 136.
Utah 59, spraying.
West Virginia 54, 55, 53.
American Journal of Pharmacy, June. [Editor.]
Botanical Gazette, Chicago, May. [Editor.]
Plant World, June. Publisher.

South America.

Boletin Museu Paraense, Para, Dec. 1898.

SEEDS.

From Hort. Soc, Madras India.
Seeds.
Burnt on receipt, as there is a Government prohibition againt receiving seeds or plants from S. India for fear of introducing the Coffee Leaf Disease, Hemileia vastratrix.
From V. E. Silvera Esq. Oracabessa.
Sabal umbraculifera.

[Issued 17th July 1899.]

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series AUGUST, 1899. Vol. VI Part VIII

COLLECTING RUBBER.

Mr. Jenman, Superintendent of the Botanic Gardens, British Guiana, has contributed the following remarks on collecting rubber and balata to the "Argosy" with references to some paragraphs on the subject in the Annual Report of Mr. Curtis, Superintendent of the Penang Botanic Garden. Mr. Curtis's experiment is interesting in showing how to obtain an increased amount of rubber from the tree, but it remains to be seen whether the total amount drained in this way during the life of the tree is more than that obtained in the old-fashioned way of single cuts renewed from year to year :—

Mr. Jenman directs the attention of balata collectors to the method of tapping described below, in which it is shown that a tree can be milked day after day by simply taking a slight shaving off the sides of the gutters. As is well known to every one who has collected balata or other rubbers,—in two or three hours after the gutters are made on the trees the milk stops running. This appears to be chiefly due to the coagulation of the milk by the drying influence of the air on the edges of the incised bark,—a design of nature in its own interest, not to exhaust itself under damage from whatever cause, accidental or otherwise; but by removing this film, the next and following days increased quantities of milk from day to day will run, thus greatly increasing the yield of gutta from a single tree. This is a matter very important to know, for it will not only tell in the yield, but in the economical working of rubber forests, and in the cost of collecting. The practice hitherto, has been to tap a tree once and leave it, tapping it again a year or so afterwards by making new channels, and then leaving the tree for good. But by the method described, a tree can be milked like a maipurie or bush-cow every day, giving more and more milk each time for a limited period, which must be determined by the collector, in his knowledge of and consideration for the permanent health of the tree. The system of collecting in the past has not only been incredibly wasteful, but ruinous to the forest, which, indeed, would have died out but for the fact that the trees, though so greatly damaged and exhausted by the recklessly conducted work on them, and, perhaps, to some extent, because of that—for however great the stress, nature never lets herself go, easily, if she can help it—still have gone on bearing fruit, which, dropping to the ground, has produced young trees, that, where allowed to live, have taken the place, in time, as the parents, damaged to death by irresponsible collectors, died out. Another economical system of collecting has been described, of merely puncturing the bark all over, with pin pricks as it were, thus allowing the milk to ooze, to be collected as tears, a day or two afterwards, when dried by the atmosphere on the bark of the tree. This system could be carried out on all parts of the tree that could be reached, and would inflict very little damage, if any, of a permanent character on it, as the minute punctures would heal quickly, when the process could be repeated again indefinitely. This system is only new in the form of the method of tapping, for the Aboriginal Indians of the Guianas, and probably the West Indies and other regions, have practised it from time immemorial by piercing the bark, in a very rough way it must be said, and allowing the milk to dry in tears on the tree, which, collected when dry, they wind like string into balls for those playing games in which balls are are used. The practice has been often observed on the t'pong tree (*Sapium biglandulosum*) in this Colony, and described many years ago. The latest proposal is to grow rubber plants, sown thickly, as wheat or hay is sown and grown, and reap it as an annual crop, using up the whole plant, bark, wood and leaves, and extracting the milk by a chemical process. This method of felling the balata trees and stripping them of bark, twigs and leaves, and using all then in a chemical process for the extraction of the rubber, or some other analagous, was tried here in this Colony many years ago. But it was abandoned, owing to the impurity and poor character of the balata so extracted and produced. It was revived again some years ago ; and it has been frequently reported that the Government of Venezuela has given out vast concessions of the enormous forests of that country in which this system of extraction is the method that is being pursued. Some gentlemen came here to Georgetown, two or three years ago, with the object of getting great concesssions of a like character of the balata forests of this Colony, they undertaking with slips and young plants just sprouting in the under brush, besides paying royalty and duty, to plant up the ground left bare behind them as they progressed in the clearing of the forests. It was found however that our forest laws did not admit of problematical experiments on the scale and under the scheme proposed. (This scheme is now about to be tested, great quantities of the native *Heveas* having been lately raised). From the schemes described, it is evident that very great economies can be practiced in rubber forests and in rubber cultivation and collecting, the method of working in the past, as every one knows who has given any attention to the matter at all, being simply ruinous to future permanance :—

RUBBER IN PENANG *

As great interest is being taken in Para Rubber and considerable capital invested in its cultivation, I have again tapped the best tree in the garden from which 1lb. of rubber was taken during the rainy season in June, 1897. A sample of this was subsequently submitted to Messrs.

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* *C. Curtis, in Report, Penang Botanic Gardens.*

Hecht Lewis and Khan for valuation, who reported it as " beautiful rubber very well cured worth to-day 3s 3d per lb." This had simply been dried in the sun and kept in the office for about a year.

This time the tapping was commenced on the 16th November which is generally about the end of the heavy rains, but there is here no season that can be counted on as absolutely dry as in Burmah and India, and in fact rain fell frequently while the operation was carried on which was spread over a period of thirty-four days. Oblique cuts leading to perpendicular channels, were made in six places (subsequently increased to seven) at the bases of which were affixed by means of a lump of clay and a nail, small tins to receive the latex. An ordinary carpenter's chisel was used for making and renewing the cuts, but both this and the tins can be improved on when the work has to be taken in hand by the practical planter. Earthenware glazed cups with a hole near the bottom so that the latex can be drawn off without removing them will effect a great saving in labour, as much time is taken up in fixing the tins securely when removed every day, and some rubber is also lost in doing this. A better cutting tool than an ordinary chisel can also be devised for the work. At the beginning the milk comes slowly and at no time continues running for long. With two exceptions the cuts were renewed between 7 and 8 a.m. and the tins brought in at 11 a.m. ; but the flow had always ceased before that time. The two exceptions were when the operation was performed in the evening, but as there is always a danger of rain during the night, and a very slight shower causes water to flow into the tins as nearly all the water trickling down the stem of the tree falls into the oblique cuts, and is thence led directly to the tins, the work is best done in this climate in the morning. Generally the latax had coagulated by the following morning, that is after standing about twenty hours, but on two occasions only partially so. In these cases, and also when rain water had got into the tins, a pinch of powdered alum was added which caused perfect coagulation in a short time. If the addition of alum does not affect the value of the rubber, it facilitates working operations in wet weather, for a little water getting mixed with the latex does not matter, provided the vessels do not overflow. All the rubber can be recovered by the addition of alum.

On the morning the incisions were first made only $\frac{1}{4}$ oz. of wet rubber was obtained, but by taking a thin shaving off the lower surface of the oblique cuts on fourteen subsequent occasions, the following quantities were obtained at each operation in ounces :—$\frac{3}{4}$, $1\frac{3}{4}$, $3\frac{1}{4}$, $3\frac{1}{2}$, $3\frac{1}{4}$, 6, 9, $6\frac{1}{2}$, $8\frac{1}{2}$, 6, $6\frac{1}{2}$, 10, $8\frac{1}{2}$, 8 ; total 5lb. $1\frac{1}{2}$ oz. of wet rubber which weighed when dry exactly 3lb. As will be seen from this the last three tappings gave a better result than any previous three and operations were only suspended as it was not advisable to make the cuts any wider. The time occupied in affixing the tins and renewing the cuts averaged half-an-hour on each occasion, or seven-and-a-half hours in all. It may therefore be taken that a man at say 30 cts. per day could attend to at least fifteen trees per day, and that the cost of collecting will not exceed 10 cts. per lb. With larger trees and better appliances it will be probably much less. I have lately visited Bertam Estate in Province

Wellesley where Mr. D. Logan planted about 2,000 young trees nine months ago and the growth is very satisfactory. From planters in Selangor I hear that the prospect is most encouraging, the trees making very rapid growth. It is evident however, that the land selected should be sufficiently drained to prevent the young plants being submerged, for in one spot where this has happened at Bertam, many have died and those that are alive do not look nearly so well as others on slightly higher land.

SCALE INSECTS: REMEDIAL MEASURES AND INSECTICIDES.

By E. E. Green, F. E. S. *

In the following pages I have endeavoured to bring together scattered information on the various methods that have been employed in dealing with insects pests of the family Coccidae. Though such treatment may in many cases be found suitable to insect pests of other families, I do not propose to give here a general treatise on insecticides, but to confine myself to measures applicable to the subject of the present work.

Little or no originality can be claimed for the following remarks. They are very largely compiled from the published work of trained entomologists (chiefly American) in different parts of the world. America has long been in the forefront in the practical application of economic entomology.

Remedial measures may be discussed under two main headings : Prevention and Cure. The former, being by far the more important, will be dealt with first :—

Preventive Measures.

Of first importance among preventive measures, I would place Quarantine Regulations. It is a fact, repeatedly demonstrated, that imported pests are the most serious. An insect may attract little or no attention in its original home, where it is kept in check by its own natural enemies, a system recognised as 'the Balance of Nature.' But take it away from its home; place it in a congenial climate with an ample supply of suitable food, and it will multiply without the checks that have prevented its increase in its original habitat. The very fact of extensive damage by any insect may of itself almost be accepted as proof of its foreign origin. Looking through the list of the different scale-insects occurring in Ceylon, I find that all the more troublesome species have been previously described from some other country, and are, therefore, presumably imported insects. The home of the 'Lantana bug' (Orthezia insignis) is now supposed to be some where in South America ; and there is evidence in

From " The Coccidæ of Ceylon," Pt. II., Dulau & Co., London, 1899.

favour of the supposition that we owe our 'green coffee bug' (Lecanium viride) to Western Africa. Aspidiotus cydoniæ, Chionaspis biclavis and Mytilaspis citricola, were originally described from America. Aspidiotus camelliae. A. cyanophylli, Chionaspis aspidistræ, and Dactylopius citri, are all well known on the continent of Europe. Aspidiotus aurantii and Pulvineria psidii have their home in Australiasia. Our former coffee pest, the 'brown bug' (Lecanium coffeae) might perhaps be quoted as an exception to this rule, as it was first recorded from Ceylon. But this insect is now considered to be merely a local variety of Lecanium hemisphaericum, an insect found all over the world, and whose origin is uncertain. On the other hand, not a single undoubtedly native species has attracted any notice as an insect pest in Ceylon.

We have only to recognise these facts to appreciate the importance of a properly conducted system of quarantine for all imported plants and fruit. Our insular position in Ceylon, with but one main port of entry, gives us a peculiar advantage in carrying out such a system. A single quarantine station, with a single fumigatorium, will be sufficient in our case to deal with the whole importations of the island. It is true that, in spite of quarantine regulations, particular pests have found their way into protected countries. In such cases failure must be attributed to incompleteness of execution. And, though some few pests may have evaded all precautions, how many others must have been refused entry? The records of existing quarantine establishments give long lists of dangerous insects detected on arrival and destroyed before they have had the chance of obtaining a footing in the new country. I believe it is the custom at most quarantine stations to examine imported plants and fruit, and, if they appear to be free from blights, to pass them without treatment. But I maintain that not even the most experienced entomologist could guarantee a plant as absolutely free from insect life. Minute larvae and eggs may lurk beneath bud-scales, in the axils of leaves, or in unnoticed crevices of the bark. To be really effective, quarantine must be complete. Every live plant and fresh fruit should be subjected to treatment, whether it appear to be free from disease or not.

The only sure way of reaching every hidden insect is by fumigation. If properly conducted, there is little danger of permanent injury, to the plant. Even though some few delicate plants may be injured, or actually killed by the process, this is a very small consideration in comparison with the damage that may be effected by a single imported pest. What, for instance, must have been the pecuniary loss to the colony from the ravages of the 'green bug'—a loss that in all probability might have been prevented. And compare this loss with the value of all the delicate plants that have ever been imported into Ceylon! But, for such tender plants, it is possible to employ other treatment than is recommended for hardy shrubs and trees.

For wholesale fumigation of plants and fruit there is nothing to equal hydrocyanic acid gas, generated by mixing cyanide of potassium, water, and sulphuric acid in certain proportions. This treatment is cheap and effectual. The gas is of the most deadly nature, and will penetrate every crack and crevice, and do its work thoroughly. The application is quite simple. All that is required is a close fitting chamber, provided with a flue for the escape of the gas after the operation. The more air-tight the chamber, the more complete will be the work. It should be fitted with racks to receive removable trays, upon which fruit may be spread. The objects to be fumigated are placed into position, the chemicals are mixed in a leaden or earthenware pan and placed on the floor, the door shut, and the room kept closed for from half to three-quarters of an hour. The flue is then opened, and, after a sufficient time (about half an hour) has been allowed for ventilation, the door is unlocked, and the plants, &c. removed. It is not advisable to take the subjected plants directly into the open air if the sun is shining. They should be kept for a few hours under shade, which will greatly lessen any danger of damage.

Mr. C. P. Lounsbury, Official Entomologist at Cape Town, has kindly supplied me with full particulars of the work of the Fumigatorium at that place. From his letters and reports I have extracted the following directions and suggestions:—

For each 300 cubic feet of space enclosed (and in proportion for greater and smaller spaces) 1 ounce of 98 per cent. potassium cyanide, 1 ounce of sulphuric acid, and 2 ounces of water will be required to generate gas of sufficient strength to kill the insects. Double this strength, or the same amount of materials to 150 cubic feet enclosed, may be used upon woody plants without danger of seriously injuring them. The greater strength should be employed whenever practicable, as it will ensure the death of the eggs as well as of the active insects.

Imported plants are usually in a more or less dormant condition which lessens danger of injury. Mr. Lounsbury writes, in his Report of June 1897, 'Injury to the tips of new growth generally results. This injury is in no wise serious, and is quickly outgrown. The operators consider it a favourable indication, as when such injury results it is quite certain that the gas has been present in sufficient strength to destroy all of the insects.'

With respect to fruit, I again quote from Mr. Lounsbury's letter: 'I had lemons and oranges analysed after treatment, and found that after few hours not more than a trace of the gas remained in the rind. There is much more natural cyanogen in a single seed (so the analyst told me) than what remains in the fruit from fumigation. We have no complaints of any effect on the keeping qualities of the fruit.'

To generate the gas 'the required quantities of cyanide and water are first placed in the generating vessel, the cyanide being broken into small pieces about the size of lump sugar. The operator then adds the acid, pouring it slowly into the vessel to avoid splashing, and immediately withdraws.'

The above treatment is suitable for fruit and hardy plants. Tender garden plants are usually imported in Wardian cases, and may be treated separately. We have—in the 'Wardian case'—an air-tight chamber ready to hand, in which the plants can be fumigated before their removal. After a large series of experiments with various fumigating media, I find that hydrocyanic acid gas remains by far the most efficient insecticide and the least injurious to the plants. But with, delicate succulent plants I find it has to be applied rather differently.

A more concentrated dose of the gas applied for a shorter period is most satisfactory in its results. In a Wardian Case, containing about sixteen cubic feet, I find a dose of half ounce cyanide, half ounce acid, and one ounce water with an exposure of half an hour will kill every individual of a colony of Orthezia (the most resistent of all Coccids) without in the least affecting the plants. The treatment should be carried out only after sunset. According to Mr. Lounsbury's tables, these proportions of chemicals should be sufficient for a space of 140 cubic feet with a longer exposure.

The other materials tested were (1) a preparation of concentrated nicotine, sold by the XL-all company; (2) McDougall's fumigation paper; (3) Jeyes' fluid; (4) naphthaline; and (5) common tobacco leaves. Nos. 1, 3, and 4 were evaporated by means of a small spirit lamp inside the case; Nos. 2 and 5 were lighted and allowed to smoulder. All these materials applied in different strength and for different lengths of time, resulted similarly in more or less complete injury to the plants, and very incomplete destruction of the insects.

If there be no Government quarantine establishment in the general planting interests, importers should safeguard themselves individually by properly disinfecting all foreign plants before distributing them or putting them out in their gardens.

Further directions for the application of the 'gas treatment' will be found in the [next Bulletin].

Perhaps of equal importance as a preventive measure is the maintenance of plants in a vigorous free-growing condition. This is a fact that has been recognised by gardeners for many generations. Anything that interferes with the free flow of sap immediately lays a plant open to attack from its insect enemies. A weakly, hide-bound plant falls an easy prey to every pest. Scale insects in particular, with a few exceptions (and such exceptions chiefly imported scales), seem to avoid a free-growing plant, possibly finding the healthy rush of sap too strong for them. Unremitting attention to cultivation will go far towards the prevention of insect pests. Amongst causes predisposing to disease may be mentioned: (1) Careless selection of plants and the retention of weakly seedlings; (2) Insufficient or injudicious drainage; (3) Unsuitable condition of soil, want of tillage, and—perhaps—of fertilisers.

Under the category of remedial measures may be mentioned the use of resistant stock. In the history of nearly every extensive plant disease it has been observed that individual plants—or established varieties of the plant—may show a marked freedom from the disease prevalent upon the less favoured type. By breeding from such individuals, or accidental varieties, a more or less completely resistant stock may be established. This fortunate fact has been frequently used with great success in dealing with fungal diseases. Thus a special variety of the potato plant—proof against the well known potato disease—has been extensively cultivated. Some varieties of wheat are found to suffer but little from 'wheat rust' (Puccinia). We have also examples of certain established strains of cultivated plants that repel particular insect pests. In Europe the vine growers have found an American stock that to a larger extent resists the attack of the dreaded Phylloxera; and by grafting on to this hardy stock they have been able to immunise their more delicate and valuable varieties. In Ceylon we have the strongest evidence that certain varieties of the tea plant (especially the Assam indigenous stock) are most markedly free from injury by the so-called 'mosquito blight' (Helopeltis). In any serious epidemic that may threaten the profitable cultivation of an economic plant we should at once be on the look out for any accidental varieties or strains that may prove resistant to that particular disease. In cases where the hardier stock is not otherwise so profitable as the more delicate variety, by grafting upon it a more valuable scion the latter may sometimes be rendered equally immune.

Curative Measures.

Where preventive measures have failed, as even with the greatest care—must often happen, recourse must be had to curative measures.

In no single connexion can the old proverb, 'A stitch in time saves nine,' be more aptly applied than in dealing with insect pests. In this case the 'stitch in time' is more likely to save ninety, or nine hundred, or nine thousand !

If a pest is to be eradicated, immediate treatment is the most important part of the process.

And the first step towards treatment should, when possible, be the isolation of the infected area. All ordinary work amongst the affected trees should be deferred until after treatment. The young larvae of scale-insects are very minute and active, and one of the most fertile sources of their distribution is by means of clothing.

Another important point is that the treatment should be applied on the spot. If the infected branches are cut down and carried off to some other part to be burned, they may be shedding the germs of the disease all along the way.

It is difficult to lay down hard-and-fast rules for action, so much depends upon circumstances, e.g. the nature of the particular pest, its extent, the nature and value of the plant attacked, &c., &c. But, for the sake of example, we will suppose a case in which three or four tea bushes are found to be infested by some scale-insect that is considered to be a dangerous pest. First dig a fair-sized hole in the midst of the affected clump, and place in it some dry grass and sticks as foundations for a fire. Fill two or three buckets with one of the insecticide washes described below. Prune back the branches one by one; immerse each branch completely in the insecticide and throw it into the hole, until nothing but the bare framework of the tree is left. Sweep all fallen leaves and rubbish from beneath the trees into the hole. Next, paint over the bare stems with the same insecticide, using a large paint brush and taking great care to saturate the entire surface down to the ground. Then set fire to the heap of prunings, and cover up the remains with earth. To kill off possible strugglers, the unpruned trees immediately surrounding the affected patch should be thoroughly sprayed with the mixture. If carried out in time, these measures will probably stamp out the pest; but a careful watch should be kept for any fresh outbreak.

The above treatment is suitable only for such plants as may be cut down without permanent injury. We may now consider the case of some larger tree to which this method would be inapplicable—say an orange or cocoa tree. In this case the gas treatment is the most suitable. The application should be repeated after an interval of about a fortnight, to ensure the death of larvæ subsequently hatched from eggs that may have survived the first operation. Full directions for gas treatment are given in the next Bulletin.

In other cases a combination of these two methods might be adopted. If two or three coffee trees should require treatment, all superfluous branches might be pruned, dipped, and burned, and the standing trees fumigated with gas. Modifications of the treatment will be required to suit particular cases.

When a serious pest has once firmly and widely established itself, little hope can be entertained of exterminating it, though much may still be done to keep it in check.

Where trees are large and more or less detached, as in orange groves, and the crop a valuable one, the gas treatment is again the most satisfactory one. But where the cultivation is denser, and the crop not so concentrated, spraying is found to be more practicable.

The choice of the insecticide must be regulated by the nature of the crop. Arsenious compounds cannot be safely applied to food crops —such as fruit and vegetables—during the cropping season. And they can on no account be recommended for such a product as tea, unless employed exclusively after pruning. For, however minute may be the actual amount of active poison deposited on a single leaf, when we consider that it takes some 400 lbs of leaf to make sufficient tea to fill a chest, and that about 3,000 of the green leaves go to the pound, or 12,000 leaves to a pound of the finished product, it is evident that the amount of poison in a single chest of tea might be considerable. And further, during the processes of packing and transport, it is by no means improbable that this mineral poison which would dry off in fine powder might gravitate and become condensed towards the bottom of the chest, with dangerous results to the consumer. The danger may be considered far-fetched ; but I think it should be recognised.

For the above reasons no patent preparations should be employed to any large extent, unless the ingredients are well known. Such mixtures, being designed for general use, may contain several different poisons acting in different ways, either externally by contact, or internally through the alimentary system. The proprietors of patent insecticides not unnaturally object to disclose their formulæ, and put off any questions by asserting that the amount of active poison in the mixtue is so very small as to be practically harmless. This may very well be true in most circumstances ; but, as shown above, in other cases the poison might become concentrated into a small portion of the product.

For other reasons compounds that depend upon arsenic or other mineral poisons for their killing properties are of little use against Coccidae. Insects that subsist upon the sap of the plants should be treated with insecticides that kill by contact, such as soap, petroleum, pyrethrum, &c. Arsenic, which adheres to the surface of the plants, is useful only against pests such as caterpillars, grubs, and slugs; that take in solid food. Mr. Maskell puts the matter concisely. He says: 'Whatever damage is done by (scale insects) is effected by the sucking of the juices of the plant through the rostrum (beak) of the insect. It follows from this that applications of any fluid to the tree externally, with the object of poisoning the insects in their feeding, would be useless, as their food is drawn from beneath the surface.'*

There are many substances fatal to insect life, but perfectly harmless to the higher animals, that may be safely used. A list of the principal insecticides, with directions for their preparation and application, is appended. (See next Bulletin.)

The most suitable season for spraying is when the young larvae are hatching. They are then in the most unprotected condition. In temperate climates this season varies with different species, and should be made the subject of careful observation. In tropical countries many species, and those naturally the most pernicious, appear to produce a constant succession of broods throughout the year.

To produce any permanent result, spraying must be very thorough. The success of the treatment depends upon the actual contact of the liquid with the individual insects. Even when the work is done by a trained man, it is practically impossible to secure the destruction of every individual. The difficulty is greatly increased when the work has to be intrusted to natives. In conducting the operation, the position of the insects upon the branches and foliage must be carefully noted, and the nozzle of the machine manipulated accordingly, so as to throw the spray upwards against the backs of the leaves, or downwards on the upper surface, or horizontally against the stems and branches.

A few words may be said as to the apparatus for spraying. This is not the place to advertise any particular make of machine; but some general principles may be given to help the would-be purchaser in his choice.

Points to be considered in the selection of a machine should be:—
1. Adaptability to Transport.—For ordinary use, where small trees only have to be treated, there is no form so convenient as the knapsack pump. This consists of a metal vessel that rests upon the back, and is supported by straps passing over the shoulders of the operator. The handle of the pump (in the best patterns) comes forward under the left arm, and is worked by the left hand, leaving the right hand free to direct the nozzle which is attached by a flexible rubber tube. The vessel usually contains the pump cylinder, and space for about four gallons of liquid. Where a large apparatus is required, a barrel pump may be used. In this form the pumping apparatus is fixed in a barrel to which handles are attached, so that the whole apparatus can be carried from place to place by two men. Where the land is flat the barrel, or a metal tank, may be mounted on wheels for transport; but it should be designed so that the vessel may be dismounted and carried by hand to such places as are inaccessible to the wheeled vehicle. Where the lay of land is suitable, and large trees have to be treated, a more powerful apparatus may be mounted on

* New Zealand Scale Insects p. 26.

a cart, and drawn by horse or bullock power. In such cases two or more lines of hose and nozzles can be worked from the same tank.

II. Strength.—The materials employed in the construction of the machine should be such as are not readily corroded by the mixtures used. Mr. Lounsbury, in his report for the year 1896 *, gives the following very practical hints on this subject :—

'Iron is so quickly corroded by many of the common insecticides and fungicides that pumps in which the working parts are of this metal are not desirable. These parts of the pumps should always be made of hard brass. For the sake of economy, the bodies of most pumps are made of iron, but even here the use of brass lends greater durability, and is an advantage which in the end will probably pay for the additional initial cost. Rod-like parts and thin handles of cast iron are objectionable because so easily fractured. Any parts of rubber are damaged by contact with paraffin. Ignorance of this fact has led to the ruin of a large number of Vermorel knapsack pumps, in which a circular rubber disc is used for the propulsion of the liquid. The paraffin causes the rubber to swell, and thus become useless for its purpose.

'Copper is the best metal for tanks in knapsack pumps, and attention should be paid to the thickness of this metal. Thin copper will rapidly wear through. Tanks of sheet iron or tin are soon ruined by contact with liquids containing copper compounds, such as Bordeaux mixture and Paris green, and these preparations are also injuriously affected. But even copper tanks are not suitable for use with all spraying mixtures, since this metal is acted upon by the sulphur in such compounds as "eau grison" and lime-sulphur-salt mixture. In these cases, the sulphur leaves the lime, with which it had united during the process of cooking, and unites with the copper to form copper sulphide. This compound forms in a thin black layer over the copper, which, if it would remain intact, would preserve the metal from further action; but, unfortunately, some of it usually breaks away, exposing fresh surface to the injurious action, and also proving an annoyance by passing through the hose and clogging the nozzle. For these reasons it is best not to use these sulphur mixtures in knapsack pumps.'

III.—Simplicity.—All the parts of the pump should be readily accessible and removable, so that, should anything go wrong, they may be taken to pieces and cleaned, or damaged parts renewed. The want of these facilities is a serious fault in many machines, the slightest injury necessitating the sending of the whole apparatus to the repairers.

IV.—The production of a Uniform and Effective Spray.—The continuity and force of the flow is dependent upon an air chamber in the pump, this feature constituting a 'force-pump.' On this account all hand syringes are almost useless. The nature of the spray is regulated by the form of nozzle employed. The chief object is to break up the liquid into such a fine spray that it will penetrate the thickest foliage in the form of a dense mist and come in contact with every part. For this purpose one of the 'cyclone nozzles' is most admirably adapted. But where it is necessary to throw the liquid to a considerable distance,

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* **Report of the Government Entomologist for the year 1896, Cape of Good Hope, pp. 139-140.**

as, in spraying large trees, a nozzle throwing a coarser spray must be used. It is advisable to have several interchangeable nozzles to suit the different kinds of work. There should always be a detachable cap to the nozzle, so that any obstruction may be quickly and easily removed. Many nozzles are provided with a fine point, held back by a spring, but which, when pushed forward, clears the aperture.

A few further remarks may be quoted from Mr. Lounsbury's report in which he gives some recommendations for the care of spray pumps. 'Before a spray pump of any kind is put away after use, it should be thoroughly washed and clear water pumped through it ; hot water answers much better than cold if sticky or soapy washes have been used. The working parts should be occasionally oiled, and if the paint on the iron parts becomes worn away it should be renewed. Attention to these details will preserve the pump for a long period, while, if they are neglected, the pump may never save its initial cost.'

Before quitting the subject of general remedial measures and entering upon detailed descriptions of particular processes, something should be said upon the important question of the introduction of 'natural enemies' of the Coccidae. The same circumstances that make an imported pest so exceptionally dangerous, act in our favour in the importation of beneficial insects. Just as the absence of its established natural enemies enables an insect pest to multiply without hindrance, so the introduction of a beneficial insect without its own natural checks will also permit of its rapid increase as long as an ample supply of congenial food is obtainable. When the food supply begins to fail, which means when the pest has been mastered by its imported enemies, then they will both decline together. There need be little fear that, when the food supply has been exhausted, the imported insect will itself become a pest. A predatory insect, by which is understood one that preys upon other insects or animals, will seldom, if ever, alter its diet and become a vegetarian.

It is noticeable that an insect seldom assumes any importance in its original home unless through some accidental or artificial interference with the balance of nature in that part. (For instance, it has been asserted that the wide-spread destruction of moles in England has resulted in a marked increase of damage to pasture land from the grubs of the 'cockchafer' beetles and 'crane-flies,' upon which the moles fed.) Consequently, if we are to obtain any benefit from the use of natural agents, we must endeavour to reproduce the conditions prevailing in the country where the insect in question is known to occur, though without attracting notice as a pest. Or, if the original home of the injurious insect is unknown, we may reasonably hope for good results from the introduction of an insect that is found to prey upon some allied pest in another country.

The most important natural enemies of the scale insects, or, at least, those that have attracted most attention, belong to a family of small beetles popularly known as 'lady-birds.' The complete success attending the introduction of an Australian lady bird (Vedalia cardinalis) into California, where it cleared the orange orchards of the destructive 'Fluted-scale' (Icerya purchasi) has led to numerous other experiments of a similar kind. These experiments have not always been successful. There must, of necessity be many failures. We are still only in the experimental stage of the work. Even when the beneficial insect has been successfully established in a country, it is by no means certain that it will thrive. There may be climatic or other conditions against it. In that case, all we can do is to try another insect. Occasional or even repeated, failures should not discourage the repetition of the attempt. The value of a single success will far outweigh the cost of many failures. In the course of such experiments the causes of failure will in time be ascertained, and improved methods be employed. The freezing method recommended by Mr. Koebele seems to be rather an uncertain one, and has led to many disappointments. I am inclined to hope for more satisfactory results from the employment of 'Wardian cases,' as suggested to me by Mr. Lounsbury. In these the insects will remain active and be supplied with food. There are certain obvious dangers connected with this method, such as is possible introduction of the insect pest upon which the 'lady-birds' have been supported during the voyage. For this reason the business should be conducted under the supervision of trained entomologists only. In choosing the food supply, an insect that already occurs in the country to which the lady-birds are consigned should, if possible, be selected* But, under any circumstances the imported beetles should not be liberated immediately, but should be transferred to fresh breeding cages and supplied with local food, and the cage in which they arrive should at once be thoroughly disinfected. In sending stocks by Wardian case, the larvae of the beetles may with advantage be included. These will complete their transformations during transit, and are more likely to survive the voyage than the adult insects.

There are other natural enemies of the Coccidae that may some day be advantageously employed in the same way. Amongst the two-winged flies (Diptera) we find the Lestophonus iceryae, which attacks the 'Fluted-scale.' Nearly every species of scale insect is subject to minute internal parasites belonging to the wasp family (Hymenoptera). The family Neuroptera supplies the 'Lace-wing flies,' the larvae of which are known as 'Aphis-lions,' from the voracious way in which they feed upon Aphides and scale-insects. Even the butterflies and moths (Lepidoptera) provide a few coccid-eating species, such as the caterpillars of the butterfly Spalgis epius and of several moths of the genus Eublemma. The 'Lady-birds' are included in the family Coleoptera.

Besides natural enemies belonging to the animal kingdom, scale insects are subject to diseases belonging to the vegetable world. There are several parasitic fungi that render great assistance in reducing the numbers of our Coccid pests. In Ceylon during the wetter months of the year, the 'green bug' (Lecanium viride) dies off to a large extent, attacked by a greyish mould which, after killing the insect, spreads outwards as a delicate fringe of interlacing whitish threads. A bright orange-coloured fungus (Septoria? sp.) is useful in checking the increase of Fiorinia fioriniae and Chionaspis biclavis on the tea plant, and Aspidiotus aurantii on orange trees. A very similar fungus (Sphaerostilbe

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* In a recent consignment of 'lady-birds' received from the Cape of Good Hope, the cochineal insect (Coccus cacti) was very judiciously chosen for the purpose. This insect is practically confined to the 'Prickly Pear' cactus, and is therefore not liable to become a pest.

coccophila) that attacks Aspidiotus perniciosus in Florida (U. S. A.) has been the subject of some very interesting experiments to test the possibility of communicating the disease to previously healthy colonies of the insect. Dr. L. O. Howard gives the following particulars of the experiment* :—

An interesting and important development of the past two seasons' work has been the identification and study of the parasitic fungus, Sphaerostilbe coccophila. Professor Rolfs, of the Florida Station, has devoted a bulletin largely to the consideration of this fungus, which, as previously stated, seems to be prevalent throughout the Southern States. He has shown experimentally that the fungus may be transferred to trees affected with San Jose scale, and the disease produced among the scales. His process was to inoculate acid bread with pure cultures of the fungus, and three weeks later the application was made in the following way :—A piece of the bread about an inch square was placed in cold water and shaken until the bread was broken up and the spores distributed in the water. This water was then applied to the scaly tree by means of a sponge, or cloth, or sprayed on. The applications were made in Midsummer of 1896, and observations were made as to the results late in February, 1897. Four of his experiments resulted successfully, and three unsuccessfully, while in the eight experiment the result was doubtful on account of the tree having died between the times of treatment and inspection. Twigs from Florida containing San Jose scales, infested by the fungus, were sent to Mr. Horace Roberts, at Fellowship, N.J., about the middle of June. On September 25th Dr. Smith found the fungus upon almost, if not quite, all of the trees on which twigs had been tied. A number of instances have come to our observation of the death of the scale in a wholesale manner from the spontaneous work of this disease, or from some other cause. For example, we received scale-infested cuttings in January, 1897, from an orchard which was said to have been freed from scales by this fungus disease. Careful examination showed that upon one cutting, out of 183 scales, but four were living; on a second cutting, out of 723, but two were living; on a third cutting, out of 579, but twenty-eight were living, giving thirty-four living scales out of 1485—a mortality rate of 97.7.'

I have, myself, repeatedly succeeded in disseminating the disease affecting Lecanium viride by tying branches with diseased insects on to trees on which the bug had hitherto remained quite healthy.

There are several methods by which spores of these parasitic fungi may be disseminated. As in the last-mentioned experiment, they may sometimes be communicated by merely transferring affected branches to the nighbourhood of the healthy insects. In such cases the spores are carried by the wind to their destination. But in some of these fungi the spores are gelatinous and agglutinated, in which case the wind would fail to disperse them. Fungi of this kind may be crushed up in water and used as a spray; or artificial cultures may be made and mixed with water, to be used in the same way. In the ordinary course of nature these gelatinous spores are probably carried from tree to tree on the feet of birds.

* Bulletin, No. 12. (New Series) U. S. Dept. of Agriculture, (Div. of Entomology.)

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PLANTS.

From Supt. Bot. Garden, Brit. Guiana.
Hevea sp. (Para Rubber from Mazaruni R.)
From W Jekyll, Robertsfield, Jamaica.
Combretum sp.
Ivy-leafed Geranium
St. Joseph's Strawberry.
From Prof. G. Landes, Martinique.
Grafted Mangoes :—Julie, Martin, Reine Amèlie, Poignèe d'or, Mangue d'or.

SEEDS

From Director, R. Gardens, Kew.
Piptadenia n. sp.
Kickxia africana
From T. J. Breakspere, Mandeville, Jamaica.
" Vegetable Peach".
From W. Jekyll, Robertsfield, Jamaica.
Gomphocarpus fruticosus.
From Supt., Botanical Garden, Brit. Guiana.
Castilloa elastica
From L. Tate, Bluefields, Jamaica.
Lime.
From Prof. Dr. Comes, Portici, near Naples.
Tobacco.

[Issued 18th August, 1899.]

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series | SEPTEMBER, 1899. | Vol. VI Part IX

CINCHONA: A RETROSPECT AND A PROSPECT.

Cinchona bark and quinine are now at one of the most interesting periods of their history since the introduction of the former to Europe in 1640 and the discovery of the latter about 1820. For the benefit of those, who have missed the opportunity of following recent developments in these drugs a few succinct notes on these will be worth giving, and we may at the same time add something new in the shape of information as to the course of events in the future.

Quinine has seen a period of active speculation, during which its price in the "second-hand" market (that is in the buying and selling of German quinine in London that mainly takes place in Mincing Lane and between parties none of which are makers) has gone up to 1s. 9¼d. per ounce, and since receded to 1s. 4d. The natural cause of such an advance was, the short supplies of bark that continental makers of quinine possessed, in spite of the huge shipments from the producing countries in 1898.

The course of events that has led up to this state of affairs is remarkable. South America, the home of the cinchonas, has for some years been almost a negligible source of supply for cinchona bark. Since the cultivation of the cinchona trees was taken up in Java, India, and Ceylon prices have declined so much as to discourage the exporters and collectors in South America from pursuing their labours. India and Ceylon, once started on the cultivation, rapidly grew, the latter especially extending its output so quickly as to cause most venturesome prophecies of its future. But prices became too low even for it, and Java, which was longer in getting on its feet, when it did stand took a firmer footing, and so has been able to endure the cutting down of prices. The Dutch in his island laid hold of the best kind of tree, and then made tremendous strides in securing the bark market, which was thus transferred from London to Amsterdam. Ceylon planters at last found prices so unremunerative that they began uprooting trees, and turning their attention to other things. India reached her height in 1889, and has since then been going down fast, her planters also being disgusted with the reward of their outlay. And all this time Java has not only managed to hold on but to grow.

While all this has been going on the consumption of quinine has been enlarging. The reduction of the price of bark was to a large extent the result of a combination of the quinine manufacturers. At length the worm turned ; the bark importers in Amsterdam made a stand, and supported by the strength of the market that had now been attained (through the fact that Java exports had not grown enough to make up for the loss from India and Ceylon and the increased consumption) they secured a slight advance in the price of bark. This encouraged India and Ceylon to ferret out all their stores and ship as much as they could. Hence it came about that in 1898 there was more quinine in bark form shipped from the growing countries than ever there has been before. Yet, to-day, stocks of bark in the public warehouses of Amsterdam and London are lower than they have been for years. So that the observant ask, What is to become of the price of quinine? Where is the bark to come from?

If it be true that India and Ceylon last year put forth as big an effort as they are capable of, then we cannot look to them for increased supplies unless they begin again to extend plantations, and the crop from these would not be ready for five years at least. Java appears (though the statement here is more doubtful) to be in the same condition. It looks then as if we must turn our attention to the original source of bark once more. And here we are dealing with a mysterious factor. No one can speak except hazily about the supplies America holds. Judging by the history of past years, it would seem that we must depend on Columbia for most of the natural South American bark. And it will not pay Columbia to start collecting again until bark is much dearer than it is at present. A planter who has a very lengthy acquaintance with the chief producing districts, considers that a unit of 4d would have to be reached before it would pay to collect even the richer barks. This means that, whereas now the unit is 2½d *i.e.* that 1-100th lb. of quinine costs whilst in the bark 2½d., the same amount would have to be worth 4d. If this were so, quinine (in bark) would be worth to manufacturers, 2s 1d per ounce, and worth to the wholesale dealers, about 2s 6d per ounce. If Java, India, Ceylon and Africa cannot produce enough to meet the demand until five or six years have elapsed and the expert's view given above is correct, then there is nothing for it but to pay the price we have named.—*British and Colonial Druggist.*

DISTRIBUTION OF HAVANA TOBACCO SEED.

Through the agency of the British Consul-General in Havana, Tobacco seed has been obtained from the Vuelta Abajo district, and is now available for free distribution. Applications should be made to Director, Public Gardens, Kingston, and should state the area which it is proposed to plant out.

A Bulletin containing a short treatise on the cultivation and curing of tobacco by a Cuban expert will be supplied free on application.

SCALE INSECTS: REMEDIAL MEASURES AND INSECTICIDES.—II.

By E. E. Green, F.E.S. *

GENERAL LIST OF SUBSTANCES AND PROCESSES EMPLOYED IN THE TREATMENT OF SCALE INSECTS:

The Gas Treatment.

Hydrocyanic acid gas is the material employed in this process. It is generated by the admixture of cyanide of potassium, sulphuric acid and water. For the details of treatment I cannot do better than quote in extenso from the admirable paper on 'Gas Treatment for Scale Insects,' complied by Mr. C. P. Lounsbury from his personal experience as Government Entomologist at the Cape of Good Hope. The process described was principally employed against Aspidiotus aurantii, an insect that appears to be distinctly on the increase in Ceylon. I may add that I have followed Mr. Lounsbury's directions in my own experiments with most satisfactory results.

'Generation of the Gas.—Hydrocyanic acid gas is generated by the action of sulphuric acid on potassium cyanide in the presence of water. The required quantities of the cyanide and water are first placed in the generating vessel, the cyanide being broken into small pieces not above the size of lump sugar. The tree is then covered with the tent or sheet and the vessel slipped under almost to the base of the tree; reaching in, the operator then adds the acid, pouring it slowly into the vessel so as to avoid its splashing and thus burning his hand or the cloth. He immediately withdraws and the men shovel a little soil on the edges of the cloth all around, to more thoroughly prevent the escape of the gas.

'The rapidity of the evolution of the gas depends largely upon the size of the pieces of cyanide. If these are like powder, the reaction is violent and immediate; but if in lumps the reaction takes place more slowly and continues for a minute or longer. The slow reaction is desired partly because less injury results to the foliage immediately above the vessel. But the lumps must not be too large, for then the reaction is liable to be imperfect owing to a black coating (carbon ?) forming over the lumps and preventing further decomposition by the acid. The water should not be added too soon or part of the cyanide becomes dissolved and gives a violent reaction. The residue which remains in the dishes is buried; and the dishes are washed in clean water before being again used.

'Time necessary for treatment.—The cover is left over the tree for thirty minutes in the case of small trees, and forty-five in the case of those over twelve feet in height. At the expiration of this period the generating vessel is removed, and the residue buried in the soil.

'A number of trees are fumigated together, the endeavour being to treat as many at time as can be covered and uncovered during

* From "The Coccidae of Ceylon," Pt. II., Dulau & Co., 1899.

the period of exposure. In this way the men are kept continuously busy, the time for the removal of the first tent arriving by the time that the last tree is covered.

'Absence of Sunlight necessary.—The originators of the fumigation process observed that the gas was most efficacious, and that less injury resulted to the foliage when the operations were performed at night than when they were carried on in sunlight. It is said that chemical changes are produced in the gas by the action of sunlight, and that the resulting gases are more injurious to the plant life and less to animal than hydrocyanic acid gas. Whether or not these theories are correct is of small practical importance, for the foliage of a tree will suffer serious injury if the tree is left covered with an air-tight oiled tent for half an hour in sunlight, without the gas being present. Having ascertained this fact by experience, the foreman in charge of the Board's outfit refrained from covering trees until the sun had sunk from sight on any but cool dull days. The great majority of the trees treated have been fumigated after sunset. The ideal night for fumigating is quiet, cool, and moonlight without dew.'

It is evident, from the above, that the period available for this process is somewhat limited. However, when only a few trees have to be treated, the hour immediately preceding nightfall will be ample for the purpose. I have personally found no ill effects following the operation when performed on dull, cloudy days, when the sun is entirely obscured.

Although hydrocyanic acid gas will certainly kill every insect—and even their eggs if used in sufficient strength and for a sufficient length of time, both the necessary strength and time will be found to vary with different species of insects, and must be made the subject of careful experiment. I find that Orthezia insignis is a very difficult insect to kill, and requires a double strength of gas, continued for fully three-quarters of an hour.

Mr. D. W. Coquillet, one of the first to employ this process, gives the following directions for making an air-tight tent : * 'The material commonly used in the construction of the tent is what is known as blue or brown drilling. A few persons have used ducking instead of drilling, but this is much inferior to the latter ; in the ducking the threads extend only lengthwise and crosswise, whereas in the drilling they also extend diagonally—this belonging to the class of goods to which our merchants apply the term "twilled"—and for this reason the drilling is both stronger and closer in texture than the ducking.

'After the tent is sewed up it is given a coat of black paint, as it has been ascertained that tents treated in this manner last longer than those which have been simply oiled with linseed oil. Some persons mix a small quantity of soap-suds with the paint in order to render the latter more pliable when dry, and therefore less liable to crack. Instead of thus painting the tent some persons simply give it a coating of size. Sometimes a small quantity of whiting or chalk is added to this sizeing with or without the addition of lampblack. A few made use of the

* Bulletin, No. 23, U. S. Department of Agriculture (Division of Entomology.

mucilaginous juice of the common cactus (Opuntia Englemanni) for this purpose. To obtain this, the cactus leaves or stems are cut or broken up into pieces, thrown into a barrel, and covered with water, after which they are allowed to soak for three or four days. The liquid portion is then drawn off, and is ready for use without further preparation. Tents which I saw that had been prepared with this substance were to all appearances as air-tight and pliable as when prepared in any other manner.'

For the oiling, Mr. Lounsbury recommends a mixture of four parts boiled linseed oil to one part turpentine. The cloth should be first well wetted with water, and the mixture spread lightly over the surface with a brush. A thin coating is found to be sufficient. Mr. Lounsbury has since informed me that he now uses, with completely satisfactory results, tents made of cloth merely shrunk in water, without any subsequent oiling. Such tents are, of course much lighter and more easy to manipulate.

Mr. Coquillet gives the annexed table, showing the quantities of chemicals required for different sized trees.

Height of tree.	Diameter of tree top.	Water	Sulphuric Acid.	Potassium Cyanide.
Feet.	Feet.	Fluid ozs.	Fluid ozs.	Ozs.
6	4	⅔	⅓	⅓
8	6	2	1	1
10	8	4¼	2¼	2¼
12	10	8	4	4
12	14	16	8	8
14	10	10	5	5
14	14	19	9½	9½
16	12	16	8	8
16	16	29	14½	14½
18	14	26	13	13
20	16	36	18	18
22	18	52	26	26
24	20	66	33	33

Mr. Lounsbury, after practical experience at the Cape, publishes the following figures, from which it appears that he found smaller quantities sufficient. This is, doubtless, due to difference in purity of the chemicals. Mr. Lounsbury was working with cyanide of 98 to 100 per cent. purity, while Mr. Coquillet was using cyanide of only 33 to 58 per cent. It is therefore important to know the exact amount of pure potassium cyanide in the particular brand employed.

Height.	Diameter.	Water.	Acid.	Cyanide.	Space Enclosed.
Feet.	Feet.	Fluid ozs.	Fluid ozs.	Ozs.	Cubic Feet
4	3	¼	⅛	⅛	25
6	4	½	¼	¼	65
8	5	1	½	½	140
8	6	1½	¾	¾	200
10	6	2	1	1	255
10	8	3	1½	1½	435
12	8	3½	1¾	1¾	535
12	10	5½	2¾	2¾	815
14	8	4½	2¼	2¼	635
14	10	6½	3¼	3¼	970
14	12	9	4½	4½	1355
16	10	7½	3¾	3¾	1130
16	12	10½	5¼	5¼	1585
16	14	14	7	7	2105
18	12	12	6	6	1810
18	14	16	8	8	2415
18	16	20	10	10	3085
20	14	18	9	9	2720
20	16	23	11½	11½	3485
20	18	29	14½	14½	4325
22	18	32	16	16	4835
22	20	39	19½	19½	5865
24	20	43	21½	21½	6500

The gas treatment has been largely used in combating scale insects (particularly Aspidiotus aurantii) on orange trees. It will be found the most effectual method for exterminating Orthezia insignis or any other insect, upon individual trees.

Soap and Soapy Emulsions.

Soap by itself has considerable insecticidal properties. In fact, in many popular mixtures, it is extremely probable that the soap is the most efficacious ingredient. It acts by asphixiation, forming an impervious film over the breathing pores of the insects.

Whale-oil soaps are found to be the best for the purpose. In Insect Life, Vol. VII., p. 369, the following conclusions are drawn from numerous experiments upon trees infested with the San José scale (Aspidiotus perniciosus) in America :—' Soap washes, particularly of Whale-oil soap, have yielded the most satisfactory results ; and at the rate of two pounds to the gallon, under the conditions of thorough drenching of the entire plant, with five or six days of subsequent fair weather, will destroy all the scales, whether applied in fall or in spring. The results with soap in less strength indicate that under the most favourable conditions the same result may be reached with mixtures containing only a pound and a half or more of soap. The action of the soap at the rate of one pound or more to the gallon, applied in the fall, is generally to prevent blooming and fruiting the following spring, but the vigour and healthfulness of the tree are greatly increased. Applied in spring at the time of blooming, it does not injure the plant nor affect the setting of the fruit to any material extent in the case of the peach, and not at all in the case of the apple.

'The experiments, as a whole, indicate the vastly superior merit of the soap wash and its fall application. The greater vigour of the plant resulting from the fall treatment more than offsets the possible failing of bloom. Owing to the impossibility of controlling weather conditions and the practical difficulty of wetting every part of the plant, one spraying cannot often be relied on to accomplish the death of all the scales, but two conscientious drenchings may be expected to accomplish this result. These may be (1) at the time of, or shortly after, the falling of the foliage in autumn, and (2) just before blooming in spring.'

Other soaps (hard laundry soap) are efficacious, but not to the same degree.

In another of the American reports * is an instructive paper on insecticide soaps, by Mr. C. L. Marlatt, from which I take the liberty of quoting largely :—'The decided insecticide value of the so-called whale oil (more properly fish oil) soaps, against scale insects particularly, has been fully demonstrated in the last few years in the work against the San José scale, and has fully substantiated Professor Comstock's early recommendation of this means of controlling scale-insect pests. The merit of these soaps is not only in their effectiveness as insect destroyers but from their being entirely without injurious effect on the treated plant. In this respect they are perfectly safe in the hands of any person, in contradistinction to all oily washes, which are very liable to be injurious in greater or less degree, although the injury may be insignificant, or perhaps not apparent immediately, or during the first season.' . . . . 'The use of soaps is attended with certain difficulties.' . . . . 'To be satisfactory for insecticide use it must, when dissolved at the desired rate, say two pounds to the gallon of water, remain a liquid capable of being sprayed with an ordinary nozzle at an ordinary temperature. This may be determined by a very simple test and one which should be invariably given any soap before it is accepted for spraying operations. It consists in simply dissolving a small quantity of the soap at the desired rate, and allowing it to cool.'

Many soaps solidify or become gelatinous and tenacious on cooling These are useless for spraying purposes. The common country soap of Ceylon has this defect. I have experimented in a small way with soap mixtures; but it is difficult to obtain here a brand that combines suitability with cheapness. Such a brand is a great desideratum. I find that one of the most useful properties of the soap mixtures is to prevent the escape of the young larvae by blocking up the natural exits, and on this account the treatment is to be very strongly recommended.

Kerosene Emulsion —Soap is often combined with other ingredients. Of these kerosene emulsion is the best known and most widely used. As its efficacy and its effect upon plant life very greatly de-

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* U. S. Department of Agriculture (Division of Entomology). Bulletin No. 6 (New Series.)

pend upon the preparation of the mixture, great care should be taken to accurately follow the directions. The formula in general use is:—

Soap	...	...	...	$\frac{1}{2}$lb
Kerosene	...	...	...	2 gals.
Soft water	...	...	...	1 gal.

'Dissolve the soap in the water heated to boiling, then add the kerosene (to the hot mixture), and churn it until a creamy fluid results, which thickens on cooling, and adheres to glass without separating into oily particles.'

Whale-oil soaps are preferable, but any kind may be used. I have personally made a very successful emulsion, employing the common country soap, which seems to be particularly well adapted to retaining the oil in an intimate mixture, and which, in this combination loses its own objectionable properties. The most important part of the process is the churning. This must be most thoroughly carried out. It can be satisfactorily managed by repeatedly drawing up and expelling the mixture through an ordinary garden syringe or a force pump. A more lengthy method is to stir the mixture vigorously with a whisk of twigs. The liquid should be boiling hot during emulsification, and then, if kept in a cool place, it is said to last for a year or more without separating. If insufficiently churned, the mixture will afterwards become separated and the oil collect at the top. A properly compounded emulsion will mix with water in any proportions.

For use against scale insects a strength of one part emulsion to ten of water is found to be effective. As in all preparations of which petroleum is an ingredient, it can be more safely used on cloudy days. When used in hot sunshine, it is liable to burn the foliage and injure the tender shoots of the plant, but the danger of injuring is much less with a properly prepared emulsion than with mechanical mixtures of kerosene and water. Mr. Marlatt, in some 'Notes on Insecticides,' * gives the following particulars of experiments which show that kerosene emulsion can be used of considerable strength without causing appreciable injury to the plants. But it cannot be recommended for general use at a greater strength than mentioned above. Mr. Marlatt writes: 'About the 1st May, when the foliage was in the vigour of its early growth, a number of plants-peach, Japan quince, elm, pine, and strawberry-were treated with the following strengths of kerosene and whale-oil soap emulsions, made after the standard formula: Diluted (1) with 8 parts of water, (2) 4 parts of water, (3) 9 parts of water, and (4) 14 parts of water, or the emulsion at $\frac{1}{3}$, $\frac{1}{5}$, $\frac{1}{10}$, and $\frac{1}{15}$, strength. The application was very thorough, and the limbs and tiwgs were thoroughly wetted by immersion in the insecticide. The treatment was made on a very bright, warm day, in the early afternoon. No rain occurred for four days, after which there were heavy rains. No injury whatever developed in the case of the pine, strawberry, and elm with any of the strengths used. With peach the injury was trifling, a very small percentage, perhaps one or two per cent, of the leaves turned yellow and fell to the ground, but I am inclined to believe that this was merely the

* Insect Life, Vol. VII., p. 116.

normal spring shedding of the leaves, which is seen in nearly all plants. In the case of the Japan quince, however, with the two stronger mixtures, namely, those with one-third and one-fifth kerosene emulsion, a few yellow spots appeared on the leaves, and later, upon handling the limbs treated with the strongest mixture, about one-fourth of the leaves were found to fall off readily. These leaves, while looking comparatively healthly and green, had evidently been injured more than their surface appearance indicated. With No. 2 this peculiarity was almost unnoticeable, and with Nos. 3 and 4 no injury whatever was shown, nor did any further injury manifest itself throughout the season in the case of any of the plants treated. These experiments would indicate that the kerosene emulsion can be applied in much stronger dilution to tender foliage of growing plants than has hitherto been supposed.'

On the other hand, there are well-authenticated reports of plants seriously injured, or even killed, by the use of too strong a mixture, and the application during sunny weather is attended with danger. In my own experience I have found the tender shoots on a recently pruned tea bush to be completely killed back by a comparatively weak mixture applied during sunny weather.

When the foliage of a plant is attacked, the applications should be made by means of a spraying machine. In the case of pruned trees, when the pest affects the bark only, the liquid can be applied with a brush or a piece of rag to the stems and branches. Care must be taken that the liquid is not used in sufficient quantities to run down and saturate the roots of the plant, or grave injury may result. When employed with proper precautions, there is no doubt that we have in kerosene emulsion a very valuable remedy against scale and other insect pests.

Milk may be substituted for the soap in the manufacture of kerosene emulsion. The formula given by Hubbard is :—'One part milk (sour milk is said to be as suitable as fresh for the purpose), to two parts kerosene. Heat the milk nearly to boiling point and mix with the kerosene. Churn the mixture violently until a thick creamy fluid is obtained. For use against scale insects dilute with nine or ten times the quantity of water.' I have been unable to find any definite statements as to the comparative effectiveness of the milk and soap emulsions. It is possibly a question of cost. In some countries a gallon of milk may be cheaper than half a pound of soap ; but in most places it is probable that the balance of advantage will be on the other side. The active insecticidal properties of soap itself must surely be an additional advantage.

Kerosene.—Much diversity of opinion exists as to the use of pure kerosene or a mechanical mixture of kerosene and water. It is undoubtedly effective as an insecticide.

But in too many cases it is equally fatal to plant life. Reports are very conflicting. In some cases spraying with the undiluted oil has been unattended by any injury to the tree, while particularly successful in killing the scale. In other cases even large trees have succumbed under the treatment. One cause of injury is said to be the collection of oil at the base of the tree, the roots being apparently much more sensitive to injury than the exposed parts. As a precaution, earth should be banked up round the base of the tree, and only sufficient oil should be used to moisten the surface of the foliage and bark without any surplus to run down the stem.

Mixtures of kerosene and water have been largely employed in America, and elaborate machines devised for ensuring the proper mixture of the two ingredients. But under any circumstances their effectiveness does not compare favourably with a properly compounded emulsion.

Referring again to one of Mr. Marlatt's reports, * I find it stated that 'kerosene mixed with water is not nearly so powerful an insecticide as the kerosene soap emulsion. It does not remain nearly so long on the plant, and is not nearly so effective an insecticide at the same strength of oil. The heavier soap or milk emulsions kill more effectively, which is, perhaps, explained by the heavier liquid actually bringing more oil in contact with the insect, and also by its greater permanency.' Taking everything into consideration, neither kerosene, nor mixtures of the oil and water, can be recommended for general use at any rate in the tropics.

Resin Washes.—These are used extensively in California to remove scale insects from fruit trees. The formula (taken from Bulletin, No. 9 of the U. S. Department of Agriculture) is as follows :—' The summer wash usually contains twenty pounds of resin, five pounds of crude caustic soda (seventy-eight per cent.) or three and a half pounds of the ninety-eight per cent., and two and a half pints of fish oil. The winter wash contains thirty pounds of resin, nine pounds of crude soda, and four and a half pints of oil. The ingredients are boiled in about twenty gallons of water for two or three hours, hot water being occasionally added until fifty gallons of solution are made. This, for both formulae, is diluted to one hundred gallons before application to trees. Greater efficiency is believed to come from long boiling of the mixture, and it is preferably applied hot. It is used on deciduous trees for the black and San Josè scales, and on citrus trees for the red and black scales; but the dense foliage of the latter renders thorough spraying difficult except for young trees, and fumigation is much preferred. An improperly made resin wash is also apt to spot the fruit of the orange. . . .

Carbolic Acid.—Crude carbolic, phenol, Jeyes' fluid, and similar compounds, all have insecticidal properties. Carbolic acid itself has been found inefficient except when applied in such strength as to seriously damage the plants. I find that phenol and Jeyes' fluid (which appears to be much the same thing) are effective against Orthezia, 'mealy bugs,' and most species of Lecanium. A mixture containing 1 part of Jeyes' fluid to 20 of water,applied to a Thunbergia bush attacked by Orthezia, was fatal to more than 90 per cent of the insects, but resulted in the death of the terminal buds of the plant. It had no bad effect upon the more mature leaves and shoots. The application did not, however, prevent the subsequent hatching of the eggs in the ovisacs of

* Bulletin No. 9 (New Series), U. S. Department of Agriculture (Division of Entomology.)

the dead insects. Weaker solutions were proportionately less effective. . .

Tobacco Water.—'Steep 5 lbs of refuse tobacco (stems, &c.) in 3 gallons of water for three hours. Strain the decoction and add sufficient water to make 7 gallons.' This mixture will kill soft bodied species that are unprotected by a covering scale, such as Lecanium viiide, Pulvinaria psidii, and Dactylopius citri. It has little or no effect against the Diaspidinae.

Lime Water.—In the early days of the 'green coffee bug' I used a very thin wash of quick lime and water. The mixture is inconvenient or difficult to apply as a spray, as it quickly clogs the nozzles and valves of the machine. I applied it with large brushes to the affected coffee foliage, and it was certainly fatal to every insect with which it came in contact. The bugs turned from green to a bright orange colour within five minutes of the application. But many individuals necessarily escaped, and the benefit was only temporary. No damage to the trees was observed, but the lime had such a caustic effect upon the hands and arms of the coolies employed in the work that it had to be discontinued. . . . .

Soot is an article that has been greatly over-rated as an insecticide and wood ashes may fall under the same category. The substances are, doubtless, useful in dealing with slugs and snails, their astringent and absorptive properties acting upon the mucous surface of such animals ; but, when applied to dry insects, such as caterpillars and scale bugs, they fail to adhere, or, when adhering, to act in any way prejudicial to the insect.

Lime, when applied dry, has little or no effect, unless there happen to be moisture upon the insects. Even then its action will be very partial and unsatisfactory.

Powdered sulphur is also quite useless against scale insects.

Many other substances have been made the subjects of experiment; but, as they are either far too costly or otherwise impracticable, it is useless to enumerate them.

SEEDLESS GRAPES.

Herr Muller-Thurgau attributes the absence of seeds in many varieties of grapes sold in the markets to two causes—functional inefficiency of the pollen and of the ovule. In some varieties the pollen-grains are well developed, but either the pollen-tubes do not reach the ovules or the ovules are themselves incapable of impregnation. To this class belong the sultana-raisins and the currants of commerce. In other varieties, on the other hand, the ovules are perfect and capable of impregnation, but the pollen grains are functionally defective ; either the pollen-tubes do not germinate on the stigma, or they are incapable of impregnating the ovules. Grapes which do not contain seeds are smaller than those which do.—(Landwirthsch Jahrb. d. Schweiz, 1898.)
Pharmaceutical Journal.

PUBLIC GARDENS REGULATION LAW, 1899.

JAMAICA—LAW 4 OF 1899.

A Law to enable Regulations to be made for the Government and Control of Public Gardens.

Be it enacted by the Governor and Legislative Council of Jamaica as follows :—

1—This Law may be cited as the "Public Gardens Regulation Law, 1899."

2—In this Law the term "Garden" shall mean and include all the land belonging to any garden now or hereafter to be established and maintained at the public expense. The term "Special Constable" shall mean any person who may be appointed a special constable of the said Gardens.

3—The Governor in Privy Council may make regulations for the government and control of a Garden, and of all persons employed therein or resorting thereto, or in any way using the same, or any part thereof, and may from time to time alter, add to, or rescind any such regulations.

4—The Director of Public Gardens and Plantations may, subject to the approval of the Governor, from time to time appoint any one employed in a Garden to be a Special Constable.

5—If any person shall do any act in contravention of any regulation made by the Governor in Privy Council under this Law, he shall, on conviction by a Court of summary jurisdiction, be liable to a penalty not exceeding five pounds, and in default of payment, to be imprisoned for a term not exceeding one month, with or without hard labour.

6—Any Special Constable wearing a uniform, cap or badge, and any person whom he may call to his assistance, may take into custody, without a warrant, any offender who in the Garden and within the view of such Special Constable, acts in contravention of any of the said regulations ; provided, that the name and residence of such offender are unknown to and cannot be ascertained by such Special Constable. If any such offender, when required by any Special Constable to give his name and address, gives a false name or a false address, he shall, on conviction by a Court of summary jurisdiction, be liable to a penalty not exceeding five pounds, and in default of payment, to be imprisoned for a term not exceeding two months, with or without hard labour.

7—When any person is convicted of an assault on any Special Constable while in the execution of his duty, such person shall, on conviction by a Court of summary jurisdiction, in the discretion of the Court, be liable, to pay a penalty not exceeding twenty pounds, and in default of payment to be imprisoned for a term not exceeding six months, with or without hard labour.

8—Every Special Constable in addition to any powers and immunities specially conferred on him by this Law, shall within the limits of a Garden, have all the powers, privileges, and immunities of a Constable belonging to the Constabulary Force.

9—Every Constable belonging to the Constabulary Force shall have the powers, privileges, and immunities of a Special Constable within a Garden.

10—A Special Constable, and all persons whom he may call to his assistance, may kill and destroy any goats, pigs, or poultry found within the limits of a Garden, and may forthwith remove and dispose of the carcases.

11—Printed copies of the regulations to be observed in pursuance of this Law by persons using a Garden, shall be put up by the Director of Public Gardens and Plantations in such Garden, in conspicuous places.

12—All regulations made by the Governor in Privy Council under this Law, and all additions to and alterations and rescissions of the same, shall be published in the Jamaica Gazette, at least two weeks before the same respectively shall be in force.

PACKING PINE APPLES.

In the Bulletin for December, 1895, attention was drawn to the advantages of exporting oranges in boxes, and to the method of packing them.

The following letter from the Pierpont Manufacturing Company deals with the subject of packing pines:—

Crescent City, Fla., 31st July, 1899.

Dear Sir:—We are in receipt of your esteemed favor of the 18th. We have never published a leaflet on the packing of pine-apples but will be pleased to give you all of the information we can in regard to the matter. For the common varieties of Pines a crate of the following dimensions is used, heads 10½ ins by 12 ins. (3). Slats 5-16 ins by 5 ins by 36 ins (8). One of the heads is placed in the middle and divides the crate into two compartments. The pines in each crate should be carefully inspected and sized by the packer, and the pines in each crate should be of uniform size, and each one should be wrapped in a good strong Manilla paper. They should be closely packed in the crate in uniform lay rs and should fill the crate about one inch above the top. The two slats which form the top of the crate should then be placed in position and by even pressuae forced down to the heads and nailed.

We also make for the large and fancy varieties of Pine-apples crates of the following dimensions. Heads 12¾ ins by 20 ins (2) Sides, 4 pieces 5-16 by 10 ins by 24 ins. Tops and bottoms, 4 pieces 5-16 ins by 10 ins by 24 ins. Tops and bottoms, 4 pieces 5-16 ins by 6 ins by 24 ins.

These Pines are of course wrapped in paper, and, in addition, the best packers use "excelsior" in the spaces around and between the fruit. It is of great importance that the fruit shouid be so packed that it cannot shake about in transportation but at the same time it should not receive the slightest bruise. Pines are frequently ruined by the careless handing of the pickers.

We should be very glad to have your people try the crates and we are confident they will find it very profitable to use them.

BANANA TRADE IN NICARAGUA.

The fruit trust, operating in the West Indies and Central America, the principal associates of which are the Boston Fruit Company, of Boston, Minor C. Keith, of Costa Rica, and others, have entered the banana fields of the Department of Zelaya (Bluefields and Rama districts), Nicaragua. Their representative, Mr. J. Lamotte Morgan, arrived at Bluefields, and, going into the heart of the banana district, secured contracts from nearly all of the larger planters. Mr. Morgan tells me that it is the purpose of his people to put on a line of steamers immediately, with the view of controlling all of the banana trade in Nicaragua. The advent of this new corporation will probably have the effect, at least for the present, of advancing the price of bananas and cheapening freights on incoming and outgoing cargoes. Mr. Morgan states that the freight and passsenger service of the new line will be in every respect superior to that of the old company, and it is probable that a small but fast steamer will be run as an auxiliary between Port Limon, Costa Rica, and San Juan del Norte, Bluefields, and Cape Gracias, Nicaragua.—*Report of United States Consul at San Juan del Norte.*

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Astrocaryum plicatum.

Castilloa elastica.

Licuala grandis.

From Mr Geo. Levy, Kingston, Jamaica.

Colorado Bottom Grass (from Texas.)

From Mr. M. H. M. Farquharson, M. Quarters, Jamaica.

Collection of Garden Seeds from Yokohama, Japan

From Botanic Garden, British Honduras.

Castilloa elastica.

From Mr. W. Jekyll, Robertsfield, Jamaica.

Zinnia (selected colours.)

PLANTS.

From Mr. W. Jekyll, Jamaica.

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[Issued 21st Sept. 1899.]

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series OCTOBER, 1899. Vol. VI Part X

TOBACCO CULTIVATION AND CURING. *

By J. C. Espin: *For many years Planter and Manufacturer in Cuba and Jamaica, and late Government Expert for Trinidad.*

PREFACE.

The clear and ordinary language adopted in writing this Guide will, it is believed, be more within the reach of those who most need it than a more elaborate and scientific phraseology. Unacquainted with science, the writer merely explains the methods of growing and curing the Tobacco plant, without entering into its Natural History, Chemistry, etc., which he deems unnecessary in a purely practical Guide like this. The writer confidently recommends the methods here explained as they are based, not on *hear say* and "*theory*," but on his own experience as a planter and manufacturer for many years. He assures those who may adopt this article as their guide that if strictly followed out, the Tobacco obtained will be of excellent quality, depending, of course, on the physical conditions of the locality where grown.

Much has been written on Tobacco, a plant which forms one of the most important factors of national wealth in the countries where it is largely and efficiently cultivated; but the works on the subject, which we have had the opportunity of reading, are either so scientific in the language and style as to be beyond the knowledge of the majority, or so diffuse and full of different and even opposite methods as to bewilder the cultivator. There are some works which give directions contrary to our experience, and others again devote more space to the botany, physical and chemical properties of the plant, than to the proper manner of growing and curing it, which latter ought to be the principal aim.

With a view to supply, as far as our knowledge allows, a thoroughly practical and reliable guide, devoid of the defects above mentioned, it was decided to prepare the present Pamphlet, not that it will be, by any means, absolutely free from errors, but it will be one which we

*Reprinted from Bulletin, No. 13, May, 1889 (now out of print.)

earnestly believe will be of real and practical assistance to the beginner, as it was written "in the field" whilst actually growing, curing and manufacturing "the weed" for the market, and therefore after every method had been thoroughly tested. Several manuscript copies of it were given to friends who desired to try the cultivation, and the results of their experiments were most successful.

As the writer is a native of Cuba and the original was written in Spanish, this is necessarily a translation, but it differs in no way from the Spanish in the arrangement, etc., the writer having carefully prepared the English as well as the Spanish, but a foreigner by birth, the writer begs the indulgence of the English-speaking readers towards the correctness or elegance of the English construction, as it is not possible for him always to frame his sentences in a style untainted by his mother tongue, and he begs to be excused for his somewhat lengthy Preface, and leave to those who might follow this *Guide* to decide how far he has succeeded in fulfilling his object.

CHAPTER I.

The Tobacco plant was not known in Europe till the discovery of America in the fifteenth century. It is said that Columbus, during his first voyage while off the coast of Cuba, sent some explorers to land and obtain information concerning the natural resources of the country, and that on their way back they, for the first time, witnessed the use of a weed, which the ingenious caprice of man has since converted into a universal luxury. They beheld several of the natives going about with firebrands in their hands and certain dried herbs which they rolled up in a leaf and lighting one end put the other in their mouths and continued inhaling and puffing out the smoke. A roll of this kind they called a "tobacco," a name since transferred to the plant of which the rolls were made.

There are many species of Tobacco, but the Cuban Tobacco plant is one known to Botanists as *Nicotiana Tabacum L.* (Cuban variety), and it is to the cultivation of this kind that we will direct our attention, it being the best Tobacco known and the only one I have cultivated.

The culture of Tobacco may be divided into five periods, viz., Nursery, Planting, After cultivation, Curing and Packing, each of which will be treated of in its respective order in the following pages; but first a few words on Climate and Soil.

Climate.

Climate is an important point in the cultivation of Tobacco, but as this cannot be modified by artificial means we should seek a district where the temperature and moisture of the locality is similar to that of Cuba, warm and humid. In a country where the seasons differ from those of that Island the periods of cultivating must be accordingly varied.

Soil.

The soil as well as the weather affects the plant to a considerable extent, for plants grown under the very same climate, but on slightly different soils, produce Tobaccos altogether distinct in quality. For instance, in Cuba two neighbouring fields, which are of course under the same climatic influences, produce Tobacco which differ in many particulars. Therefore, not only must the seasons be carefully selected, but the soil also requires to be chosen with great care, a light sandy loam, mixed with a fair proportion of vegetable debris, being preferred to any other. City lands are very unsuitable. Sandy, loose-grained soil, absolutely free from clay, will produce Tobacco of far better quality in every respect than any other kind of soil.

CHAPTER II.

CULTURAL INSTRUCTIONS.

Nursery.

In the selection of the land for making the Nursery attention must be paid to the existing conditions of the soil, and action taken in accordance therewith. We will therefore describe in a concise manner the most convenient and the best methods of preparing it.

The best soil for making the Nursery is to be found on virgin or untilled land, and it is more easily prepared. On the other hand, in cleared and cultivated land the seedlings grow better and safer, but give more trouble than in virgin soil. Old, abandoned dung-hills, the sides along old wooden fences, hog-sties and similar places, are very good soils for making Nurseries on. The Nursery may be formed into BEDS or left LEVEL land, as appears most suitable.

1. Virgin land is prepared by cutting down every tree on the portion intended for the Nursery, leaving only a certain number of small trees whose branches will afford sufficient shade to the tender plants (these will have to be removed later on). The land should be prepared long and narrow and with a North-easterly exposure. The land should now be swept with a broom made of the thin branches of trees or boughs so as to remove away all rubbish, etc., from it. The soil should be slightly hoed, and the rubbish arising from this hoeing swept and thrown away also. The soil is now ready for sowing the seed.

2. On cultivated soil it is preferable to select the plot as level as possible, but if it should be too much on the incline it must be drained by means of trenches dug *at the sides* of the Nursery to prevent rain water from running into it and carrying away the seed. This should also be done to Nurseries on newly-cleared land. The seedlings will thrive much better if it should be that the land has been used the year previous as a horse or sheep-pen, pig-sty, or dung-hill. The soil is prepared for sowing the seed just the same as on virgin soil.

3. Whether on virgin or on cultivated soil the seed may be sown in BEDS. The method of procedure is as follows:—In the month of May the soil is ploughed and immediately after, it is hoed, and then covered with a layer of vegetable rubbish, such as dry grass, etc. A few days after, when weeds have sprung up, the rubbish is burnt for the purpose of destroying all insects and grubs which infest decaying vegetable matter, and left in this state till weeds again spring up. Another layer of vegetable rubbish is put on and burnt as before, and a couple of days after this last burning the soil is hoed and the BEDS

made. They should not be above four feet in breadth and of any desired length, though for the convenience in walking through the Nursery they may be made about ten feet in length, the pathways along and across the beds being about half a yard in width. The height of the beds should not be more than ONE INCH above the level, having long wattles placed at the edges or borders of the beds sustained by pegs driven down at their extremities so as to support the earth. Corn is then planted in the middle of the beds, two grains per hole, and each hole two feet apart. Near the time of sowing the seed the soil is chopped with a cutlass without injuring the corn. Corn protects the young plant from the rays of the sun. If when the seedlings spring up the corn has EARS, they should be picked off, for they damage the seedlings.

4. A Nursery can be made so as to be at the same time a Tobacco field. It is done as follows:—The land is cleared of trees, the boughs and rubbish burnt and corn immediately planted on the land. Previous to sowing the seed, the earth is chopped and prepared as explained for beds. The seed is sown as usual, but when the plants are fit for transplanting they should be thinned out where too many grow together, and those taken out planted where there are few or none at a regular distance from each other as on a field. The Tobacco grown by this method yields more leaves than by being transplanted to a field, possessing besides the advantage of their being finer in texture and of a better colour. The after-cultivation and curing is identical to that planted otherwise. The Cuban planter calls the Tobacco so grown "*Criollo*" (Creole.) This is generally done in the Nurseries after planting in the field is finished, but is never adopted as a regular system of culture, because their is no uniformity in the quality of the leaf and the quantity produced per acre.

The Seed.

Among the most important points in Tobacco culture is the selection of the seed. It should be taken off the most healthy and perfect plants, and when properly ripe, that is, when the seed-pods blacken. The plants selected for seed should be left uncut and should not of course be "topped," and all suckers plucked off. The seedpods on their stalks should be thoroughly dried and then hung up in bundles for some length of time. It is preferable to rub out the seeds of the pods, winnow and put into well-covered demijohns, jars, or glass bottles. The seeds sown the first year ought to be imported directly from Havana as the only means of securing the Cuban kind of Tobacco. Frequent supplies of seeds should be regularly supplied as it is apt to deteriorate if grown too long in one district.

Method of Sowing the Seeds.

Care must be observed in sowing the seeds that they are evenly scattered on the soil for if they be thickly sown the young plants will spring up too closely and will be so delicate and tender that they will not stand transplanting. To secure the seeds being evenly scattered, they should be mixed with dry fine earth or sand. If when the seed is sown it does not rain the soil must be moistened with a fine-rosed watering-pot, raising the hand as high as possible so that the water may bury the seeds, being careful at the same time that the water does not wash away or throw the seeds together. The seed should be sown a month and a half before the seedlings are required for planting, for at the end of this time they should be fit for transplanting. The proper sowing season is from the middle of August up to the beginning of October, on such a day as it is likely to rain. Should it not rain the soil must be watered as before explained.

Care of the Nursery.

When the leaves of the seedlings are about the size of a sixpenny piece or a shilling piece, the corn and branches of the trees left must gradually be cut away so that the young plant may become gradually accustomed to the heat of the sun, preventing by this means the risk of their perishing when transplanted.

The Nursery must be frequently weeded to prevent exhaustion of the soil and weakening the seedlings. The weeds must be rooted up with the hands, being careful not to injure the seedlings. Whenever the Nursery is weeded or seedlings have been removed for transplantation fresh seeds should be sown in order to always have a supply of seedlings. According as the shade is taken away the supply of water to the seedling should be slightly watered with lime water, SUFFICIENTLY DILUTED SO AS NOT TO BURN THE SEEDLINGS, and the larger grubs destroyed every morning by hand. The seedlings, to be fit for transplanting, must have six leaves and these leaves of the size of a *half dollar* piece. Before rooting up the seedlings for transplanting, if no rain occurs, the ground should be properly wetted to facilitate their extraction with all their roots. They should be slightly shaken to remove some of the earth attached to their roots. In taking out seedlings for transplanting the fingers should be carefully put down to the root in order to avoid breaking the stalk.

CHAPTER III.

PLANTING AND PREPARATION OF THE LAND FOR PLANTING.

The proper month for planting is September, but if inundation of the land be expected, planting should commence in November.

We have noticed in various works on Tobacco Culture that artificial manures are highly recommended. We believe that by this means the Tobacco can be made to yield larger leaves, according to the quality of the artificial manure, but it can never be obtained possessing the aroma and other qualities essential to Smoking Tobacco. The only application admissible is that of lime, which SHOULD ONLY BE USED when the soil is very much exhausted. In the Island of Cuba, the Smoking Tobacco produced is doubtless without a rival in the world and there manuring with artificial manures is never practised, as the experience of the *Vuelta-abajo* planters a few years since proves clearly the disadvantages attending such usage. It should be remarked that the manure used was Peruvian Guano. The crop obtained during that short period suffered greatly in its quantity and quality, so much so that the planters of *Vuelta-abajo* have given up altogether manuring with such foreign matters. The best method of preparing the soil for planting is the following, which is that employed in Cuba, the manure used being purely vegetable, with the exception indicated, viz., lime.

No other animals but hogs should be allowed to feed on the land intended for planting from the month of May. Weeds and shrubs are allowed to grow freely till July, when it is ploughed lengthwise and crosswise with all the bush. Fifteen or twenty days after, about which time the weeds, etc., ought to be thorougly rotten, the land should be frequently ploughed, with a few days interval between each ploughing, if the soil be not too wet, so that by the month of September it shall have been ploughed about eight or ten times, and the whole of the vegetable rubbish be perfectly rotten. All the sticks, roots of small trees which have not rotted should be picked up and thrown away and the land raked if not wet. It is convenient to have hogs feeding on the land during this time, as they help to mix up the soil. It is unnecessary to say that when about to begin planting they should be kept out of the field, for they would destroy the Tobacco plants. When there is no fear of floods, and planting time has arrived, if there be any weeds growing on the land, it should be ploughed, attaching this time to the plough a log, about four feet in length, in such a manner as to break up the lumps of earth and at the same time collect the rubbish.

To Plant.—The land is ploughed in a direction from North to South, leaving at least a yard between each furrow, but if the soil be very fertile four feet should be left. The seedlings, after being uprooted as before mentioned, are distributed along the furrows at a distance of eighteen inches from each other. Planting should be commenced *not earlier than three* o'clock in the afternoon on sunny days, but on a cloudy light showery day, planting may be carried on the whole day. Planting may also be begun before daybreak, so that the planting be finished by eight o'clock in the morning. The seedling is held with the left hand and the earth taken out of the hole with the right, and placing the seedling into the hole, throw some earth on the roots and slightly press it down, being very careful not to injure the tender stem of the seedling, and then fill up the hole with the loose soil. The depth at which the seedlings should be placed in the holes depends on its size, for which reason no exact rule can be given, but generally speaking, in ordinary size seedling the root and a small portion of the stem only should be buried. Tall seedlings can be placed a few inches deeper, according to the size, but in no case should any seedlings be buried so deeply that the lower leaves touch the earth. One should also be careful not to ALLOW ANY EARTH TO FALL ON THE TOP OF THE YOUNG PLANT. Wet weather is most suitable for planting, and if the soil be very wet, the seedlings should be planted lightly, that is avoiding all pressure on their roots. If the planting be done in furrows, the seedlings should be placed on that side of the furrow called by the *vegueros* "*oreja*," which is the side on the *west*.

Seedlings from a distance.—When on any account planting has to be done with seedlings brought from a far distance, the greatest care should be observed in transporting and preserving them, for otherwise many will die when transplanted. The best manner is to take out the seedlings early in the morning and place them on the river bank (if there be any near) and under the shade of a tree so as to keep them altogether out of reach of the rays of the sun. After six in the evening of the same day or before dawn of the next they should be put up in small bundles, and before starting for their destination they should be sprinkled with cold water. As soon as they arrive at their destination they should be placed in the cool, under the shade of a tree. Every bundle should be undone and the seedlings separated widely apart and water again sprinkled on all so that when planting time arrives they are quite cool. If planted whilst warm very few seedlings will live.

If there is no rain when planting begins and the soil is very dry, sufficient water must be poured into each hole, and planting ought not to be performed till the following day, when the soil is moist. The newly-planted seedlings should be watered twice daily, before sun-rise and after sunset, for two or more days successively until it is seen that they have taken root. After the young plants are transplanted in the field those which have died must be replaced, and the operation repeated if necessary to insure a good crop.

Planting on Virgin Land.—For planting no trees or shade of any kind should be used, and therefore every one should be taken away on the land intended for a Tobacco field. Newly cleared land cannot be ploughed on account of the stumps and roots of the trees cut down. The roots, could of course, be dug out, but the expense attending this operation would be great. They may, however, be gradually dug out until in a few years none be left on the land.

When the soil suited for planting has been newly cleared and cannot for the reasons given be ploughed, HOLING must be adopted, which is done by means of a pointed pole or an iron implement made in the shape of a lance. After driving the instrument used with some force into the soil, turn it in several directions so as to break up the earth thoroughly, keeping a distance of EIGHTEEN INCHES from each hole and three feet from each row of holes. To give a regular and symmetrical appearance to the field we use a long, strong, single cord with pieces of coloured rags, or any other material fastened in at the distance apart which has been mentioned, namely, eighteen inches. The cord is kept stretched out by means of a stake driven in the ground at each end of the cord. In forming the rows of holes with this line the stakes tied at the end of it are placed at a distance of three feet from the preceding row.

CHAPTER IV.

AFTER CULTIVATION.

About eight or ten days after planting, if the soil is not too wet, the furrows are closed up by hoeing up the earth carefully around the plants and again performing the same operation at intervals of about fifteen days. This operation should be done if it does not rain. As a general rule it may be said that this operation of hoeing, or as it is commonly called, "MOULDING" should be performed as often as necessary to keep the soil loose and free from weeds. Moulding exerts a beneficial effect on Tobacco, aiding its growth and proper development nearly the same as rain does.

When the plants are still young two little narrow leaves (called "*barbas*" in Cuba) appear at the junction of the stem with the two lowest leaves, and they must be picked off as soon as they become visible, for if left they develop into long, narrow leaves, which greatly injure the plant. A process called "pruning" consists in taking off the two lower leaves of each plant as soon as they ripen. Care must be taken not to strip a piece of the bark of the stalk when removing them. When cured they produce a fairly good Smoking Tobacco. Particular care must at all times be taken to keep the plants free from grubs or caterpillars, and for this purpose hand-picking should be done at least twice daily, otherwise many of the best leaves will be perforated and rendered useless for wrapping purposes.

TOPPING (desbotonar).—The Tobacco plant grows more or less high, according to the fertility of the soil and the state of the weather during its growth. "TOPPING" is an operation which consists in plucking off the shoot button or bud (which encloses the flower) at the TOP of the plant. It should be taken off with the finger and thumb as being the safest way. The time when it should be plucked off is when the two little leaves which enclose the bud open out. Not more than *twelve leaves* should be allowed to remain *on each plant*, and the surplus leaves should be taken off along with the bud from the top of the plant. One must be very careful not to allow too much time to elapse and the flower to make its appearance, for then the leaves of the plants will be small in size and of inferior quality. Eight days, or thereabout, after the "button" or bud has been removed, the suckers begin to appear, every one of which should be removed as soon as seen, and the operation must be performed as frequently as necessary in order that the plants may grow strong and vigorous. This operation is called ("deshijaar") SUCKERING, the suckers being all those leaves which spring up at the junction of the stem and the leaves of the plant, as well as those that grow from the root and lower part of the stem. After the third suckering the plants will be fit for cutting, but this should never be done until the leaves are matured so as to obtain the Tobacco of prime colour, being careful at the same time to avoid their being too ripe, if this should happen they get discoloured, or dappled, thus losing in quality and producing much "FUNK" (that is, almost valueless Tobacco.) The leaf is MATURED when on its surface are formed ELEVATION BLISTERS, called by Cuban planters "*vejígar*" BLISTERING, and when the tops of the leaves, held in the hand, sound as if they cracked. It is then that the leaf is fully developed. When the plant has been cut, suckers spring up. The leaves developed from these are called "CAPADURAS" or "CAPONES" and to obtain a good Tobacco from them NOT more than TWO SUCKERS must be allowed to grow from each parent-root, according to its strength, and leaving only those which sprung up from *below the surface* of the *earth* and furthest from the cut stalk. The suckers or "ratoons" should be carefully weeded, avoiding throwing the earth on the cut stem or on the suckers, and moulding should be performed as frequently as the weather and the vigour of the parent-root requires it.

The after-cultivation and curing of these suckers is identical with that of the first crop of Tobacco. "Ratoons" or suckers are developed as many as five times in success, provided the weather be rainy and the number of suckers left be proportionate to the vigour of the parent-root. The Tobacco obtained each time will be of good size and quality, and sometimes, in every respect, superior to the first cut.

CHAPTER V.

HARVESTING.

When the plant is properly ripe and fit for harvesting, cutting must not be commenced until the dew has disappeared and the leaves are thoroughly dry, that is, after ten o'clock in the morning, and continued till about three o'clock in the afternoon. The best knife for use is the hook-nosed pruning knife.

The leaves are best cut in pairs "*mancuernas*," commencing from above and proceeding downwards to a level with the earth, in preference to the method of cutting down the whole plant. The "mancuernas" should be placed on poles (of convenient length and thickness, first stripped of their bark) as quickly as possible to prevent the sun from burning the leaves while on the ground, for if this should happen the Tobacco would be greatly damaged. Each "CORTADOR" OR CUTTER should have as many COLLECTORS as may be found necessary in order that the Tobacco cut may be on the ground the least possible time. The CUTTERS should throw the "CAPA" or *wrappers* (the best Tobacco) on the space or walk between the rows of plants which they may be following and the "TRIPA" or *fillers* in the next, thus keeping the two classes separate, for a like reason each pole should be filled with the same class, and when full of the Tobacco should be kept separate in the House. When on the poles the Tobacco should be kept for a while in the sun to wither and then taken to the House ; for while it is beneficial to dry in the sun when on the poles, it is destructive to the quality of the leaves if it is dried by the sun while lying on the ground.

If it be decided to cut the plant whole, as is sometimes practised, cutting always commencing at the proper time of the day, each CARRIER should be provided with bands eighteen inches in width and of any desired length. With these bands the cut plants are carefully tied into BUNDLES or "MATULES," so as not to break the leaves, and should be of a size which the men employed as carriers can readily carry. Instead of bands, bags may be used to carry the cut Tobacco to the Tobacco-house. Every endeavour ought to be used not to allow the Tobacco to remain on the ground longer than is absolutely necessary to pick it up, to avoid the inevitable burning which will occur if left long on the ground. The bundles or bag-fulls may be carried to the House either on head, small carts, or any other manner.

The manner of curing the Tobacco cut in these two ways will be described in another Chapter.

Before detailing the CURING, which has to be done in the HOUSE, it is convenient to give a brief sketch of a TOBACCO-HOUSE, and at the same time of the "PILON" or "PRENSA," the "BULKING-BOX" or "PRESS."

CHAPTER VI.

CURING.

Tobacco-house and Press.

It is understood that the House must be finished by the time cutting is to commence. The " Pilon " or Press is to be made when the Tobacco is dry on the poles and nearly ready for bulking or fermenting in the Press.

The Tobacco-House.

The house should run from North to South (one end looking North and the other South.) Of whatever length it is built, take half the length, less one part for the breadth, and with these dimensions a well-shaped house will be constructed. Two-thirds the breadth is taken for the length of the rafters, and if the House be thatched, one foot more should be added to the length, so as to have a greater inclination of the roof to throw off the rain water rapidly. For example, a house of 20 yards in length (the posts supporting the roof being 4 yards high), the breadth will be 9 yards and the length of the rafters 6 yards : half of 20 = 10, less 1 yard = 9 yards, and two-thirds of 9 yards = 6 yards. A house of these dimensions is to be divided into sections, " aposentos " allowing a space of 27 inches between each section so that a man may easily get in to put up or bring down the poles. The same space left between each section (27 inches) should be left at both ends of the house to afford the same facility. A passage one yard in width should be left, dividing the house lengthwise into halves, and each half will have by this passage four sections on each side, thus making in all eight sections, and each of these sections will have *four* square yards. The apartments are framed by posts.

The poles for a house of the foregoing dimensions must be at least thirteen feet in length.

The poles filled with the Tobacco are placed on what are called in Cuba "Barrederas," which are stout, strong rails, of the length of the sections, nailed horizontally on posts, which form the sections one above the other and at a convenient distance, namely, one yard, so that the tip of the leaves of the upper poles do not touch the butt ends of the lower. The space above the tie-beam is divided in the same manner as was done below it. To be able to do the division above as below, it is necessary to put two *tie-beams* and two *cross beams* or *cross pieces* to form each space, and by these the spaces separating each apartment below will be continued above. We would advise the beginner to see a house built by an Expert as the best means of becoming acquainted with its construction.

When the house is shingled or thatched, a kind of window or ventilator should be left at the top of each gable so that the air may refresh the Tobacco which is at the upper part of the house. In a foggy locality the sides of the house should also be covered with thatch. Several doors should be made so that after the fog has disappeared they may be opened and air allowed to circulate freely through the house. The sides of the house should be wattled.

The Press or "Pilon."

The Press is made in one of the sections of the Tobacco-house, and of the required size. The section in which the Press is constructed must be well closed to exclude the outer air. Long logs are placed parallel to, a little apart from, each other, and on these a kind of floor is made of either board or wattles, at a height of about one foot. The floor so formed is covered with thatch or dry plantain leaves, and the Tobacco can now be placed in it.

Conditioning or Fermentation.

1. Mancuernas, or pairs of leaves.

As soon as the poles are carried to the House filled with the Tobacco, cut and arranged as before described, they are placed on the horizontal rails or "Barrederas" closely packed together. They are left in this state for three days, if it be in the months of October, November or December, but in any of the following months they must be kept so packed for not more than one or two days.

When the leaves become *yellow* they are said *to be ripe* and then the poles *must be* separated *a foot* from each other.

There are two methods of treating the Tobacco when in this condition :—

Method A.—Allow the poles to remain the foot apart till the stalks and the *midribs* or *middle veins* of the leaves get dry, then carry up the poles to the *upper "barrederas"* and again pack closely, *if there be want of room*; but if room be not needed, then they may be put a foot apart.

Method B.—Separate the leaves which may be sticking together and place the poles filled with the Tobacco out in the sun for three days, being very careful *not to allow the rain to wet the Tobacco*, and replace them in the house every day at about 3 or 4 o'clock in the afternoon to avoid the dew. Horizontal bars of a kind similar to those used in a gymnasium are made on which to place the poles filled with the Tobacco. At the end of three days the poles are placed on the upper "barrederas" and there allowed to dry properly. The poles may be closely packed if room be needed, *but this should never be done unless the "middle vein" or midrib be thoroughly dry.*

I prefer this method to the former, because there is no fear of "*Sahorno*" (putrid fermentation), and the Tobacco acquires a better colour.

Considering the advantages of this method it is almost superfluous to advise the adoption of it in preference to the former.

2. *When the method is adopted of cutting the whole Plant.*—The bundles or "matules," when brought in from the field, are unloaded at the House, and should be opened out at once and the Tobacco scattered about as widely as possible to allow it to cool to prevent its sweating. When cool and there is no risk of sweating, the stalks of two plants are tied together at the root end with any kind of string, fastening four stems to one string, which should be just long enough to allow the Tobacco to be hung up on the pole, like the "mancuernas." In case the Tobacco plants be rather large, instead of two, only one should be tied at each end. The string should be tied below the upper leaf, on

the butt of the stalk, so as to prevent their falling down. One must be very careful to see that the labourers tying do not put more than four small plants or two large ones in each string.

After being placed on the poles the Tobacco cut in this manner is treated just the same as that cut in pairs of leaves, or "mancuernas." Although we have attempted here to describe one of the most important operations, yet it is a fact that scarcely any one can become efficient in the practical part unless he assists in carrying out the work for some time under the instruction of an Expert.

Method of Bulking in Press.

(Empilonar.)

Method 1.—At the beginning of Spring, when the Tobacco becomes soft and pliant on account of the humidity of the weather, the poles are taken down—the time for which must also be regulated by the condition of the leaf—the leaves are stripped off, or removed from the stalks and made into bundles or "matules," 18 inches in length by 18 inches in depth, the breadth being the length of the leaves. The leaves are placed with all their butt ends together and properly tied to form the "matul." The "matules" are more easily formed by means of two pairs of short stakes driven in the ground in the House, at the proper distance, viz., 18 inches, strings to be used for tying up the bundles are passed between each pair of stakes. The stakes in each pair being driven apart at a distance according to the length of the leaves. After the bundles are made they are put in the *pilon* or press, tightly packed together, covering them up with thatch or dried plantain leaves, putting on top of all a few blocks of wood, or any other weight to press the Tobacco slightly. It should now be allowed to remain in the press for *at least eight days* before commencing the SORTING of the leaves, but it is preferable to allow the Tobacco to remain in the press for about *thirty days or more*, as the Tobacco is benefited by the press, and there is no risk in its remaining here for any length of time, provided *the leaves as well as their mid ribs be thoroughly dry* when put into the press. The *weights should be removed after* thirty days.

When about to SORT the leaves as many bundles as can be worked up in a day are taken out of the press, opened out, and the tips and the butt ends of the leaves are moistened with a wet sponge. The bundles are again made up and placed into the press, covering them as before. *Twenty-four hours after*, when the leaves will have just enough moisture to be handled without breaking, the bundles are taken out as fast as the leaves are SORTED.

SORTING, classification or choosing of the leaves, is done to separate the different kinds of leaves according to their qualities, etc. Each planter may classify or sort his tobacco as he thinks best, but the simplest classification is: into *first class* CAPA (wrapper); *second class* CAPA, *first class tripa* (filler); *second class tripa* and *third class tripa* the remainder being " FUNK" or inferior Tobacco. The leaves which have been SORTED should be immediately, or rather simultaneously, made into *hands* or " *manillas*." A " *hand*", " *gavilla*" or " *manilla*" is made by placing the butt ends of the leaves evenly together until the hand is full of leaves, selecting a leaf which is not very sound, twist it like a rope, and wrap it around the butt ends of the leaves so as to tie them properly together, then divide the whole bunch of leaves with the hand and draw the tying-leaf through and close the bunch, thus securing the leaves, afterwards place the HANDS in the press again.

I am greatly in favour of the foregoing method of bulking on account of the many advantages it possesses over the following, which is by some adopted as the usual method of curing at this stage:—

Method 2.—If for want of room in the House or on account of very wet weather the Tobacco becomes mouldy and there be fear of losing it, it should be put into the press at once. In such a case it should remain in the press not longer than is absolutely necessary for stripping off the stalks and sorting the leaves, *never beyond eight days*, as the dampness of the stalks spoils the leaves. The after-treatment is the same as the first method.

CHAPTER VII.

PACKING AND BALING.

As soon as it is desired to pack the Tobacco the *wash* is prepared with which to sprinkle it The "manilla" is held in the left hand, and with the right the wash (betun) is sprinkled on evenly, and the hand of Tobacco well shaken to remove drops of wash on the leaves: they are then put aside in a heap and allowed to remain so for a couple of hours, or until the leaves be sufficiently pliant and soft to permit handling without breaking, and they are again put back into the press. After remaining in the press for about four or six days the *hands* or *manillas* are taken out and shaken and made into *bunches* of three or four *hands* each, called "*manojos*," and then put into bales. When *baled*, the Tobacco undergoes its last fermentation, being ready at the same time for the market, and the curing of the crop is at an end. The *yaguas* which are strips of palm bark used in baling, must be properly dry and pliant and evenly flattened by pressure. Each bale should hold eighty-one *manojos*. The bales are made in a wooden frame, which is constructed on different patterns. It is useless to describe the process, as no description whatever can teach the manner of making a bale. It must be learnt by practice as many of the other processes also must be. After the bales are made, they should be put out in the sun till the *yaguas* and ropes with which the bales are tied be thoroughly dry. After drying they should be stored away in a suitable dry place having a wooden floor.

When more than three bales are put together, one on the other, the pressure of such a weight takes away the softness and elasticity of the leaf, but on the other hand renders it a better Smoking Tobacco. Every one, therefore is at liberty in this particular to use his discretion to suit his interest.

Besides *yaguas* cases are used for packing Tobacco, those made of cedar-boards being preferable, but packing in *yaguas* or baling is by far the best. Such is the prevailing opinion amongst planters in Cuba that it is a common saying there, that "God made the *Yagua* for the Tobacco" (Dios hizo la yagua par el tabaco.)

APPENDIX.

(*a*) A Nursery 110 yards long and 22 yards wide will grow a sufficient number of healthy seedlings to plant a field of 12 acres.

(*b*) For a Nursery of the foregoing size about two pounds of good, healthy seed should be sown, and if these do not grow, fresh seed must be sown again.

(*c*) On an acre of land 10,000 plants can be cultivated, but the exact number is 9,680 plants. One man should not attend to more than the number of plants which can be grown on an acre of land.

(*d*) The number of plants that will give a quintal (100 lbs) of Tobacco cannot be exactly estimated, for it depends on the state of the weather and the fertility of the soil. But in general terms it may be said that if the soil is good and the weather is favourable 1,000 or 1,500 plants will give a quintal.

(*e*) Should it rain whilst cutting is going on, the operation must be discontinued until the weather is again fine—as the leaf must on no account be cut while wet.

Tobacco should not be cut during rainy weather, as at that time the suckers are growing freely and it would take away the quality of the leaf, which is in measure regained by succeeding dry weather.

Betun or Wash.

Take 5lbs of old, strong Tobacco stalks and put into 2 or 2½ gallons of water, and boil sufficiently to reduce the quantity of water to about one third so as to obtain a strong well boiled infusion. The vessel in which this infusion is made should be new and perfectly free from grease. Take a clean barrel,fill with clear water, and put into it a sufficient quantity of Tobacco-stalks, three quarters of which should be of the former crop and one fourth of the last. Allow it to ferment for four days, and on the fifth day, when it should be used, add as much of the infusion to this as will darken it, and it may now be used.

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Plants.

From Lady Blake—Hong Kong,

Renanthera coccinea.

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Epidendrum Rodigesianum.
Cattleya giganteum.
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Grias zamorana.
Musa sp. (Congo Banana)
Haemanthus Lindeni.
Vanilla cuttings.
Colombian Pine-apple.

From Royal Gardens, Kew.

Acalypha hispida.
Anodendron paniculatum.
Aristolochia saccata.
Bignoniad (Saharanpur)
Bixa Orellana, var. alba
Carica Chongona.
Croton Laingii.
Ehretia acuminata.
Evodia elegans
Fagraea auriculata.
Ficus Canoni.
" damaraensis
Flemingia semialata.
Garcinia ternophylla.
Hibiscus collinus.
Irvingia Barteri.
Lucuma sericea.
Nepenthes coccinea.
" cylindrica.
" lawrenciana.
" Morganæ.
" rufescens.
" Williamsii.
Owenia cepiodora.
Peltophorum africanum.
Randia chartacea.
Rhus rhodanthina.
Martinezia erosa
Crinum sp.
Solanum Wendlandii.
Strobilanthes gossypinus.
Strophanthus dichotomus.
Strychnos potatorum.
Toxicodendron capense
Uvaria membranacea.
Alocasia Curtisii.
" longiloba.
" Thibautiana.
" Watsoni
" zebrina.
Amomum Daniellii.
" echinatum.
Andropogon Nardus.
" Schœnanthus.
Areca Aliciæ.
Asplenium nidus, var. multilobatum
Bentinckia nicobarica.
Caryota mitis.
Chamærops humilis, var dactylocarpa.
Corypha sp. (Bombay.)
Curcuma sp. (Gamble.)
Erythea armata.
Musa Livingstoneana.
Pandanus sp. (Sander.)
Ptychoraphis augusta.
Raphia Hookeri.
Sagus lævis.
Veitchia Johannis.

SEEDS.

From Lady Blake—Hong Kong.

Quercus sp. (China)

From Acclimatisation Soc. Gards. Queensland.

Aralia Veitchii
Brassaria actinophylla
Castanospernum australe
Sterculia acerifolia
,, lurida

From Mons. Chas. Patin

Colombian Palm.

From Mr. W. Cradwick.

Physalis Francheti

From Botanic Gardens, Penang.

Durio zibethinus.

From Botanic Gardens, Bangalore.

Shorea Talura.

From R. Botanic Garden, Trinidad,

Syagrus amara.

[Issued 26th October, 1899.

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series | NOVEMBER, 1899 | Vol. V / Part XI

DISEASES OF THE VINE.

Diseases of the Vine may be conveniently classed into :—

(1) Those directly traceable to the action of parasitic fungi. *

(2) Those directly traceable to the action of injurious insects.

(3) Those for which neither fungi nor insects offer a sufficient explanation.

The first and second class of diseases we propose on this occasion to pass over.

The unexplained diseases of the Vine are important enough to merit special notice, as they have been the subject of many investigations. As a general conclusion of the perusal of some of the more important results obtained, we are led to regard most of the unexplained diseases as "physiological," that is, they are due to defects in cultivation, to adverse climatic or other conditions, and to the use of unsuitable varieties of the Vine. Fungi or insects may appear along with diseases of this kind, but they come later and only because the plants are already weakly. One might even go further, and say that most of the fungus-diseases of the Vine are really started by defects in cultivation ; the Vines are weakened, the fungi come and complete the mischief.

The methods employed to produce a large supply of fruit of high quality may easily result in conditions favourable to the development of disease.

Shanking.

"Shanking" is a trouble which accompanies Grape-growing all over the world. The Grapes as they approach maturity fall off the bunch, breaking away where the stalk joins the fruit ; or they may simply shrivel up and remain attached. The Grapes to go first are those towards the lower end of a buuch, or those on the shoulders. The number may vary from one to many, and the trouble may be apparent all over the Vine or only on parts of it. The foliage is at the same

* See Bulletin, 1897, page 37.

time more or less affected ; generally the leaves turn brown and curl in places, or all over. Insects or fungi have never been proved to be the real cause of the trouble, the chief reason is to be sought in the condition of the Vine itself. No doubt, the disease is not always due to the same cause. Over-cropping frequently leads to "shanking," so, also, does too early ripening of the wood. Both of these conditions result in a drain on the food-supplies which the plant has to provide, and will lead to starvation of maturing fruit. Excessive moisture and heat produce conditions favourable to "shanking" if they cause undue forcing of the Vines ; on the other hand, any check due to sudden dryness or cooling will be first seen in the fruit bunches.

From what we can learn, the soil itself has no direct effect, but a weak root-system due to defects in the air, heat, texture, or moisture of the soil, will not be in a condition to supply the necessary water and food to a fruiting Vine. Excess of nitrogenous substances in the Vine due to over-manuring or to over-cultivation of a rich outside border, easily aggravate "shanking." It is said by good authorities that "shanking" occurs when the Vine is deficient in potash, and they recommend this to be supplied in some form as a manure to the soil. Dropping of the Grapes is also a common result of any disease of the foliage, stems, or roots of the Vine.

A disease on out-door Vines, recently described by French investigators under the name "maladie pectique," seems to us very like a form of "shanking." The leaves in the lower parts of the Vines show discoloured patches, which become wine-red in dark-fruited varieties, or yellowish in white-fruited. This is followed by withering, curling, and drying up of the leaves ; as this goes on, the blade breaks away at the top of the leaf-stalk. Flowers and young fruit behave in the same way, shrivel, and drop from their stalk. The disease was never seen to cause total loss of a Vine, as it never seemed to spread beyond the lower branches. No parasites of any kind could be found. The conditions which lead to the disease are sudden changes of climate affecting the soil. The soils most liable to it are light, and of a pebbly or slatey nature. The vine-yards, where it showed most, were subjected to severe drought in 1893, followed early in 1894 by continual rain and a marked fall in temperature of both air and soil. These facts support the view that "shanking" on our indoor Vines is not caused by either fungus or insect, but by conditions arising from soil or climate.

Blanching.

"Chlorose" or "blanching," is a disease which has caused much trouble in the south of France. The Vine-leaves lose their deep green shade, then become yellow or completely blanched. The loss of colour generally begins near the margin of the leaf, and spreads inwards between the veins ; the affected parts may or may not become withered. Young green twigs sicken like the leaves, and may dry up. The woody branches are retarded in growth, and new leaves given off remain small and blanched. As the malady almost always develops before the flowering period, both flowers and young fruit are stunted and discoloured, and probably dry up or fall off. French experience shows that chlorose is worst on very limey calcareous soils. On such soils the Vines sicken in the first year, and gradually lose their vigour ; death may ensue, but frequently the Vines recover gradually each year, and the chlorose may disappear. Where the soil is less calcareous, the disease is less intense. On clay or siliceous soils, chlorose only appears in some cold wet spring, when yellow patches may appear on the leaves, but growth is hardly interrupted, and, if the weather improves, all comes well again. The primary cause of chlorose is the presence of too much carbonate of lime (limestone or chalk) in the soil, and its action is assisted by any condition of the soil which increases the amount of soluble lime. This is further assisted by want of water, light, heat, or air, which defects tend to weaken the general health of the Vines. The disease is diminished by any mode of cultivation which promotes good drainage in the soil, or which strengthens the growth of the Vine. Above all, applications of sulphate of iron (green vitriol) to the soil round the roots of the Vine do most to cure chlorose ; this is the case, even though the soil, naturally contains iron. As many of the great Vine-growing districts of France have a calcareous soil, chlorose is a serious disease, and, during the Phylloxera epidemic, it assisted in almost exterminating the Vine, and in ruining many a grower. During recent years, however, great progress has been made in checking both Phylloxera and chlorose. This is done by selecting Vines produced by grafting the European Vine (Vitis vinifera) on stocks of American Vines. We cannot discuss the subject fully in this paper. Briefly, however, certain varieties of Vitis vinifera grow fairly well on calcareous soils (e.g., Folle-Blanche, Pinot, Colombeau, etc.) ; these are grafted on stocks of the American Vitis Berlandieri, which is found wild only on calcareous soils. The Vinifera-Berlandieri hybrids have been used to re-stock hundreds of acres in France, and the Grapes produced are not inferior in quality, while the Vines are much more resistant to disease. This is an important chapter in the history of Vine cultivation, and illustrates the great value of resistant varieties or hybrids as a means of combating diseases of plants. We have urged this before, and believe that more substantial progress will be made against diseases of plants by means of hardy varieties than by any methods of spraying or sulphuring sickly plants. (Wm. G. Smith in *Gardener's Chronicle.*)

EUCALYPTI IN THE TRANSVAAL.

According to an Indian contemporary, extensive areas of land are being planted, in the neighbourhood of Johannesburg and Pretoria, with eucalyptus trees. The gold-mining companies, it is said, have been for some time getting hard up for timber for their mines, and as the Australian gums grow so rapidly they have been planted in preference to other trees. One plantation of 1,000 acres planted twelve years ago, had produced trees ranging up to 40 feet in height, supplying good pit-wood. The predominant species planted was blue gum (*E. Globulus*). *E. viminalis* ranking next in value. *E. robusta*, *E. resinifera and E. diversicolor* have also been tried. The plantations referred to are all situated on elevations varying from 4,500 feet to 6,000 feet above sea-level. The soil is generally a poor red loam, much impregnated with iron.—*Chemist and Druggist.*

EFFECT OF TILLAGE ON SOIL-MOISTURE.

In two previous Bulletins * it has been shown of what very great importance is the proper tilling of the soil. Cultivation not only makes it easier for the roots to spread all round and get more food, but really increases the amount of food in the soil.

But tillage is also most useful in another way, especially in districts subject to drought: it prevents waste of water from the soil, and so helps to store up moisture for the use of plants during dry weather.

This is not merely opinion, but has been carefully tested and proved by scientific methods at many Experiment Stations. An instance may be given from work carried on in Michigan. †

Corn was grown on two series of four plots each. The soil of the first series was a sandy loam somewhat gravelly below a depth of one foot, while the soil of the second series was not quite so sandy at the surface, and contained more clay below the first foot. In each series plot one was not cultivated ; plots 2 and 3 were given three cultivations with a weeder, seven with a Gale cultivator, and seven with a Planet Jr. cultivator ; and plot 4 was cultivated five times with a Gale cultivator. The average percentage of moisture at different depths, and the yields of the different plots are given in the following table:—

	Cultivation.	Yield of Corn.		Moisture Content of Soil.			
		Green Corn.	Dry Matter.	First Foot.	Second Foot.	Third Foot.	Average for 3 feet
First Series		*Pounds.*	*Pounds.*	Per cent	Per cent.	Per cent.	Per cent
Plot 1	None	2,180	723	6.16	4.70	6.66	5.84
Plot 2	Frequent, 3 in. deep	13,207	5,532	7.15	5.72	8.23	7.03
Plot 3	Frequent, 5 in deep	12,687	4,799	7.45	5.98	7.83	7.09
Plot 4	Ordinary, 5 in. deep	12,167	4,380	6.28	5.64	8.44	6.79
Second Series.							
Plot 1	None	1,848	620	7.16	6.36	11.73	8.42
Plot 2	Frequent. 3 in. deep	12,258	4,790	8.41	6.81	12.74	9.35
Plot 3	Frequent, 5 in. deep	12,700	4,728	8.75	7.36	12.10	9.40
Plot 4	Ordinary, 5 in. deep	10,514	3,849	7.74	8.26	11.41	9.14

This table shows very clearly that there is much more water in the soil in the plots that have been tilled than in those that have had no cultivation.

The weight of corn harvested fromtthe cultivated plots was 6 or 7 times as much as in the untilled plots.

The Agricultural College in Kansas ‡ has also been experimenting on the subject of soil moisture. An experiment reported in Bulletin No. 68 showed that a dry soil mulch is quite as effective in conserving soil moisture as a hay or straw mulch, and that by its application immediately after a rain, a very considerable amount of moisture can be held

* Bulletins, 1895 Aug., page 162 ; 1896 Nov. page 241.
† Michigan Sta. Bull. 164, pp. 79-96.
‡ Kansas State Agri. Coll., Bull. 89, pp. 12-22

in the soil for the use of growing plants during a drought, or to germinate seed that might be planted. During the summer of 1897 this experiment was repeated in a modified form. Four small plots were laid off in a field where conditions were as nearly uniform as possible. A mulch of green grass about four inches deep was placed upon No. 1; No. 2 was left untreated; No. 3 was cultivated about 4 inches deep, with a hoe; and No. 4 was raked about 1 inch deep with a garden rake. The treatment given plots 3 and 4 was repeated after every rain as soon as the crust became dry enough to work without puddling. The percentages of moisture present at certain dates were as in the following table:

Number and Treatment.	July 10	Aug. 13	Aug. 14	Sept. 1	Sept. 3	Oct. 15
No. 1—Mulched ..	27.7	24.7	29.1	23.4	20.9	12.9
No. 2—Untreated ..	27.1	19.3	23.3	18.0	17.0	12.6
No. 3—Deep tilled ..	27.9	20.2	23.9	20.8	20.9	17.5
No. 4—Shallow tilled ..	27.4	19.6	23.7	20.0	20.0	18.0

It will be seen that at the beginning of the experiment, July 10, the plots were of practically the same moisture content, but by August 13 there was a decided advantage in favour of the mulched plot. A rainfall of 0.65 in. occurred on that date after the sampling, but from that date until October 17 was a period of almost unbroken drought. The change in the moisture-content of the plots during this period is of special interest and value.

On August 14 the mulched plot contained about 5½ per cent more moisture than the others, and it continued to maintain about this advantage over the untreated plot up to September 1. The cultivated plots lost water at a much slower rate than the mulched plot, so that by September 3, the three had practically the same amount. From that date on, the tilled plots showed an increasing advantage over the other plots. On October 15 the mulched plot was as dry as the untreated one, while the tilled plots contained 5 per cent more than the others. The dry soil-covering was thus very effective throughout the entire period in conserving the moisture. The untreated plot was dry to the depth of the sample, one foot, while the tilled plots were in excellent condition for seeding below the soil mulch. The soil mulch was very dry,and as it was a part of the sample in cutting a core to the depth of a foot, the part of the sample below the dry covering was more moist than the figures would suggest if compared with determinations of water in soil in the ordinary state. The soil from the lower 8 inches was moist enough to stick together when compressed with the hand,

Experiments were also carried out on a large scale in the field, and the effectiveness of simple ploughing as a means of conserving soil moisture was clearly demonstrated. It is not necessary to go to large additional expense in both tools and labour in order to preserve the moisture, but it is necessary to do the ploughing promptly, while the moisture is still in the soil. Another experiment was the following :

One of the * Station fields which contained in round numbers 26 per cent of water in the first foot of soil, on July 7, 1898, had one portion ploughed, another disk-harrowed and a portion left untreated. The ensuing dry weather in the course of four weeks, notwithstanding several light rains, reduced the moisture of the untreated part to 15 per cent and that of the disked land to 18 per cent, the ploughed ground retaining 21 per cent. The last two were in excellent condition for seeding, while the first would plough up lumpy and unsatisfactory.

The weight of an acre of the dry soil to the depth of one foot may be taken as 1,600 tons. Each per cent of water in soil to that depth represents about sixteen tons of water per acre, or one-seventh of an inch. The water apparently lost by the untreated soil was 176 tons per acre, equivalent to over one and one-half inches of rain. This is about one-half what the soil would hold after a soaking rain. The real loss was much more than this, since as water escaped from the upper foot, other would be drawn up from below by capillary attraction. The figures given are minimum quantities, therefore.

Stubble ground should unquestionably be ploughed while the moisture is still in the soil. Experiments of the Station show that simple ploughing is quite as effective for moisture conservation as any tillage yet tested. If time does not permit ploughing, the speedy work of the disk harrow compares favorably in efficiency. In either case, if rain follows sufficient to start the weeds, kill them with a harrow. This will at the same time break up any crust and preserve the soil mulch.

These principles apply to the provision ground as much as to the large estate, and every man can test them for himself, and make his own ground an experiment station. To test the matter in a small way does not require a plough, a harrow, or a cultivator. All that is necessary for the small proprietor or tenant, is to hoe over part of his ground, say one-half,—during dry weather, very frequently, say at least once a week. The hoeing should be done at any rate if a shower of rain should fall, and as soon after the rain as surface has become dry; this is especially necessary when the soil is clayey. The top layer of 1 or 2 inches of stirred dry soil prevent will the evaporation of water from the soil below.

ROYAL BOTANIC GARDENS, KEW.*

Kew as a scientific establishment dates from 1759, when a Botanic, or, as it was then called, a Physic, Garden was established by the Princess Augusta of Saxe-Gotha, Dowager Princess of Wales.

It was energetically maintained by her son, George III., with the scientific assistance of Sir Joseph Banks, who was virtually for the greater part of his life Director. Under his advice collectors were sent to all parts of the world. The first new Holland plants were introduced during Cook's voyages, 1768-1780. At Sir Joseph Banks' instance the system of inter-colonial exchange was commenced, which

* Pr. Bull. No. 4.
* From Colonial Office List, 1899.

has been maintained ever since. The most memorable undertaking of this kind was the voyage of the 'Bounty' (1787) for the purpose of introducing the bread-fruit tree from the South Seas into the West Indies. Nelson, the Kew collector, was amongst those sent adrift by the mutineers, and eventually died of the exposure. Another Kew gardener, James Hooper, who had been attached to Lord Amherst's Embassy to China, remained in Java, and was from 1817-30 Hortulanus of the celebrated Dutch Colonial Botanic Garden at Buitenzorg, which he helped to create.

Both George III. and Sir Joseph Banks died in 1820, and the colonial and other work of Kew languished, though it was not absolutely abandoned, during the reign of George IV. and William IV. In 1838 the abolition of the whole establishment was contemplated by the Government. Public opposition led to the appointment of a Treasury Committee, the report of which was presented to Parliament in 1840. The following paragraphs briefly defined the functions of the reorganised establishment :—'A national garden ought to be the centre round which all minor establishments of the same nature should be arranged . . . From a garden of this kind Government would be able to obtain authentic and official information on points connected with the founding of new colonies ; it would afford the plants there required without its being necessary, as now, to apply to the officers of private establishments for advice and assistance.'

These recommendations having been adopted by the Government, Sir W. J. Hooker, F.R.S., was appointed Director in 1841 to carry them out. A close connection between Kew and the Colonial Office immediately sprang up. A scheme for a complete series of Colonial floras was sanctioned in 1856, and has been steadily prosecuted. Kew serves to a large extent as an advanced horticultural school. Special attention is given to the preparation of gardeners for Colonial service. Some 60 men trained at Kew are now in official employment in different parts of the Empire.

Relations with the botanical institutions of the self-governing Colonies are maintained by semi-official correspondence. With those of Colonies more directly under the control of the Colonial Office, the connection is closer.

Colonial botanical institutions fall roughly into three classes. Those of the first class are usually, like Kew, administered by a scientific Director ; those of the second class by a skilled Superintendent ; the third class consists of Botanic Stations. These last are small and inexpensive gardens, devised in 1885, in order to afford practical instruction in the cultivation of tropical crops, and were intended to develope the agricultural resources, at first, of the smaller West Indian Islands, and subsequently (1887) of British Possessions in Tropical Africa. Each is in charge of a Curator, who is a gardener trained at Kew.

The principal members of the Kew staff are :—

Director : Sir W. T. Thiselton-Dyer, K.C.M.G., C.I.E., LL.D., F.R.S.

Keeper of the Herbarium and Library : W. B. Hemsley, F.R.S.

Honorary Keeper of the Jodrell Laboratory : D. H. Scott, Ph.D., M.A., F.R.S.

Keeper of Museums : J. R. Jackson, A.L.S.

The most important Colonial botanical institutions in intimate relation with Kew are :—

Ceylon.—Director of Royal Botanic Gardens : J. C. Willis, M.A.

Straits Settlements.—Director of Gardens and Forest Department: H. N. Ridley, M.A.

Jamaica.—Director of Public Gardens and Plantations : William Fawcett, B.Sc.

In 1898, in accordance with the recommendations of the West India Commission, a Special Department of Agriculture was created for Barbados, the Leeward and the Windward Islands, and was placed under the charge of a Commissioner, with headquarters at Barbados.

"Commissioner of Agriculture at Barbados : D. Morris, C.M.G., D.Sc., M.A."

IMPROVEMENT OF SUGAR-CANE BY CHEMICAL SELECTION. *

In the *Kew Bulletin* for 1894 (pp. 86-96), ** 1897 (p. 318), and 1898 (pp. 331-334), account was given of the method pursued at Calumet Plantation, Louisiana, and subsequently in Queensland and Barbados, of improving the sugar-cane by chemical selection. This is based on the known variability of cultivated plants and the consequent possibility of enhancing any desired character by the continued selection of the plants in which that character is most marked.

As long ago as 1886 it had been pointed out in a letter to the Colonial Office from Kew that the saccharine contents of the sugar-cane could be improved by progressive selection quite independently of reproduction by seed.

Mr. Bovell's results at Barbados have attracted the attention of Dr. Kobus, the Director of the Sugar-cane Experiment Station in East Java. He has lately favoured us with the following interesting letter, which is printed for the information of those working on the subject :—

Director, Sugar-Cane Experiment Station, East Java, to Royal Gardens, Kew.

Pasoeroean, March 26, 1899.

Dear Sir,

In the "Report of the results obtained on the experimental fields at Dodd's Reformatory, 1897," I see that you suggested to Mr. Bovell to try the selection of sugar-cane by chemical analysis of the juice.

* From Bulletin of Miscellaneous Information, R. Gardens, Kew. March and April, 1899.

** See Bulletin of Botanical Department, Jamaica, 1895, Sept., page *183*.

Nearly three years ago I proposed the same to the principals of the experimental station at Pasoeroean. As I myself was appointed Director in the same year, I commenced after my return from Europe in May, 1897, with the analysis of nearly 6,000 canes and cane-clumps, and found that the available sugar in canes of the same age varied by as much as 2 per cent. At the same time I showed that canes grown from the same cutting and of nearly the same age might show a difference in available sugar of from 7 to 8½ per cent. I concluded therefrom that it was not advisable to select individual canes, but that it was necessary to select cane-clumps. When the juice of a whole cane-clump, except the tops, has a great amount of available sugar,every cane of the clump must have it also, and the chance that its descendants are rich in sugar is greater than when some canes are very rich and others of the same clump are very poor, and the cuttings of these rich canes used for selection. After I had arrived at this conclusion, I analysed 5,000 cane-clumps belonging to five varieties, and selected 10 per cent of the highest and 10 per cent. of the lowest polarizing plants. I had the pleasure to send you the pamphlet No. 41 with the results of the analyses in October, 1897.

Since then I have reaped the canes grown from the cuttings, and found that the descendants of the rich canes contained 1½ per cent. more available sugar than the descendants of the poor canes (average of 3,200 analyses), I was astonished to find that the rich canes' descendants were heavier than the descendants of the poor canes.

I continued the selection with canes from other varieties or other fields (5,700 analyses), and found as a general rule that the rich canes were the heaviest, and also that the heaviest canes were the richest in available sugar. I concluded from this that both a high content of available sugar and a heavy weight are inherited by the descendants.

The results of these investigations I had the pleasure to send you in August, 1898 (Pamphlet No. 3, Third Series). The sugar estates who pay the expenses of our experiment station have granted me £500 to continue the selection on a larger scale, and placed at my disposal a cane-field of about 30 acres. Herefrom I selected 30,000 kgs rich canes and 10,000 kgs. poor canes for cuttings, and these showed again the same properties.

I mention these investigations which,perhaps, escaped your attention, as the pamphlets are written in Dutch. But you would find them worth making known to sugar growers in the West Indies.

I am, &c.,

(Signed) J. D. Kobus.

The Director,
Royal Gardens, Kew.

ELEMENTARY NOTES ON JAMAICA PLANTS.—III.

4.—Nelumbium luteum, Willd.

The Lotus and other Water Lilies.

In the Bulletin for January, 1897, some general remarks were published on the native Lotus (Nelumbium luteum) ;—in the present number the notes are botanical.

Nelumbium, Nymphaea, the Victoria regia, and some other "Water Lilies" are grouped together in one family or order—the Nymphaeaceae.

The general characters of the order are as follows:—

Nymphaeaceae

Aquatic herbs, with perennial submerged rootstock.
Leaves with a long stalk, usually floating.
Sepals 4 or 5.
Petals numerous, all, or the inner only, inserted at different heights on a receptacle enclosing the carpels, sometimes all free and hypogynous.
Stamens numerous, inserted as the petals.
Carpels several, free or coherent ;
Fruit a berry bursting irregularly, or an indehiscent nut.

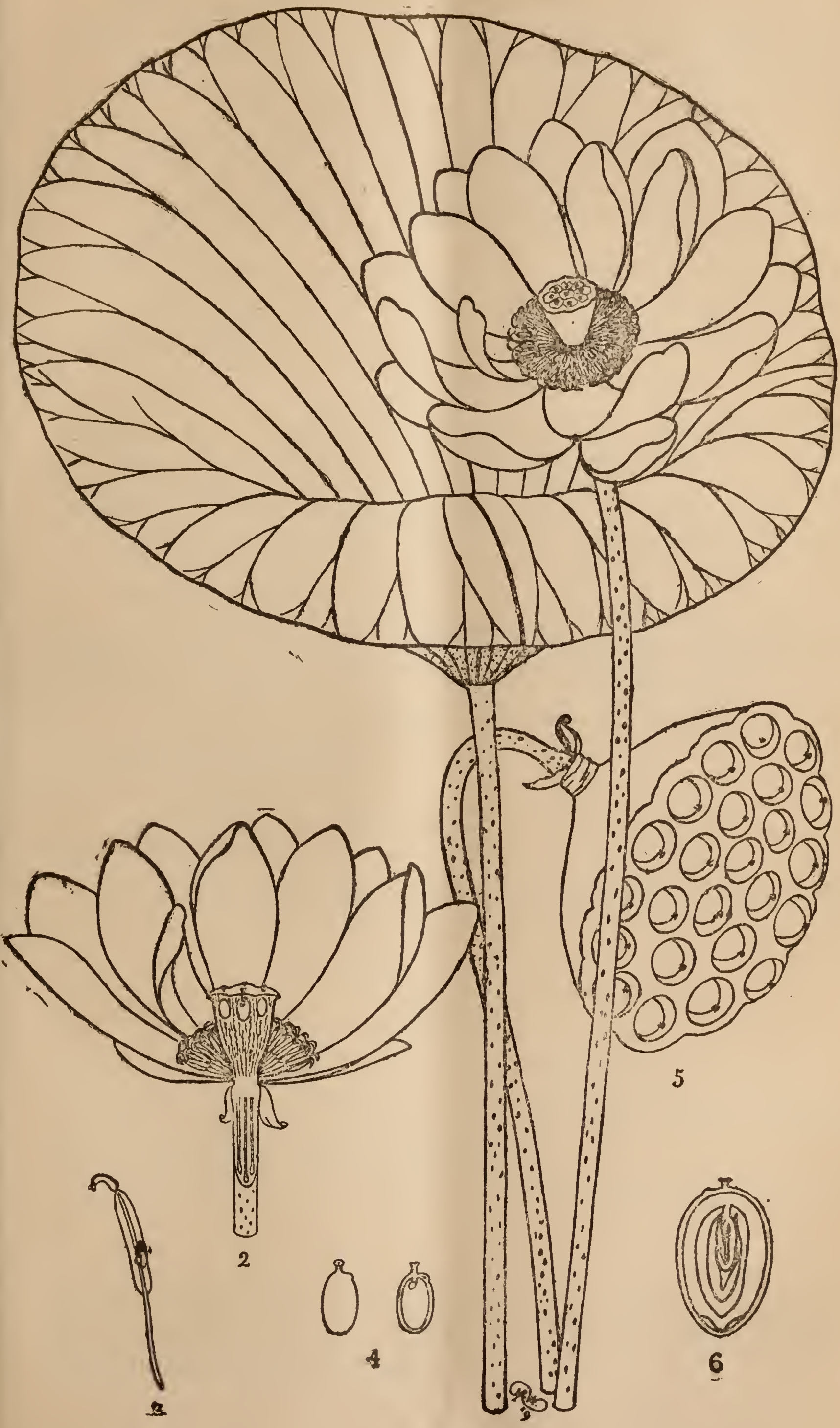
The character of the native genera and species may be indicated as follows:

Nelumbium.

Leaves young floating, adult standing out of water (fig. 1.)
Flower standing above the water (fig. 1.)
Sepals 4 or 5 inferior (fig. 2.)
Petals and stamens numerous, hypogynous, in several series at the bottom of the receptable. (fig. 2.) ; *anthers* opening inwards, connective produced as an appendage (see figs. 2, 3) beyond the anther-cells.
Ovaries several, sunk separately in the pits of a fleshy, obconical, flat-topped receptacle (figs. 2 and 4.) ; *style* short ; *stigma* terminal, somewhat dilated ; *ovules* 1 or 2 in each ovary, pendulous.
Nuts roundish, indehiscent (fig. 5) ; *seeds* without endosperm, cotyledons thick, fleshy, plumule with young leaves well developed (fig. 6.)

Nymphaea.

Leaves peltate, floating.
Flowers white (in native species), floating.
Sepals 4, inserted almost at base of receptacle.
Petals numerous, passing gradually from sepals into stamens, inserted with the numerous stamens at different heights on the receptacle surrounding the carpels, the innermost being almost superior.
Filaments somewhat petal-like, those at the outside broad with small anthers, those on the inside narrow with longer anthers, turned



H. A. Wood, del.

Nelumbium luteum, Willd.

inwards ; connective sometimes produced beyond the anther as an appendage, sometimes scarcely produced.

Carpels numerous, sunk in the fleshy receptacle, forming with it a several-celled half-inferior ovary, concave at the top with a gland projecting from the centre; *stigma* sessile and radiating, the number of rays corresponding to the number of carpels ; *ovules* numerous, situated on the surface of the partition walls.

Fruit a spongy berry, ripening under water and then bursting irregularly ; *seeds* numerous, immersed in pulp, furnished with a saccate aril and provided with a large perisperm in addition to the endosperm.

Nelumbium.

N. luteum, Willd. Flowers yellow. Leaves glaucous-green.

Nymphaea.

N. ampla, DC. Flowers opening during the day. Petals 1 to 3 inches long. Exterior anthers with an appendage $\frac{1}{6}$ to $\frac{1}{2}$ inch long. Appendages of the stigmas conical pointed.

N. Rudgeana, Mey. Flowers opening during the night. Petals 1 inch long. Exterior anthers with appendage scarcely produced beyond the cells. Appendages of the stigma club-shaped, and at length coiled inwards.*

There is a small white flowered aquatic, which some have mistaken for a true "water lily." This is noticed under the heading Limnanthemum Humboldtianum in Bulletin for 1897, page 232.

Explanation of Plate of Nelumbium luteum.

Fig. 1—Leaf and flower.
2—Section of flower.
3—Stamen
4—Carpel, entire and in section.
5—Fruit.
6—Seed in section.
(Nos. 1 and 2 much reduced ; 3, 4 and 6 natural size ; 5 half natural size.)

CASHEW.

Anacardium occidentale, Linn.

The cashew nut is kidney-shaped, about an inch long, situated at the top and outside a large pear-shaped fruit.

The kernel is a most delicious nut, and the export on a large scale ought to be profitable. It contains a light-yellow bland oil, very nutri-

* Specimens of this Water Lily are wanted at Hope Gardens. Rootstocks could be packed in a tin in mud, and sent by Railway to Kingston, and advice and parcel receipt sent to Superintendent, Parade Garden, Kingston. Flowers and leaves can be sent between sheets of papers and cardboard to Director of Public Gardens, Kingston.

tious, and said to be equal to almond oil, and superior to olive oil. The yield is 40 per cent.

The shell of the nut contains a thick, oily, caustic juice, called "cardole" in the East Indies. Cardole contains an oily matter which on exposure to air assumes a fine black colour, permanent against acids, alkalies, chlorine and hydrocyanic acid. It has been recommended as a marking ink, and is used for giving a black colour to candles. The yield is nearly 30 per cent. It is valuable as a preventive against white ants in wood-work, books, &c. In India it is used for tarring boats and dyeing fishing lines to preserve them.

The oil, "obtained from the shell by maceration in spirit," is an excellent remedy for the cracking of the cuticle of the feet (Joynt). It has been used beneficially in the anesthetic variety of leprosy, and in psoriasis as a local stimulant when faintly brushed.

The fruit is 2 or 3 inches long, varying very much in size and quality, and in colour—either yellow or red. It is the enlarged top of the flower-stalk. Stewed it makes an excellent and wholesome dish. A spirit can also be distilled from it of good quality.

A gum is obtained from the trunk. "It is sub-astringent, and highly unpalatable to insects. It consists principally of arabine and dextrine, both soluble in water, with a minor insoluble portion, probably bassorine. It forms a strong, yellowish mucilage with water. In South America it is largely used by book-binders ; it is occasionally imported from that continent into England, and possesses the same commercial value as the common and inferior sorts of Arabic and Senegal gums." (Spon's Encyc.)

The juice issuing from incisions in the bark is used as a marking ink, and in India native workmen make use of it as a flux for soldering metals.

The timber is strong and lasting, of a reddish colour, moderately hard, close-grained. Weight 38 lbs per cubic foot used in Burma for boat-building and charcoal, (Watt, Dict. Econ. Prod.)

The tree is of quick growth, often bearing fruit in two years time.*

INSECT PESTS IN PEAS, &c.

In a former Bulletin † remedies have been suggested for insect pests in peas, grain, etc. A correspondent states that he has found that a small amount of sugar mixed with red peas prevents the attacks of weevils. About two large tablespoonfuls of brown sugar are mixed with a bushel of peas, and he finds that although kept open, the peas are not touched for at any rate six months.

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* Plants are now ready for distribution grown from carefully selected seeds. Apply to Director of Public Gardens, Kingston, P.O.

† Bulletin, May 1898, page 106.

HOPE GARDENS.

REGULATIONS.

1.—No carts, drays or waggons shall be allowed to enter except such as are engaged in any business connected with the Garden.

2.—No bicycle, carriage, or other vehicle shall move at a greater speed than 6 miles an hour.

3.—Horses or mules when ridden shall not go beyond a walking pace.

4.—Horses or mules when ridden or driven, shall not be left standing without some one to take care of them.

5.—All games, such as running, jumping or flying kites, are prohibited.

6.—Picnics and luncheon parties are not allowed.

7.—Public Meetings shall not be held nor addresses delivered.

8.—No person shall sell, or expose for sale, any article except at the licensed bar. Plants may however be sold by certain employees.

9.—Any employee selling flowers, plants, etc., without at the same time giving a receipted bill for the money will be instantly dismissed. Visitors are requested to insist on having receipts.

10.—On Sundays no orders can be received, and no flowers, plants, etc., will be sold.

11.—Employees giving away flowers, leaves, etc., or allowing any visitor to take them, are liable to instant dismissal.

12.—Visitors shall not touch, cut or pick any flower, leaf, or twig, nor in any way injure any plant.

13.—Visitors shall not climb any tree nor walk on any bed or border.

14.—Visitors shall observe strictly any notices that may be exhibited for their guidance.

15.—Any person who conducts himself in a disorderly manner, or who is not decently clothed, or who contravenes any of the Regulations may be removed from the Garden.

16.—Any person who does any act in contravention of any of these Regulations will be prosecuted under Section 5 of Law 4 of 1899, whereby he is liable to a penalty not exceeding £5, and in default of payment to be imprisoned for a term not exceeding one month with or without hard labour.

17.—The whole, or part of the Garden may be closed at any time for any period, by order of the Governor, on notice being given in the Gazette, and at the gates of the Garden, at least 7 days beforehand.

18.—The Gardens shall be open every day from 6.30 a.m., and shall be closed at the following hours in the evening:—

During October, November, December and January, at 5.30.
During February, March, April and September at 6.0.
During May, June, July and August at 6.30.

19.—A bell shall be rung a quarter of an hour before closing time, as a notice to Visitors.

ADDITIONS AND CONTRIBUTIONS TO THE DEPARTMENT.

LIBRARY.

Europe.

British Isles.

Annals of Botany, Sept., [Purchased.]
Botanical Magazine, October, [Purchased.]
British Trade Journal, Oct. [Editor.]
Chemist and Druggist, Sept., 9-16, 23, 30, Oct. 7, 14. [Editor.]
Garden, Sept., 9, 16, 23, 30 Oct. 7, 14. [Purchased.]
Gardener's Chronicle, Sept., 9, 16, 23, 30, Oct., 7, 14. [Purchased.]
Journal, Board of Agriculture, England, Sept. [Secretary.]
Journal of Botany, Oct. [Purchased.]
Nature, Sept., 7, 14, 21, 28, Oct. 5, 12. [Purchased.]
Pharmaceutical Journal, Sept., 9, 16, 23, 30, Oct. 7, 14. [Editor.]
Produce World, Oct. [Editor.]
Rothamsted Report for 1899. By Sir J. H. Gilbert. [Committee.]
Sugar, Sept. [Editor]
Sugar Journal, International, Oct. [Editor.]
West Indian and Com. Advertiser, Sept. Oct. [Editor.]
Trans. and Proc. Bot. Soc., Edinburgh, xxi, 1, 2, 3. [R. Bot. Gard.]

France.

Sucrerie, indigène et coloniale, Sept. 12, 19, 26, Oct. 3, 10, 17. [Editor.]
Revue des cultures coloniales, 20 Aug., 20 Sept. [Director.]

Germany.

Tropenpflanzer, Oct. [Editor.]

Switzerland.

Bulletin de l'Herbier Boissier, Sept. [Conservateur.]

Asia.

India.

Agricultural Ledger (Calcutta) 1899, No. 7. [Lt. Govr., Bengal.]
Planting Opinion, Aug. 19, 26, Sept. 2, 9, 16, 23. [Editor.]
Report on Govt. Bot. Gard. Saharanpur, 1898-99. [Curator]
Report on Govt. Hort. Gard., Lucknow, 1898-99. [Curator]

Ceylon.

Circulars R. Bot. Gardens, Nos. 11-16 [Director.]
Times of Ceylon, Sept. 6, 14. [Editor.]

Java.

Proefstation, E Java, 3rd Series, No 12, 13.

Australia.

N. S. Wales.

Agr. Gazette, Sept. [Dept. of Agri.]
Sugar Journal, Aug. Sept. [Editor.]

Africa.

Cape of Good Hope.

Agri. Journ., Aug. 3, 31 Sept. 14. [Dept. of Agri.]

Central Africa.

Times, July 15, 22, 22, Aug. 5, 12, 19, 26. [Edinor.]

Natal.

Natal Plants. By J. M. Wood and S. Evans, I. 2. [Authors.]

West Indies.

Barbados.

Agricultural Gazette, Sept. [Editor]

Jamaica.

Journal, Jamaica Agri. Soc., Oct. [Secretary.]

Trinidad.

Bot. Garden Bulletin, Oct. [Superintendent.]
Proc. of Agri. Soc., pp. 277—284, 285-291. [Secretary.]

Windward Islands.
Bot. Station, Grenada, 1898. [Curator.]

NORTH BRITISH AMERICA.

Montreal.
Pharmaceutical Journal, Oct. [Editor.]
Ottawa.
Experimental Farm Reports, Catalogue of Trees and Shrubs in the Arboretum and Bot. Garden. [Dept. of Agri.]

UNITED STATES OF AMERICA.

Publications of the U. S. Dept. of Agriculture.—Scientific Bureaus and Divisions [Directors.]
Division of Forestry, Primer of Forestry, Pt. I., The Forest. By G. Pinchot.
Forest Conditions of Porto Rico, by R. T. Hill.
Division of Soils, Cult. of Cigar-Leaf Tobacco in Florida by Marcus L. Floyd.
Experiment Stations.
Alabama: Auburn, 105 (Hairy Vetch.)
Arizona: Report for 1898-99 (Date Palm &c.)
Connecticut: New Haven, Report for 1898 (Fertilisers, Plant Diseases, Insect Pests, Curing and fermenting tobacco, etc.)
Florida: 50 (Pine Apple Fertilisers.)
Kentucky: 83 (Wheat.)
Minnesota: 62 (Wheat.)
Ohio: 108 (Bovine Tuberculosis.)
Rhode Island: Report 1898, Pt 2; Bulletins 53 (Field Experiments), 54 56, (Fertilizers) 55 (Rhubarb) 57 (Nitrogen for grass) 28 (Lime for grass)
Virginia: Blacksburg, 8 (Strawberries), 9 (Fertilisers for Potato.)
Wicsonsin: 78 (Tuberculosis in cows.)
American Journal of Pharmacy, Oct. [Editor.]
Botanical Gazette, Chicago, Sept. [Editor.]
Fern Bulletin, Oct. [Editor]
Massachusetts Hort. Soc. Trans. 1896, Pt. III., 1899, Pt. I. [Society.]
Torrey Club Bulletin, Sept., Oct. [Editor.]
Flower and Embryo of Spaganium. By D. H. Campbell. [Author]

POLYNESIA.

Planters' Monthly, Hawaii, October. [Editor.]

SEEDS.

From Bot. Garden Adelaide.

Acacia decurrens
A. pycnantha
A. Sentis
A. tetragonophylla
Abutilon Mitchelli
Andropogon exaltatus
Anthistiria membranacea
Arthropodium fimbriatum
Aster ramosus
Astrebla triticoides.
Atriplex angulata
,, fissivalvis
,, halimoides
,, holocarpa
,, nummularia
,, velutinella
Boerhaavia diffusa
Eucalytus miniata.
" obliqua.
" Planchoniana.
" resinifera.
" rostrata
" viminalis.
Enchylæua tomentosa.
Frenela australis.
Geitonoplesium cymosum.
Gnephosis arachnoidea.
Gossypium Sturtii.
Hakea rostrata.
H. saligna.
Helipterum strictum.
Heterodendrum oleaefolium.
Hymenosporum flavum.
Kennedya rubicunda.

Brachycome pachyptera
Brassaia paradoxa
Bursaria spinosa
Cassia desolata, var.
,, eremophila
Clianthus Dampieri
,, puniceus
Coprosma lucida
Cryptocarya triplinervis.
Doryanthes Palmeri.
Echinospermum concavum.
Elaeodendron australe.
Eleusine cruciata.
Eremophila maculata
Eucalyptus calophylla.
" capitellata
" citriodora.
" cornuta.
" corymbosa.
" corynocalyx.
" cosmophylla.
" Gunnii.
" amygdalina.
" maculata.
Leptospermum lanigerum
" myrsinoides.
Lophostemon australe.
Loranthus pendulus.
Melaleuca glomerata.
" styphelioides.
Menkea australis.
Notelaea longifolia.
Panicum adspersum.
Pimelea glauca.
Pittosporum phillyraeoides
" undulatum.
Persoonia juniperina.
Psoralea patens.
Pterigeron microglossus.
Ptilotus nobilis.
Scirpus littoralis.
Scolopia Brownii.
Spondias Solandri.
Stenocarpus sinuatus.
Sterculia acerifolia.
" heterophylla.
Tetratheca ericifolia.
Thryptomene Mitchelliana.

From Mr. G. French, Melbourne, Victoria,
Acacia iteaphylla
" longifolia
" melanoxylon
" saligna
Eucalyptus Lehmanni
Eucalyptus longifolia
" macrandra
" resinifera
Sterculia acerifolia

From Mr. Henry A. Dreer, Philadelphia, U. S. A.
Dianthus laciniatus 'Salmon Queen'
Lobelia heterophylla major
Marguerite Carnation
Nelumbium album grandiflorum

From Lady Blake, Hong Kong.
Sterculia lanceolata
" platanifolia

From Supt. R. Botanic Gardens, Trinidad.
Cocos amara

From Mr. W. Jekyll, Robertsfield, Jamaica.
Berberis aquifolium

Plants.

From Mr. Henry Dreer, Philadelphia. U. S. A.
Acalypha Sanderi
Aponogeton distachyon
Arundo Donax, macrophylla, glauca.
Clivia miniata (Imantophyllum)
Nymphaea dentata
,, gracilis
,, scutifolia
Passiflora princeps
Sagittaria Japonica
Vriesia splendens

From Mr. W. Jekyll, Robertsfield, Jamaica.
Freesia refracta, alba

From Supt. Govt. Gardens, Nagpur India.
Rhizomes collected in Central Provinces.

Herbarium.

From Director R. Gardens, Kew.
123 dried specimens of Ferns.

[Issued Nov. 23rd 1899.]

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series | DECEMBER, 1899 | Vol. V / Part XII

CAMPHOR. *

(*Cinnamomum Camphora*, Nees)

Enquiries continue to be made as to the cultivation of the tree producing this substance. A brief note was given in the *Kew Bulletin* for 1895 (p. 305).

Hitherto the use of camphor in medicine and the arts has been comparatively small. A new application is, however, likely to increase its consumption, perhaps indefinitely. This is described in the following words by Sir Frederick Abel, in a letter printed in the *Bulletin* :—

"This substance has been used extensively for many years past, and no doubt in continually increasingly quantities, for the conversion of collodion cotton into the material known as *Celluloid*, which is applied to the manufacture of imitation ivory, tortoise-shell, horn, and a great variety of purposes."

An excellent account of the natural history and economic applications of the camphor tree was issued in 1897 by the Division of Botany of the United States Department of Agriculture, *Circular* No. 12. It is reproduced with some slight condensation :—

"DESCRIPTION.

"The camphor tree is an evergreen, related to the bay and to the sassafras of the United States. In its native habitat it attains a height of 60 to 100 feet, with wide-spreading branches and a trunk 20 to 40 inches in diameter. The leaves are broadly lanceolate in form, acuminate at both base and apex, of a light green colour, smooth and shining above and whitish or glaucous on the under surface. The lower pair of lateral veins are more prominent than the others, but the leaves are not as distinctly 3-nerved as those of the cinnamon and many other species

* From Bulletin of Miscellaneous Information, R. Gardens, Kew, May and June, 1899.

of the genus. The small white or greenish-white flowers are borne in axillary racemes from February to April on shoots of the previous season, and are followed in October by berry-like, one-seeded fruits about three-eights of an inch in diameter. The fruiting pedicels terminate in a saucer-shaped disk, persisting after the mature fruit has fallen.

" NATIVE RANGE.

"The camphor tree is native in the coast countries of Eastern Asia from Cochin China nearly to the mouth of the Yang-tse-kiang, and on the adjacent islands from the southern part of the Japanese Empire, including Formosa and the Loocho Islands, to Hainan, off the coast of Cochin China. Its range also extends into the interior of China as far as the province of Hupeh, about 500 miles from the coast on the Yang-tse-kiang in latitude 30° north. This area, extending from 10° to 34° north latitude and from 105° to 130° east longitude, is all embraced in the eastern monsoon region, which is remarkable for abundant rains in summer.

"The camphor trees growing wild in the native range are usually most abundant on hillsides and in mountain valleys where there is good atmospheric as well as soil drainage. The temperature in the greater part of this region, which is partly within the tropics and partly subtropical, rarely falls below freezing. The tree is an evergreen, changing its leaves generally in April, and therefore the winter temperature is a factor of more importance than would be the case with a deciduous tree.

" RANGE UNDER CULTIVATION.

" Notwithstanding the comparatively narrow limits of its natural environment, the camphor tree grows well in cultivation under widely different conditions. It has become abundantly naturalized in Madagascar. It flourishes at Buenos Ayres. It thrives in Egypt, in the Canary Islands, in south-eastern France and in the San Joaquin Valley in California where the summers are hot and dry. Large trees, at least two hundred years old, are growing in the temple courts at Tokyo, where they are subject to a winter of seventy to eighty nights of frost, with an occasional minimum temperature as low as 12° to 16° F. The most northern localities in the United States, where the camphor tree has been grown successfully out of doors, are Charleston and Summerville in South Carolina, Augusta, Ga., and Oakland, Cal.

" At Charleston, Sommerville, and Augusta the trees have withstood a minimum temperature of 15° F., but they have been protected by surrounding trees and buildings. At Mobile, Ala., the trees have grown and fruited in protected situations, while in exposed places they have been repeatedly destroyed by frosts. While the camphor tree will grow on almost any soil that is not too wet, it does best on a well-drained sandy or loamy soil, and it responds remarkably well to the application of fertilisers. Its growth is comparatively slow on sterile soils, but under favourable conditions it sometimes grows very rapidly. An instance is recorded of a camphor tree in Italy a foot in diameter and 90 feet high, eight years from the seed. Under ordinary conditions, however, such a girth is not often attained in less than twenty-five years, and such a height is rearly attained in a century. Under favorable conditions an average of 30 feet in height, with trunks 6 to 8 inches in diameter at the base, may be expected in trees ten years from the seed.

"Uses of the Tree and its Products.

"The principal commercial uses of the camphor tree are for the production of camphor and camphor oil. Camphor is employed extensively in medicine. It enters into the composition of many kinds of liniments for external application. For liniment it is used especially in combination with olive oil. It is taken internally for hysteria, nervousness, nervous headaches, diarrhœa, and diseases affecting the alimentary canal. It is a specific in cases of typhoid fever and cholera. Camphor fumes have been used with success in cases of asthma. It has been used very extensively to keep insects out of furs, woolens, etc. In Japan, camphor and camphor oil are used in lacquer work. The oil is somewhat similar to turpentine, and could doubtless be used to advantage in varnishes and shellacs. It is now used in the manufacture of toilet soaps. In Japan and China it has been used for illuminating purposes, but it produces a smoky flame.

"Among the secondary uses of the camphor tree the most important is for ornamental planting. Its bright evergreen leaves, rapid growth, and long life make it valuable for this purpose. In Japan and China it has been the principal tree planted in the temple courts for many centuries, and in those countries it takes the place of the historic oaks of England. It has been extensively introduced into Southern Europe and South America for ornamental purposes.

"The wood, with its close grain, yellow colour, and susceptibility to polish, taking a kind of satin-like finish, is exceedingly valuable in cabinetwork, especially for making drawers, chests, and cupboards proof against insects. The leaves and young branches, although they have but a slight odour of camphor, are packed with clothing or scattered about unused rooms to guard against insects.

"The tree produces an abundance of berry-like fruits, which are used in Japan and China to make a kind of tallow. The fruits are greedily eaten by chickens and birds.

"Conditions of successful Cultivation.

"For most of the secondary purposes, the camphor tree may well be cultivated wherever it can be made to live; but for commercial distillation, and for the production of wood for cabinet purposes, it must be grown under the most favourable conditions. The minimum winter temperature should not be below 20° F., and this minimum should be of rare occurrence. The soil, preferably sandy and well drained, should be irrigated unless there are abundant rains. Fifty inches of water during the warm growing season is desirable, and much more may well be used where the air is very dry.

"An abundance of plant food, rich in nitrogen, is required for rapid growth, but the kind of fertiliser that can be most profitably applied will vary according to the character of the soil in each locality. In the absence of definite information in this regard the kind of fertiliser producing most rapid growth of wood in the orange or in other fruit trees may be taken as an index.

"PROPAGATION.

"Camphor trees may be grown either from seed or from cuttings. They are usually grown from seed, as the trees fruit abundantly, and seedlings can be grown more easily than cuttings. The seeds are collected at maturity in October and November, and after drying are packed in sharp white sand or some similar material to keep them fresh until the time of planting in spring. About the last of March they are sown in drills in the seed bed.

"The soil of the seed bed should be a good sandy loam mixed with about one-third leaf mould. The seed bed should be kept moist, but not too wet, and should be shaded from the direct rays of the sun if the weather is warm. The best soil temperature for germinating camphor seeds is from 70° to 75° F. The temperature of the atmosphere may be ten degrees higher. The seedlings will grow well at higher temperatures, but are likely to lack vigour and hardiness.

"The seedlings may be grown in pots, which will facilitate transplanting at any time, or they may be transplanted in nursery rows early in April when one year old. Plants two years old are generally regarded as best for final planting. At this age they vary from 20 to 40 inches in height.

"PLANTING AND CULTIVATION.

"In Japan, where the law requires that a new tree shall be set out for every one cut, they are not generally set in straight orchard rows, but cultivation there is performed almost exclusively by hand labour. There are no records showing results of regular orchard planting, hence the distances at which trees should be planted must be determined by the size and form of the trees and the methods of cultivation and of procuring the gum. They may be set closely in rows about 10 feet apart, and alternate rows cut and reset every five years, thus producing bush-like plants of ten years' growth. They may be planted in checks 10 feet square, and alternate trees cut every ted to twelve years, or they may be planted in larger checks, and all of the trees be cut at the age of fifteen or twenty years.

"There are not sufficient data obtainable upon which to base definite statements as to the best methods of planting, or the age at which the trees may be cut with greatest profit. A recent English consular report from Japan states that 'although hitherto the youngest wood from which camphor was extracted was about seventy to eighty years old, it is expected that under the present scientific management the trees will give equally good result after twenty-five or thirty years.' Camphor of good quality has been produced in Florida from the leaves and twigs of trees less than twenty years old, 1 pound of crude camphor being obtained from 77 pounds of leaves and twigs.

"The trees will endure severe pruning with little apparent injury. One-third of the leaves and young shoots may be removed at one time without materially checking the growth of the tree. The largest proportion of camphor is contained in the older, larger roots ; the trunk, limbs, twigs, and leaves containing successively a decreasing proportion. When the camphor tree is killed nearly to the ground by frost it sends up vigorous shoots from the base. It may be expected to do the same when cut, especially if cut late in the fall. Experiments are needed to determine whether this growth may be depended upon, or whether it will be more profitable to dig out the larger roots and set out new seedlings.

"DISTILLATION.

"In the native forests in Formosa, Fukien, and Japan, camphor is distilled almost exclusively from the wood of the trunks, roots, and larger branches. The work is performed by hand labour, and the methods employed seem rather crude. Different methods of distillation are employed in different districts, but those in use in the province of Tosa, in Japan, appear to be the most skilful. The camphor trees are felled, and the trunk, larger limbs, and sometimes the roots, are cut into chips by hand labour with a sharp concave adze.

"The fresh chips are placed in a wooden tub about 40 inches high and 20 inches in diameter at the base, tapering toward the top like an old-fashioned churn. The perforated bottom of the tub fits tightly over an iron pan of water on a furnace of masonry. The tub has a tight-fitting cover, which may be removed to put in the chips. It is surrounded by a layer of earth about six inches thick to aid in retaining a uniform temperature. A bamboo tube extends from near the top of the tub into the condenser. This consists of two wooden tubs of different sizes, the larger one right side up, kept about two-thirds full of water from a continuous stream which runs out of a whole on one side. The smaller one is inverted with its edges below the water, forming an air-tight chamber. This air chamber is kept cool by the water falling on the top and running down over the sides. The upper part of the air chamber is sometimes filled with clean rice straw, on which the camphor crystallizes, while the oil drips down and collects on the surface of the water. In some cases the camphor and oil are allowed to collect together on the surface of the water and are afterward separated by filtration through rice straw or by pressure.

"About twelve hours are required for distilling a tubful by this method. Then the chips are removed and dried for use in the furnace, and a new charge is put in. At the same time the camphor and oil are removed from the condenser. By this method 20 to 40 pounds of chips are required for 1 pound of crude camphor.

"The principles generally held to be essential in distilling camphor of good quality are :—(1) The heat must be uniform and not too great, producing a steady supply of steam ; (2) the steam after liberating the camphor must not come in contact with metal, that is, the tub and condensing apparatus must be of wood.

"SUGGESTED IMPROVEMENTS.

"Many improvements upon the methods described can doubtless be made, tending both to a reduction in cost and an increase in the proportion of crude material obtained. Instead of an adze wielded by hand labour a machine similar to the 'hog' used for grinding up waste slabs in sawmills may be used to reduce camphor limbs to the requisite fineness for distillation. Better distilling apparatus can probably be devised. Thermometers may be introduced to determine the heat in the distilling tub, and the furnace may be so arranged as to permit better control and greater economy in fuel. Camphor and camphor oil are both slightly soluble in water, and the condensing chamber should be improved so as to recover the product that is being constantly carried off in the running stream which cools the chamber.

"OUTLOOK FOR FUTURE MARKET.

"The consumption of camphor in the United States, as measured by the importations, has been decreasing during the past ten years, while the price has been increasing.

"The tariff act approved July 27, 1897, imposes a duty of 6 cents per pound on refined camphor and leaves crude camphor on the free list, as heretofore.

"There has been an increase in importations of refined camphor due to improved methods of refining and packing in Japan and to changes in the tariff, but this increase has been much more than counter-balanced by the decrease in importations of crude camphor. The decrease may be attributed to the following causes: (1) the exhaustion of the supply of the available camphor trees near the shipping ports; (2) the governmental restrictions on the trade in camphor in Formosa; (3) government taxes on the exportation of camphor from Formosa; (4) hostilities and wanton destruction of camphor stills by the natives in Formosa; (5) disturbances in the camphor producing district of China; (6) the China-Japan war; (7) attempts by speculators to corner the market.

"These causes have increased the price of camphor, and this in turn has led to the introduction of substitutes. Menthol and other peppermint derivatives or compounds, carbolic acid and its derivatives, naphthalin, formalin, and insect-powder are now used for various purposes where camphor was formerly employed. Camphor has been manufactured artificially, at a cost leaving a margin of profit at present prices. It is therefore apparent that if the production of camphor from the trees is to be carried on with profit in this country, and the industry increased to any considerable extent, the price of camphor must be reduced to compete with the prices of substitutes now taking its place.

"Camphor has been obtained from several other plants not at all related to the ordinary camphor tree, but only two kinds, Borneo camphor and Blumea camphor, are of any importance commercially.

"Borneo camphor is obtained from the camphor tree of Borneo and Sumatra, *Dryobalanops aromatica*. It is deposited in clefts and hollows in the wood, and has simply to be taken out. This camphor is comparatively rare, and the supply is consumed almost exclusively in China, where it is valued at from thirty to ninety times as much as ordinary camphor.

"Blumea camphor is obtained by distillation from *Blumea balsamifera*, a shrub growing in Burma and the Malay Peninsula. This is usually refined in Canton, whence about 10,000 pounds are exported annually. The source of this supply is abundant, and as the industry develops it is likely to enter more into competition with ordinary camphor. Neither of these plants can be grown in the United States, except possibly in southern Florida, without protection against cold.

" Lyster H. Dewey,
" Assistant in Division of Botany.

" Washington, D. C.,
" August 12, 1897."

There is a brief note on Borneo camphor wood in the *Kew Bulletin* for 1887 (September, p. 15), and a full account of Blumea camphor in the volume for 1895 (pp. 275-277, with plate, and also 1896, p.73).

Production in Formosa.

The following is extracted from the Foreign Office *Report on Trade in Japan* for 1897. (Misc. Series, 440, pp. 71-72.)

The trade in camphor will probably undergo some modification. Camphor trees are not found in that part of the island (of Formosa) occupied by Chinese settlers. They occur only in the country of the aborigines, or upon the immediate border, and up to the present time the destruction of trees has been carried on in the most wasteful manner. The mode of obtaining supplies of camphor was for foreign merchants through Chinese agents to advance money to the savage chiefs for permission to cut down trees. The stills were erected at the expense of the foreigners, who paid a tax of 8 dol. a still to the Chinese authorities, and a local tax of 10 dol. on each picul (133 lbs.) of camphor produced. When the island was ceded to the Japanese the privileges which foreigners had enjoyed under Chinese rule, of having these camphor establishments in the interior, seemed likely to be withdrawn by the Japanese Government. The Chinese treaty, much more than the Japanese, gives freedom of travel and trade to the foreigner ; and if the limitations imposed by our treaty with Japan had been strictly enforced in Formosa, foreigners would have had to retire to the treaty ports. They would have been debarred from distilling or purchasing camphor in the interior, and they would have suffered heavy losses in abandoning the capital already sunk there. Considering that the present treaty had only two more years to run, the Japanese Government has consented to let matters remain *in statu quo* ; and when under the new treaty, foreigners obtain a right to settle anywhere in the interior, they wlll be able to distil as much as they like. But there is also a probability that the preparation of camphor will be made a Government monopoly. With the Formosan supply under its control the Japanese Government could almost secure a monopoly of the camphor trade, for Japan and Formosa are almost the only sources of supply ; and advantage may be taken of this to put Formosa's finances on a satisfactory basis. The land where the camphor trees grow are not privately owned as is the best portion of Formosa's fertile plains, so the Government could appropriate the camphor producing districts without interfering with vested interests.

The following further information is given in the Report on the Trade of Tainan for 1897 (*Foreign Office Annual*, 2149, pp. 5-6) :—

The camphor trade has, so far as concerns foreign merchants in South Formosa, almost entirely stopped, owing, among other causes, to the disturbed state of the country and the difficulty and danger of sending money into the camphor districts. The roads continued throughout the year to be infested with armed robbers, who, on the approach of the military or police, fled to the hills (where it was, apparently, impossible to pursue them), only to reappear at the first favourable opportunity. Robberies became of such freqnent occurrence that no foreign or native merchant would venture to send money into the interior. The Japanese authorities, on their part, did not see their way to allow the tax to be paid in the treaty port on arrival of the camphor, and business was consequently brought to a standstill.

In the raids and skirmishes, too, which have taken place in the camphor-producing districts, numbers of stills have been destroyed. Their destruction was, perhaps, inevitable, but as they were almost entirely erected with money advanced or loaned by foreign merchants in South Formosa, the losses incurred by the latter have been very considerable. It is estimated that not one-third of the stills in existence, two years ago, in which foreigners in South Formosa are interested, are now available for camphor production.

The hope expressed by Her Majesty's Consul in last year's reports that the camphor trade might revive and assume large proportions, has not been realised ; in fact, far from this being the case, the camphor export business, as far as South Formosa is concerned, has now (April, 1898) almost stopped.

These remarks, of course, apply exclusively to the export of camphor by foreign merchants in this district (South Formosa) who have in the past invested considerable sums of money in the business. The production of camphor in the districts of Rinkipo and Shu Shu (Hunlin and Chip Chip), the principal districts whence the drug came to South Formosa, still, I am informed, continues, though to nothing like the same extent as formerly ; but all the camphor so produced finds its way via the port of Rokko (Lokkang) to Tamsui, whence it is shipped to Hong Kong and Japan. The roads north of Rokko are said to be perfectly safe, so that dealers can reach the neighbourhood of Chip Chip and buy up any camphor that, under other circumstances, should and would go to the foreign firms in Tainan, with whose money the business was first started. Things may remedy themselves in course of time, but the outlook at present is certainly not very bright.

The following table shows the export of camphor from this port since, practically, the commencement of the trade :—

Years.	Number of Boxes Exported.
1892 - -	4,315
1893 - -	6,691
1894 - -	12,157
1895 - -	10,145
1896 - -	8,001
1897 - -	3,057

NOTE —One box contains about one picul (133½ lbs.) of camphor.

PRODUCTION IN CEYLON.

The cultivation of the camphor tree has attracted some attention in Ceylon. But, as will be seen from the following correspondence which has appeared in the *Ceylon Observer*, both it and the production of the drug are in the experimental stage.

SUPERINTENDENT, HAKGALA BOTANIC GARDENS, TO EDITOR "CEYLON OBSERVER."

Botanic Gardens, Hakgala,
April 6th 1898.

DEAR SIR,

REFERRING to your question as to what is being done with camphor cultivation in Ceylon, I may add the following to what I wrote you on the 11th of February last. Wishing to satisfy myself that solid camphor exists in the leaves and twigs of even very young plants, I sent a small bundle of prunings from plants planted out at the end of 1895, to Mr. S. A. Owen, of Messrs. W. Jordan & Co., of Lindula, who had very kindly undertaken to make the experiment for me. I am pleased to state that he has been very successful in extracting solid camphor from them; and as this is of general interest to planters, I shall be much obliged if you will be good enough to publish Mr. Owen's letter in an early issue of your paper.

The prunings from an average plant 28 months, old, as grown here weigh from 10 to 12 lb.

I have a good many plants that want pruning, and if applied to before the end of this month, April, I shall be very glad to supply 10 or 20, or 35 lb. prunings to any person wishing to make the experiment for himself.

I am, &c.,
W. NOCK.*

* Mr. Nock was at one time Superintendent of Government Cinchona Plantation, Jamaica, [Ed. Jamaica Bulletin.]

MR. S. A. OWEN to SUPERINTENDENT, HAKGALA BOTANIC GARDENS.

Talawakele, March 30, 1898.

DEAR MR. NOCK,

THANKS for the parcel of camphor prunings duly recsived. I have made several experiments. The following is the account of method employed and results :—

* * * * *

A gallon iron kettle was packed with 1½ lb. of leaves and small twigs, together with about two pints of water. The cover of the kettle was luted on and the spout fitted with a cork, while a long glass tube proceeded from the cork to a condenser. Applied heat gradually, and kept it up for five hours. At the end of this time the sides of the condenser were coated with camphor, and small lumps were floating in the water which distilled over. All the camphor was collected carefully and dried between bibulous paper (to absorb most of the adhering oil). It then weigheed 55 grains, which is equivalent to 12 ounces to the cwt or 15lb to the ton.

I think the results very encouraging, as the leaves and young parts of the camphor tree contain but a very small proportion of camphor compared with the trunk-wood. Indeed, I believe that in Formosa and other camphor-producing countries, it is customary to altogether discard the branches and leaves and use the mainwood only.

I should think that planters who have young camphor trees coming on here in Ceylon would find it well worth their while to utilise their prunings—especially if firewood is available and cheap, as this latter item would be practically the only expense, beyond the small amount of labour required and the initial expense of a still,which latter could be easily extemporised out of almost any kind of large iron vessel to which heat could be applied. As the camphor tree is a long while coming to maturity, considerations of this kind ought to be borne in mind.

I have pleasure in enclosing a small sample of the camphor obtained. As you will see, it has a rather dirty appearance, due to unavoidable impurity and the sample smells of camphor oil, but these are easily got rid of in the process of refinement. I also enclose a small sample of the same camphor partly purified by sublimation.

You are, of course, very welcome to make what use you like of this account of these small experiments, whether by publication or otherwise. No doubt it would be encouraging to those who have gone to the expense of planting up camphor trees to know that there is camphor in our locally grown trees. I have heard of one or two misgivings as to whether the soil and climate here would favour the formation of camphor in the tree.

Yours faithfully,

S. A. OWEN.

[Seeds of the camphor tree (Cinnamomum Camphora) were imported a few years ago into Jamaica by the Director of Public Gardens and Plantations, and plants were raised in the Hill Gardens and distributed.]

MEXICAN SUNFLOWER.

TITHONIA DIVERSIFOLIA, A. Gray.

Four or five years ago His Excellency Sir Henry Blake received seeds of a "Sunflower" and sowed them in King's House Garden. They grew into shrubs 8 or 10 feet high, covered with bright golden yellow flowers, 4 or 5 inches across, more beautiful and graceful than the common Sunflower. The sight of a single bush is charming, but when the bushes are massed in quantities, the general effect is "a beauty and a joy" for the short time that they are in flower.

But, alas, eternal beauty is denied them, as it was to Tithonos, after whom they are named. He was beloved by the Goddess Dawn, and desiring immortality, obtained it, but neglecting to ask also for eternal youth, his beauty passed away, and at his own prayer he became turned into a grasshopper. So Tithonia's flowers fade all too soon, but more happy than he, they renew their youth with each succeeding Autumn.

Tithonia diversifolia is a native of Mexico : it is also found in Ceylon where it was first introduced in 1851 from California. There it has spread on waste ground, and along roadsides over the moist country up to 5,000 feet with all the appearance of a native weed. It is not a pest, as the seeds are not carried by the wind, but simply drop on the ground.

MEXICAN TOBACCO.

A Foreign Office Report has been issued dealing with the Mexican tobacco trade. Mr. Chapman, British Consul at Vera Cruz, states that until the year 1897-8 the exports of Mexican tobacco showed but little advancement in the trade. Whereas in 1896-7 the total export of raw tobacco from the whole Republic was 1,349,903 kilos, representing 1,718,232 Mexican dollars, in the following year they were 3,107,619, valued at 3,563,620 dollars. Manufactured tobacco, on the other hand, showed a decrease of from 420,282 kilos, representing 1,001,859 dollars in 1896-7, to 389,697 kilos, valued at 926,148 dollars in 1897-8. The increase of raw exports in 1897-8 was due to abnormal causes. In that year the Mexican export trade in tobacco received an impetus during the Cuban Revolution, when the Spaniards impeded the cultivation and export of Cuban tobacco, and large stocks in hand were detained in the island. At the same time certain Mexican tobaccos were imported into the United States as fillings and used as wrappers, and in view of the contemplated change in the Dingley tariff, large demands were made for Mexican tobacco for the supply of Tampa, Key West, and Florida factories before the contemplated change in the Dingley tariff took effect. This caused a boom in tobacco. Prices rose, exports increased, and the resources of capital and labour were strained to increase production.

With the change in the Dingley tariff, the freeing of the Cuban supply in hand, and the prospects of an early resumption of cultivation in the island, prices fell, and it was found that Mexican tobacco could not retain the temporary footing it had acquired on the American market. With the fall in prices many people were ruined who had indiscreetly invested in increased cultivation. Growers were unable to reimburse advances, and purchasers were left with large supplies on hand. Since then the Mexican tobacco trade has declined towards its normal condition. Labour, at all times scarce and of an inferior quality has been a serious factor in this business ; but hopes were raised by an influx of Cuban labour, in consequence of the Spanish-American war. This labour greatly improved the cultivation, sorting, and preparation of the product for market, and enabled it to compete for better prices ; but since the termination of the war the pick of this labour has returned to Cuba, and although this immigration has been of permanent benefit to Mexico and the tobacco trade, yet the increased, and still increasing demand for labour, without any apparent adequate means of supplying the deficiency, makes labour the burning question of the day with regard to developing the resources of the country. The tobacco industry requires a supply of skilled and unskilled labour that can be depended upon, and such a supply can only be obtained from free labour that can command a fair wage and a standard of living superior to that at present obtained by the ordinary Mexican field hand.

When the necessary supply of reliable labour shall have been found, and the means for improvements in the cultivation and preparation of the product introduced, there will be an opportunity for the investment of large capital in this business, for good tobacco is grown in the country, and there is no reason why, with proper handling, it should not obtain an advantageous footing on the markets. Tobacco is one of the Mexican articles of export that will greatly benefit by the establishment of direct communication with the United Kingdom, and there are reasonable grounds to expect that before long a direct and regular steamship service will be offered to the public.

INTERNATIONAL CONFERENCE ON HYBRIDIZATION.

At the International Conference lately held in London under the auspices of the Royal Horticultural Society, Mr. Herbert J. Webber, of the United States Department of Agriculture, gave an interesting lecture, on the work of his department in plant hybridization. He said that the work of hybridizing was started not more than three years ago, and the results attained were far from complete. All the plants on which they had worked were, in the main, horticultural products of America, and one of the principal was the orange plant. A few years ago almost the entire orange industry for a season in Florida was destroyed by frost in a single night, and about a hundred million dollars was lost by the damage done. In consequence of this they arrived at the conclusion that either they must abandon the orange industry in Florida, or secure a variety of orange which was very much hardier, and which would resist the frost. Accordingly they set to work to hybridize the Japanese orange, Citrus trifoliata, with the sweet orange The trifoliata was found as far north as New York, and was used as a hedge plant. The fruit was bitter and resinous, and was used as a preserve fruit; but the plant was hardy in character, and by hybridizing it with the common sweet orange it was hoped that the frosts would be resisted and that they might obtain hybrids of the two species and a deciduous as well as an evergreen orange. The true hybrid plants, already obtained, had been found very much more vigorous than the common sweet orange. His department had also made experiments with the view of combining the character of the tangerine with the common orange in order to secure, if possible, the loose skin of the tangerine with the common variety. The sweet orange was of much better quality and more desirable than the tangerine, but if by hybridizing they could produce a fruit to combine the characters of the two, he thought that such a fruit would take the market ; and they were working on those lines. They were further endeavouring to improve the quality of the orange by crossing the bitter-sweet pomelo with the sweet orange. The United States Agricultural Department had, also been working more or less with pineapples; and he pointed out that it had been ascertained that by the crossing of fruits which were commonly seedless they could frequently produce seeds, and that the plants so dealt with were more vigorous and better able to resist disease. Another branch of their work was with cotton plants, the main point being to hybridize between the Upland cotton and the so-called Sea Island cotton. By this hybridization they hoped to extend the cotton industry considerably. The last experiment dealt with by the lecturer was the hybridization of corn (maize) by introducing the wild species into the cultivated strain. They were endeavouring to cross the common maize with the wild Mexican grass Teosinte, which was supposed to be the progenitor of maize; but, of course, there must be numerous generations before they could bring out the character of the corn to any great effect.

DRYING HOUSE.

In a former Bulletin * an account was given of a Drying House for Cocoa used in Ceylon. The following extract on the subject of a Drying House for general use is taken from "Planting Opinion," an excellent journal published in Madras.

"HOW TO MAKE A HOT-AIR DRYING HOUSE.

"There are so many ways of doing this that I think I had better simply describe the way mine has been built, and leave others to improve upon the idea according to the cheapest material and cost of transit in their district. It is first necessary that the principle upon which the heat is to be obtained and regulated should be understood. It is well known that hot air rises, and only falls again to a lower level

* See Bulletins 41 and 48.

upon cooling ; consequently, the hot-air must be allowed to enter by a flue, as near the roof or ceiling of the shed or house as convenient, and so that only the coolest air may be exhausted. The point furthest away from this, and consequently the lowest, should be the place from which to exhaust the air by means of fans. The building of course may be of any size, but should be greater in length than in breadth, and should be, as near as possible, hermetically sealed.

" In the first place, a framework of sawn hardwood timber is erected to the height of, say, 10 to 12 feet, with flooring joists set on blocks 3 inches or 4 inches above the level of the ground, but not boarded (open battens being the floor, which is afterwards covered with coir or other matting.) Upon the roof is also placed flooring joists for the ceiling, and set on the wall plates as if for a two storey building. If bricks are a cheaper material than galvanised iron, the whole building may be made of brick, but I have found iron both cheaper and more portable. I prefer the flat galvanised iron to the "corrugated," as it does not require skilled labour to turn, rivet and solder the edges. The inside only of this building is next covered with iron sides, ends, and ceiling. At the angle of the ceiling it is best to turn the edges, rivet, and solder, before nailing up. All other joints can be stuffed, or calked with hemp or cotton, even pasted over with brown paper is good.

" The roof can either be left flat, or an ordinary shed-roof of corrugated iron. It may even be raised into a second storey, or loft, to be used as a finishing room above the hot-air chamber.

"A brick furnace is now built at one end of the shed with smoke stack either of brick or iron. The furnace should be built about two feet away from the end of the shed to allow of the hot-air flue (2 feet inside measurement) to connect the furnace with the shed which will emanate about six inches from the ceiling of the chamber and in the centre. In building the furnace a double row of four inch gas pipes are laid, one set of ends set in fire clay but entering the flue, and the other set of ends, open to the air on the other side of the furnace. Great care must be taken that neither fire nor smoke is allowed to enter the flue direct from the furnace, and the pipes, or tubes should never be allowed to get red-hot, or they are liable to burn, or crack. Now,at the other end of the shed, a trench should be dug in the ground, below the flooring of the same size as the draught capacity of the flue, and emanating below the wall for a few feet. Over this draught trench, either one or two exhaust fans are built, and these are in my case worked by water power, so that I could regulate their pace to one degree of temperature night or day.

"It will be understood that, as the air is exhausted from the chamber it must necessarily pass through the heated pipes to replace the air withdrawn, and that, that heated air is drawn through the matting on the battened floor, and, consequently, through the crop that is spread upon it, thus only the coolest and dampest air is withdrawn."

ADDITIONS AND CONTRIBUTIONS TO THE DEPARTMENT.

LIBRARY.

Europe.

British Isles.

Botanical Magazine, Nov. [Purchased.]
British Trade Journal, Nov. [Editor.]
Bulletin Kew Gardens, Sept. and October. [Director.]
Chemist and Druggist, Oct. 21, 28, Nov. 4, 11. [Editor.]
Garden, Oct., 21, 28, Nov. 4, 11. [Purchased]
Gardeners' Chronicle, Oct. 21, 28, Nov. 4, 11. [Purchased.]
Journal of Botany, Nov. [Purchased.]
Nature, Oct. 19, 26, Nov. 2, 9. [Purchased.]
Pharmaceutical Journal, Oct. 21, 28, Nov. 4, 11. [Editor.]
Produce World, Nov. [Editor.]
Sugar, Oct. [Editor.]
International Sugar Journal, Nov. [Editor.]
W. Indian and Com. Advertiser, Nov. [Editor.]
Climate No. 1 Oct. [Editor.]

France.

Sucrerie, indigène et coloniale, Oct. 24, 31, Nov 7. [Editor.]

Germany.

Konigl. Botanische Garten, Berlin, 1898-9.

Switzerland

Bulletin de l'Herbier Boissier, Oct. [Convervateur.]

Asia.

India.

Agriculrural Leger (Calcutta) 1899, No. 8.
Planting Opinion, Sept. 30, Oct. 7, 14, 21. [Editor.]
Report Govt. Cinchona Plantation and Factory in Bengal 1897-98. [Kew]

Ceylon.

Times of Ceylon, Sept., 20, 27, Oct. 4, 12. [Editor.]

Java.

Proefstation E. Java, 3de Serie No. 14. [Director.]

Australia.

N. S. Wales.

Agri. Gazette, Oct. [Dept. of Agr.]

Queensland.

Agr. Journal, Oct. [Sec. Agr.]
Sugar Journal, Oct. [Editor.]

Africa

Cape of Good Hope.

Agri. Journ. Sept. Oct. [Editor.]

Central Africa.

Times, Sept., 2, 16, 23. [Editor.]

West Indies.

Barbados.

Agricultural Gazette, October. [Editor.]

Jamaica.

Journal, Jamaica Agricultural Soc. Nov. [Secretary.]

Trinidad.

Report of Supt. Bot. Gards. on Experiments. 30th Oct. [Supt.]

British North America.

Montreal.

Pharmaceutical Journal, Nov, [Editor.]

Ontario.

Annual Reports, Live Stock Associations. 1898-9.

Ottawa.

Experimental Farm Bulletin. No. 33. June.

United States, America.

Publications of the U. S. Dept. of Agriculture—Scientific Bereaus and Divisions

Division of Botany. Vol. V, No. 4. (Useful Plants of Mexico, etc.)

Division of Soils in co-operation with Division of Vegetable Philosophy and Pathology : 60 (Temperature changes in fermenting piles of cigar leaf tobacco.)

Division of Soils, 9 (soil moisture), 15 (Electrical Instruments for determining the moisture, temperature, and soluble salt content of soils.)

Experiment Stations.

Experiment Station Record : XI. 2.

Arkansas : 58 (Grazing a Corn and Cowpea field. Experiments with Peanuts. Legume Manuring, etc.)

Georgia : 44 (Wheat, Oats, Rye, Barley), 45 (Insects on Cucurbits.)

New Jersey : 137 (Dairy Experiments), 138 (Crude Petroleum as Insecticides), 139 (Analyses of Fertilisers.)

Texas : Annual Report, 1898-99.

American Journal of Pharmacy, Nov. [Editor.]

Botanical Gazette, Chicago, Oct. [Editor.]

Torrey Club Bulletin, Nov. [Editor.]

Philadelphia Comm. Museum : State of Nicaragua ; The World's Commerce and the U. States share of it.

Polynesia.

Planters' Monthly, Hawaii, Nov. [Editor.]

SEEDS.

From Royal Botanic Gardens, Trinidad.

Hevea brasiliensis

From Royal Gardens, Kew.

Ptaeroxylon utile

Tabernaemontana sp.

Musa Livingstoneana

From Messrs. Vilmorin—Andrieux & Co.

Araucaria Brasiliensis

" excelsa

" imbricata

PLANTS.

From Botanic Gardens, St. Lucia.

Eugenia Micheli

Cocos Romanzoffiana

Pritchardia pacifica

Flacourtia sepiaria

Gulielma speciosa

Sabal minor

From Mrs. Plaxton, Belle Vue, Kingston, Jamaica.

Bulbs of Crinum sp.

[Issued 22nd December 1899.]

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series **Appendix, 1899.** **Vol. VI App.**

Report of the Director on the Department of Public Gardens and Plantations for the year ended 31st March 1899.

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ECONOMIC PLANTS.

BANANAS.

Extension of cultivation.—The planting of Bananas has gone steadily forward, and there need be no fear of overdoing the market. If the whole of the West Indies, including Cuba, and adjacent territories on the mainland, grew bananas wherever good bunches were produced, the demand would still increase with the supply. There could be no better nor cheaper food for the hungry millions of the British Isles, Canada and the United States than the banana.

Meal.—No further advance has been made in the utilisation of bananas to make meal. Excellent meal has already been made in the Island, and no doubt a company with a large capital could put it on the market at a much lower cost than has hitherto been found possible, especially if they started work in a banana district where they could buy up small bunches. But it must be produced at a cost that will enable it to compete with flour.

Dried bananas.—At the Hon. Evelyn Ellis' estate Mr. Zurcher has solved the problem of so drying and putting up bananas that they keep in good order like figs for a very long time. It is a secret process, but, as the demand grows, factories will probably follow in other districts. As it is probably possible to put the fruit in this condition on the market at as low a cost as the fresh banana, there are immense possibilities in this direction.

CITRUS TREES.

The Superintendent of Hope Gardens reports results of experiments in budding on various stocks: sweet orange on lime has done well, although the tree has not grown large. Sweet orange on lemon are looking fairly well. A sweet orange on sour stock gummed and was destroyed. Navel oranges on sour have done well, especially the Washington navel. The Imperial lemon on sweet orange did so badly that they were destroyed; on rough lemon, half are looking well, and half were destroyed; others will be tried on sour stock. Grape fruit on rough lemon are looking well, but some on sweet orange were unhealthy and were destroyed. The tangerines are looking well.

At the Hill Gardens some of the trees have suffered a little from scale-insects, but otherwise they are very healthy. There are in the orange grove 556 citrus plants put out in their permanent places, and 156 other fruit trees, making a total of 712 fruit trees, covering an area of more than 10 acres actually under permanent trees. The nurseries and roads are perhaps of equal or even greater extent.

Throughout the island there has been great activity in the planting and cultivation of new orange groves. In many places the trees have been affected in various ways, and assistance has been given by the Department in ascertaining the causes of the troubles, and giving advice as to remedies. Frequently unhealthiness was caused by planting the young trees too deep, instead of so placing the topmost roots that they should be only just covered by the soil; or by giving too much shade ; or by heaping up weeds, &c., round the stem of the tree. In some cases grubs were found eating the roots, for which hand picking and application of kainit and lime were effective; or scale-insects attacked plants wanting in vigour for which the kerosine and soap mixture is recommended.* Diseases of the bark, such as gumming, should be treated with the preparation, the recipe of which is given in the Bulletin for September, 1887.† Against ants, bitter wood has been found effectual, 1 lb. chips are steeped for 12 hours in water, then more water added to make up a gallon, the whole is allowed to boil slowly for 12 to 24 hours ; then it is allowed to cool, and is made up to 10 gallons ; 10 ounces of soft soap may be added.

In the Bulletin for December, 1895, the article on budding recommended that the wood should be taken away from the bud. This is the practice in budding in England, but it has been found by experience here that the Florida method of leaving the wood with the bud of citrus plants is preferable. It has also been seen that it is better to make the T-shaped cut upside down. In Florida a leaf is fastened with the tying-material over the bud as a protection against the sun.

The number of citrus trees distributed by the Department has been very large :—

Sweet Orange	...	21,201
Grape Fruit	...	16,551
Rough Lemon	...	7,200
Sour Orange	...	5,287
Navel Orange	...	244
	Total	50,483

Cocoa.

Distribution.—The price of cocoa on the markets is now high, and with the increasing consumption there is every prospect that the price will remain high for at any rate a few years. It is therefore very important that every encouragement should be given to the industry. The price of plants has been reduced to ½d. each, delivered at any railway station or seaport, so that the poorest man can start the cultivation. The plants are in bamboo pots, the roots are therefore not disturbed in sending out, and the plants can be taken straight to the field, the bamboo split, and the soil enclosing the roots placed at once into the hole prepared for it. Very much depends for success on the weather when planting takes place, the percentage of losses being less than 1 per cent. in favourable showery weather, and perhaps as much as 50 per cent. when the weather is dry. One advantage of having the plants in bamboo pots is that if the weather is not showery, they can be kept together under shade, and watered until a favourable opportunity occurs. About 6,000 plants have been distributed in the year, besides 400 pods which ought to give 12,000 more plants.

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* Bulletin, December, 1898, page 271.
† Bulletin 3, page 4.

The cocoa trees at Hope and Castleton are of the best kinds, and the seeds for sowing are carefully selected, so that planters may be certain of having good trees.

Instructions.—In supplying cocoa plants to small settlers, leaflets are given with full directions for cultivating and curing, and this teaching is supplemented by practical demonstrations by the Travelling Instructor. While the export of cocoa has increased this year by 30 per cent. the value has increased nearly 50 per cent.

Investigations.—Messrs. Rowntree, cocoa manufacturers of York, England, have leased an estate in the island, and have sent out a chemist to study the process of curing on the spot. It is to be hoped that these scientific investigations may be published for the benefit of cocoa planters, and supplement the good work already done by Prof. Harrison and Mr. Jenman in Demerara.*

Coffee.

Arabian Coffee. (Coffea arabica).—There is considerable demand for seedlings of Arabian or common coffee, and there appears to be no good reason why these should not be supplied by the Department as well as any other plant. The proper place to raise these plants is in the Hill Gardens; they grow very much more slowly than at Hope, but they are of much stronger constitution, and the loss in planting out should not be nearly so great as in dealing with those grown at lower levels.

Experiments in manures for coffee ought to be carried out at the Hill Gardens, but there is not sufficient money voted for either growing seedlings or testing manures.

At Hope Gardens a small plantation has been made, rather for the purpose of training the Industrial School boys than for experiment. But it will be useful in comparing the different mode of growth from coffee grown at an elevation of 4,000 feet and also the different treatment necessary in topping, pruning, etc.

Liberian Coffee. (C. liberica).—The Liberian Coffee at Castleton has, as usual, borne well, and a large number of young plants were raised. The trees at Hope have produced an abundant crop, and the young trees have improved since the shade has been lessened, and more water supplied.

Berries in the cherry were supplied to Messrs. Lascelles, de Mercado & Co., for the purposes of trying their ordinary machinery with Liberian, and testing the value of the coffee on the New York market. From the sample received it was evident that the machinery had not been set quite right, or was not perfectly adapted for it. The beans, moreover, had not been picked over nor sized. These imperfections would affect the price. The following letter with reference to the price obtainable on the market will be of interest.

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* **Bulletin, March, 1898, page 49.**

Messrs. A. S. Lascelles & Co. to Messrs, Lascelles de Mercado & Co., Kingston.

New York, U. S. A.,
April 21st, 1899.

Dear Sirs,

JAMAICA LIBERIAN COFFEES.

In response to the request of Products Co. to report on two bags of this variety of coffee which reached us this week we have to inform you that the universal consensus of opinion among the experts, jobbers and dealers is that these coffees would sell here at from 7¼ to 7½c.† the latter being probably the outside valuation for to-day. We have also submitted the samples to the expert in these coffees to-day and he reports as follows :—

" We hand you with this green and roasted samples of 275 bags " genuine Liberian Java J which we are jobbing out in a small " way at 8½c. We are confident we can buy this coffee at 7¾c. " In fact we are offered much handsomer coffees at the former " figure. The sample of Jamaica Liberian which you showed " us to-day is of inferior style, the colour being much against it. " We doubt if such coffee would sell to New York jobbers at " from 7 to 7¼c. and we are confident that no jobber would make " a profit on it 7½c. We have tested both of these coffees in the " cup and while our coffee is much superior coffee in the roasted " bean, we must say frankly that your coffee possesses superior " drinking merit, having a fine flavour and clear acid which we " do not think our coffee possesses. We do not know, however, " that this favourable feature would overcome its poor appear- " ance in the green as the consumer apparently cares very little " for the drinking quality of this sort of coffee."

And in order that you may understand his letter we send you by this opportunity two sample bags of his sample in the green and two cans of his sample roasted, also two sample of your own Liberian coffee roasted so that you can, if necessary, make the comparisons which he does in his letter. You will see that, whilst your coffees are inferior in style and colour in the green, they nevertheless make a superior flavour roasted to those which are now on sale in this City.

We are, Yours faithfully,

A. S. LASCELLES, & Co.

Highland Coffee of Sierra Leone. (Coffea stenophylla.)—This coffee grows on the hills about Sierra Leone at from 500 to 2,000 feet. The coffee is sold by French merchants as "best Mocha," but the interest connected with it, is not so much the relative value as compared with Arabian coffee, as the possibility of its being able to resist the *Hemileia vastatrix*. The Director of Kew Gardens has distributed seed to Botanic Gardens in the tropics. It has succeeded fairly well at Hope and Cas-

† [That would be 26/ to 27/ per cwt., in Jamaica.]

tleton, and given a small crop at both Gardens ; but it is still too early to decide whether it is worth growing at all in Jamaica, or whether it is likely to do better than Arabian Coffee below 2,000 feet.

GRAPES.

Varieties.—Mr. Cradwick, the Superintendent of Hope Gardens, reports as follows:—" The grape vines bore a large summer crop, which commenced to ripen about the middle of May and lasted until the end of July. The variety first to ripen was Raisin de Calabre and after that Foster's seedling; at this period exceptionally heavy rains fell, as much as twelve inches in twenty-four hours, a great many of the berries split and in some bunches the whole of them split and were spoiled. On the morning of the 28th May, one cwt. and 4lbs., were spoiled in this way and were cut off the vines.

" The Muscat Hamburgh turned out fairly well, as did also Royal Ascot and Black Prince, but of the black varieties Alicante appears to be best suited to the Hope climate, as it is the only variety not attacked by mildew. The Muscat of Alexandria has again proved to be the best of the white varietes. Foster's seedling is a heavy cropper.

" In consequence of the unusual quantity of rain during the last nine months of the year, 1898, the grape vines did not ripen any wood at all for autumn pruning. In order however to demonstrate that unless the wood is properly ripened, it is useless to expect fruit, 16 vines were pruned, and, as expected, not a single good bunch was produced."

Instruction.—Mr. Cradwick has travelled in several parts of Jamaica, giving instruction in handling and caring the vines and grapes. Some planters have taken great interest in vine culture, and now possess a large number of vines. Their experience is unfortunately the same as in every land where grapes are grown on a large scale, fungoid pests are exceedingly troublesome. The only plan to save the vines is to adopt the methods found successful in other countries. Notes on the subject are to be found in the Bulletin.*

Market.—Whether it will be found possible eventually to produce grapes from January to March for the London and New York markets, is still a matter of experiment, but there is a local demand at remunerative prices even for summer grapes.

Distribution.—Young vines to the number of 1,383 have been distributed, mostly to small settlers in the neighbourhood of Alligator Pond, which appears to be a district admirably suited to the cultivation.

KOLA.

The interest in planting kola is still maintained, as many as 12,489 plants having been distributed.

MANGOES.

The mangoes at Hope, mis-called " East Indian," as all come from the E. Indies, are derived from one of the trees imported by Governor

* Bulletin, February, 1897, page 37.

Sir J. P. Grant from Bombay, and planted in Castleton Garden.* It would be better therefore to call them Bombay mangoes. They have no stringy fibre, nor flavour of turpentine; and, unlike the favourite "No. 11," they can be eaten with a spoon. The fruit has been sent to England in good order, and should therefore be profitable for export. Numbers of seedlings have been distributed, but as they could not be guaranteed to come true, and as some complaints on that score were received, not much has been done lately in growing these seedlings. Some grafts have been taken, and the grafted trees distributed, but the original trees will not bear too much cutting in this way. There are other mango trees at Castleton, making in all the "four noted Bombay grafted mangoes" of Sir J. P. Grant which on rare occasions bear a fruit. The mangoes known locally as the "Governor" mangoes are doubtless from grafted plants of these trees.

There are some excellent mangoes in Martinique. There are two or three trees at Hope but probably not of the best kind. My late attempts to get the grafted plants of the best kinds failed; but Prof. G. Landes, who recently visited Jamaica on an agricultural mission, has very kindly interested himself in the matter and no doubt some healthy plants will be received.

A tree raised from seed of a mango from Mexico, has produced large fruit of an excellent character, and ripening rather later in the season.

Col. Griffith of Hodges imported at considerable expense some grafted mangoes from Bombay, and a graft from one of these is now growing at Hope.

The common mango, when ripe, can be made into an excellent preserve, and, unripe into a pickle remarkable for its stomachic qualities. As thousand of tons go to waste every year, it might be found profitable to do something with them in this way.

Nutmegs.

The cultivation of nutmegs is on the increase, more than 3,000 plants were distributed during the year.

Pine-Apples.

Varieties.—The varieties of Pine-Apples cultivated at Hope Gardens are:—Red Ripley, Green Ripley, Charlotte Rothschild, Smooth Cayenne, Abbaka, Black Pine, Cow-boy, Sugar-loaf, Queen, Cheese Pine.

Selection of Suckers.—The Superintendent of Hope Gardens in continuation of his remarks on correlation of the colouring of the leaves and good fruit, states:—"Of the 55 plants of the Green Ripley pine with red markings in the centre of the leaf only, ten have fruited, every fruit being a good one free from blemish; the remainder of the plants are now fruiting, but it cannot be determined whether these will be perfect until they ripen. No more of these plants have developed red markings on the edge of the leaf.**

"Of the 11 plants from parent with red markings on the outside

* See Blue Book for 1871, quoted in Bulletin, January, 1898, page 5.
** [All produced good fruit.]

of the leaf as well as in the centre, 2 have produced inferior fruits cracked near the base and exuding gummy matter which attracted large quantities of the black stinging ants, these fruits are quite useless; 3 have produced little knobs; the remainder of the plants are just commencing to fruit, but are not sufficiently advanced to enable us to form an opinion as to the quality.*

" Of the 27 plants with the marking on the outside of the leaf, only 7 have produced little knobs, 11 have simply grown with the leaves twisted round in the centre of the plants and developed side suckers as though they had fruited ; 4 have produced fruits which were of fair quality, although very small ; and 4 plants produced small bad fruits,—cracked and exuding gum.

" The greatest care should be taken to propagate plants from those having the red colouring matter well developed and in the centre of the leaves only ; plants with faintly coloured or colourless leaves, or plants having leaves with the red colour on the edge of the leaves, should be avoided.

" Red Ripley : Since observing the variation in the colouring of the Green Ripley Pine Apples, I have also noticed that something of the same kind occurs in the Red Ripley. When the colouring of the leaves is particularly bright, and the leaves have not the fine bloom observable in the best type of plant, it often produces an abortion similar to those produced by the green variety when badly marked."

Manures.—Mr. F. Watts, suggested various manures for trial with Pine Apples. The plan was as follows :—

Manures applied to Pine-Apples.

Series A : Size of plots, 18⅓ square yards each.

Plot	Manures: Number of pounds per acre.			Manures : amount in ounces applied to plots.		
	Phosphate	Potash.	Nitrogen.	Super-phosphate.	Sulphate of Potash.	Sulphate of Ammonia.
A1	80	40	80	13½	4½	23½
A2	80	40	0	13½	4½	0
A3	80	40	40	13½	4½	11¾
A4	0	40	40	0	4½	11¾
A5	No Manure.					
A6	80	0	40	13½	0	11¾
A7	160	40	40	27	4½	11¾
A8	0	0	40	0	0	11¾
A9	80	80	40	13½	9	11¾
Series B.—Size of plots, 23⅛ square yards each.						
B1	80	40	40	16¾	4¾	15
B2	0	40	40	0	4¾	15
B3	80	0	40	16¾	0	15
B4	80	40	0	16¾	4¾	0

*** [Two of the remaining six produced little knobs, the other four rather small fruits cracked at the base.]**

Ramie.

An attempt was made more than a year ago by some few who are interested in the McDonald Boyle Ramie Machine, to induce farmers to form a company to grow the plant and prepare filasse, but the time was not opportune for the investment of capital. A considerable amount of interest is, however, still taken in the subject, and planting is still going on : 39,200 roots were distributed during the year under review.

Rubber.

The Central American Rubber tree (*Castilloa* spp.) appears to be the best suited for growth in Jamaica. A small plantation of this tree has been made at Hope, a few trees have been planted at Bath, and others have been put out in the woods in order that they may propagate themselves by natural means.

Seeds from Rubber trees in the Gardens have been sown, as well as some received from the Botanic Gardens of British Guiana and British Honduras ; and numerous plants have been raised and distributed throughout the island.

Mr. S. T. Scharschmidt writes that Ceara Rubber trees (*Manihot Glaziovii*), received from the Department in May 1887, and planted at Hanbury (elevation 1,550 feet, and rainfall 99 inches), began to yield rubber when 11½ years old.*

Hon. Dr. Johnston, in his travels through Africa, met with a rubber plant, the swollen underground stem of which yielded rubber of good quality. This plant is doubtless one that been lately determined by botanists to be a species of *Carpodinus.* It is probable that this plant may be grown in large numbers to the acre, and yield rubber in far less time than trees, thus opening up the industry to planters and small cultivators.

Mr. R. H. Biffen, a Cambridge botanist, who travelled lately in America, investigating the subject of rubber, has invented a machine, in principle somewhat like a centrifugal cream separator, by which the rubber is separated at once from the milky juice free from all impurities and its value raised 25 per cent. This machine is likely to revolutionise the rubber industry.

Sugar Cane.

Distribution.—The number of cane tops distributed during the year was 17,500. There has been great demand for the seedling canes, and especially for that named "D. No. 95." The demand on the part of some planters was much more than could be supplied with the resources even of a large experiment station,devoted to cane alone as in Barbados, but we have endeavoured to satisfy to some extent all who have applied. It would greatly facilitate the work of distribution, if planters would state a year beforehand the number and kind that they wish for. So far as land and money allow at Hope, as many as possible are grown and distributed, and planters then experiment with different varieties and make choice of the most suitable.

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* **Bulletin, February, 1898, page 37.**

Increase in yield of Sugar.—The great aim in all experiments with cane is to increase the yield of sugar; it is satisfactory to find that several of the seedling canes are very promising in this respect.

It is understood from one proprietor that from 5 acres planted with "D. No. 95" he reaped 23 tons whereas with the Mt. Blanc variety which was the cane hitherto planted on the estate, he only got at the rate of 2 tons per acre, that is to say, that with the same area and the same expenditure, he hopes that when the whole of the estate is planted with D. No. 95 more than double the amount of sugar will be produced.

At the Conference held at Barbados in January, Dr. Morris called the attention of those present to a remarkable seedling cane that had originated in Barbados, known as "B. 147." Mr. Bovell, Superintendent of the Botanic Station, who raised this seedling, states:—"This cane has been under cultivation here for the past five years, and it has during that time given an average yield of nearly half a ton of available sugar per acre over the Cal donian Queen, which comes next, and more than three quarters of a ton more than the Bourbon." Mr. Bovell recommends this cane for the "black soil" districts of Barbados. The following are Mr. Bovell's figures:—

Name of Cane.	Llbs. per gallon. Sucrose.	Llbs. per gallon. Glucose.	Llbs. of Sugar per acre.
B. 147	1·794	·114	7,190
Caledonian Queen	1·980	·041	6,137
Bourbon	1·775	·086	5,210

According to Mr. Bowrey's analysis, the seedling D. No. 95 yields at Hope nearly half as much more as the Caledonian Queen; but the direct comparison between the two seedling canes is a matter for future analysis.

Through Dr. Morris's kind offices, I was enabled to purchase 200 tops of cane B. 147 from the proprietor of an estate where it was grown somewhat extensively, and brought them back for experimental growing in Hope Gardens. It was found unfortunately that a very large proportion were riddled with the borer, these were burnt, but the remainder were planted and promise well.

Analysis of Cane at Hope. Mr. Bowrey, Government Chemist had analysed shortly before his death a good number of the canes under cultivation at Hope Gardens *. His successor, Mr. Francis Watts, recommended as a preliminary to undertaking work on the Hope canes, that a row, one chain in length, of each variety should be planted out, with the intention of analysing them when ripe.

Analysis of Canes on Estates. It is evident from the Reports published in the Bulletin from time to time of different varieties of canes grown for experiment by Messrs. Kemp, Webb, Shirley, and Craig, that it is important for every Sugar Planter to experiment for himself with various canes until he finds out certainly the variety which yields

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* Bulletin, Oct. and Nov., 1897.

most sugar on that particular estate. If the yield can be increased by even a quarter of a ton per acre, it is worth all the trouble entailed.

In 1895 the Department supplied a collection of canes to Mr. Thomas Kemp who devoted a large area to their cultivation, and tested them himself. * The same idea was carried out by Mr. Webb and Captain Shirley. ** But in order that the analysis be done systematically, so that the results may be on the same basis, and capable of comparison, it should be carried out on different estates by the same person and he should be an Agricultural Chemist.

Mr. Craig also undertook experimental work, and fortunately when his canes were ready for testing, Mr. Watts was at hand to go to Danks and analyse them. †

Government Chemist.—When the Government Chemist is appointed, it would be well that one definite portion of the work assigned to him, should be the analysis on the spot of canes grown experimentally on one or two estates in each sugar growing district. With the assistance of the sugar planters themselves, the estates might be carefully selected as typical of certain districts, arrangements could readily be made for the distribution from these experimental plots of the most successful canes throughout the surrounding districts, and for the exchange of tops from one district to another, so necessary for maintaining a vigorous constitution in the cane.

Another portion of the Chemist's duties should be to continue Mr. Bowrey's work in analysing, and undertake experimental work on manures for canes at Hope Gardens.

Treatise on Sugar Cane.—During the year an important treatise was published on the "Agriculture of the Sugar Cane" by Dr. Stubbs, Director of the Sugar Experiment Station in Louisiana, U. S. A., summarising all the latest information on the subject, and giving results of his experience in Louisiana. Copious extracts from this work were printed in the Bulletin, and Mr. Watts added notes, giving his view on certain points derived from his long practical acquaintance with sugar growing in the West Indies.‡ But the treatise itself should be in the hands of every sugar-planter, copies can be obtained direct from the author.

TEA.

There is a demand for tea plants, which are supplied from the Hill Gardens. The number distributed was 3,760 besides some seed.

TOBACCO.

Distribution of Seed—Seed was imported by the Department from Havana through the agency of the British Consul-General of the best tobacco of Vuelta Abajo, and was distributed free to everyone who applied for it.

At Montpelier, the Hon. Evelyn Ellis's estate, 60 acres were

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* Bulletin, Sept, 1896.
** Bulletin, Mar. 1897. † Bulletin, April, 1899.
‡ Bulletins May to October, 1898.

planted out exclusively with seedlings raised from this seed, * and the tobacco which was cured on the spot, was sold to a New York buyer, realizing high prices. A grade of wrapper superior to Sumatra was obtained. As a measure of the success obtained, Mr. Ellis proposes to put 130 acres under tobacco next season.

It is well known that the Cubans are careless in the collection of seed, taking it from inferior plants, and from suckers from the old roots. Plants were therefore grown at Hope for the purpose of obtaining first class seed for distribution. This was sent out under the name of "Hope Havana," and reports have been received of the excellence of the plants raised from it.

Manures.—Mr. Watts drew up the following plan for testing various manures on tobacco :—

MANURE FOR TOBACCO.

Plots. No.	Stable Manure, or Grass (instead of green dressing) at rate of 20 tons per acre.	Artificial Manure, and rate per acre in lbs.		
		Potash.	Phosphate.	Nitrogen.
1	Stable Manure			
2	Grass			
3	"	40		
4	"	40	80	
5	"	...	80	
6	"	40	80	40
7	"	...	...	40
8	No Manure.			
9	...	80		
10	...	40		
11	...	40	80	
12	...	...	80	
13	...	...	160	
14	...	40	80	40
15	...	...	...	40
16	...	...	...	80
17	...	...	80 †	
18	...	40	80 †	40
19	...	...	...	40 ‡
20	...	...	...	80 ‡

The potash and phosphate were applied as soon as the plots were ready for the plants, and throughly worked into the soil. The nitrogen, *i. e.*, Sulphate of Ammonia and Dried Blood were applied later. On the plots each of 17 square yards, to supply at rate of 80 lbs. phosphate,

* Bulletin, January, 1899, page 1.
† Thomas Phosphate. ‡ Dried Blood.

12½ oz superphosphate was applied; for 40lbs. potash, 4¼ oz. sulphate of potash; for 40 lbs. nitrogen as sulphate of ammonia 11 oz. of sulphate of ammonia; for 40 lbs. nitrogen as dried blood, 16½ oz. dried blood. It was found convenient to weigh out a number of packets containing 12½ oz. superphosphate and another series containing 4¼ oz. phosphate of potash. These were carried to the ground and the packets belonging to each plot laid out against the beds and checked before opening. They were then opened, the contents mixed on a sheet of brown paper, or in a dry, clean tray, with a few pounds of dry earth to increase the bulk, and then the mixture was carefully distributed over the bed. Mr. Watts' directions, as given above, will probably be useful to those who propose to experiment in the same way. He stated also that it would be well to put samples of all the manures into dry clean bottles that they might be analysed. As Thomas Phosphate was not obtainable at the time, Mr. Watts suggested that plot 17 should get 3½ lbs. of wood-ashes with 12½ oz. superphosphate and 11 oz. sulphate of ammonia ; and that plot 18 should have 1¾ lbs. of wood-ashes, and the same amount of phosphate and ammonia as No. 17. This would give 1,000 lbs. and 500 lbs. respectively of ashes per acre.

The tobacco from the different plots were labelled, and dried at Hope. Through the kind consent of Mr. Zurcher, it was then sent to Montpelier to be cured, and afterwards to be submitted for the opinion of the expert on the estate. Although it is scarcely to be expected that the first year's trials will be worth much, they will be a guide to future experiments at Hope.

At High Elevations.—Tobacco grows spontaneously at 4,000 feet in the Hill Gardens so magnificently, that it is proposed to cultivate a small patch there next season, and ascertain its value.

Expert.—The engagement of an Expert in curing tobacco at Montpelier at a high salary is justified as a mere matter of business. It would be a great boon to the whole island, if an Expert of like character could be attached to the Hope Gardens to demonstrate in his work there to all comers the manifold minutiæ of the process of curing. When there was no work that required his presence at Hope, he could travel through the island, giving public demonstrations, examining tobacco undergoing curing at different estates, and affording advice and assistance in every way to any who should seek it.

Instruction.—At present our means of instruction are very limited, but every one who receives seeds may also have the Bulletin(May, 1889 No. 13), written by a Cuban Expert, dealing with the cultivation and curing of tobacco.

Tobacco Beetle.—A complaint having been received of the destruction done to cigars by a minute boring beetle, samples of the infested cigars were sent to England. Mr. A. G. Butler of the British Museum kindly made a report on them.* The only effectual remedy in factories seems to be to store the cigars in tightly-fitting cases, and to prevent old tobacco from lying about and harbouring the insect.

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* Bulletin, May to July, 1898, page 105.

Investigations in U. States.—Prof. Milton Whitney of the U. States Department of Agriculture has examined and classified the soils of the principal tobacco districts of the U. States.* Similar analysis of soils in Jamaica can be compared with Prof. Whitney's results, and very fair deductions made of the kind of tobacco that might be grown on that soil.

Suchsland and others have stated that the fermentation of tobacco is caused by bacteria, and that the aroma is due to specific forms. Dr. Loew under the direction of Prof. B. T. Galloway, chief of the Division of Vegetable Physiology and Pathology, has investigated the curing and fermentation of Cigar-leaf tobacco, and states as the result of his work that the principal changes that take place are due to the action of soluble ferments or enzymes, not bacteria ; and that the development of colour and aroma is due principally to the action of oxidizing enzymes.† This discovery is not only one of the scientific interest,but will be also of great economic value, when the investigations under the charge of Prof. Whitney have been carried further, and the conditions and principles of this process are better understood.

Bulletins.

An Index is in course of preparation to all the Bulletins from April 1887, to December 1898. ‡

The number of Bulletins distributed every month is 1,370, of which 227 are sent abroad. Besides this regular number, many are constantly being sent which contain articles on special subjects on which information is sought.

During the year under review the following articles have appeared in the Bulletin:—

Botanical Notes—
- Wild Olives of Jamaica.
- Ferns of Jamaica.

Chemistry—
- Analysis of Cuba Tobacco Soil
- Analysis of Jamaica Chalk

Diseases of Plants—
- Diseases of Citrus

Economic plants—
- Melaleuca leucadendron
- Citrate of Lime and concentrated Lemon and Lime Juice
- Cotton Seed Oil.
- Ginger in Jamaica.
- Notes on extract of Ginger.
- Plants in the Gardens.
- Tobacco in the United States.

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* Div. of Soils, Bulletin No. 11, 1898 ; and Farmers' Bulletin, 83, 1898.
† Misc. Publications, No. 52, 1899.
‡ Published in July, 1899.

Fruits—
  Banana Meal.
  Propagating Citrus plants.
  Tamarinds.
  Vines and Vine culture.
Insect Pests—
  Beetles in Cigars.
  Entomological Notes.
  Experiments with Insecticides.
  San José Scale.
  Scale Insects
  Weevils in Grain and Peas.
Manures—
  Denitrification and Farmyard Manure.
  Gas Lime in Agriculture.
  Recent Experiments on Denitrification.
  Soil Inoculation.
Rubber—
  Notice of Dr. Morris's lectures on Rubber.
Sugar Cane—
  Agriculture of the Sugar Cane.
  Reports on Sugar Cane.
Timbers and Cabinet woods.—
  Jamaica Satin Wood.
  Jamaica Woods for the Royal Yacht.
Vegetables—
  Bermuda Onions.

Library.

Besides the additions made to the Library by contribution and purchase, already announced month by month in the Bulletin, the following have been added :—

Books added to the Library during the year 1898-99.

Collins (S. J. and others). Phycotheca Boreali-Americana. Fasc. IX, X, XI. Malden, Mass. 1898. Fol.

Engler (A. and K. Prantl). Natürliche Pflanzen-familien. III Teil. Ab. 6 and 6a. III Teil. Ab. 7 and 8. Leipzig 1898. 8vo.

Journal of the Royal Agricultural Society of England, London, 3rd Ser Vol viii Pts. 1 and 2, and Vol. IX. Pt. I. 1898. 8vo.

Morris (Dr. D.) Cantor Lectures—On Plants yielding Rubber. London, 1898. 4to.

Sargent (C. S). The Silva of North America. Vols. XI and XII. Boston and New York, 1897 and 1898. Fol.

Trimen (Dr. H. & Sir J. D. Hooker). Handbook to the Flora of Ceylon. Pt. IV. By Sir J. D. Hooker. London 1898. 8vo.

Wolff. Agricultural Banks, Their object and their work. London. 1898. 8vo.

Wolff. Peoples' Banks. A Record of Social and Economic Success. London. 1898. 8vo.

Catalogue of Welwitsch's African Plants. Vol. I. Pt. III [Trustees British Museum.]

Herbarium.

In connection with Herbarium work, several planters, after reading articles in the Bulletin, such as "Leguminous plants for green manuring,*" and "Soil inoculation,†" have sent to the Herbarium specimens of native leguminous plants, with enquiries as to their names and their power of adding nitrogen to the soil. There is no doubt that many of our native plants are useful in this way, but probably the expense of collecting seed for sowing would be as great as that of importing cow-peas or velvet beans. It would be well to bear in mind that leguminous weeds are not pests in the same sense as others, to be rooted up for robbing cultivated plants of their food, for they actually contribute valuable nitrogen.

Many persons, still under the impression that the olive bears fruit in the island have sent up specimens as proofs. These turned out to be various plants, but not the true olive. A short article was inserted in the Bulletin, pointing out the differences.

Mr. G. S. Jenman, Superintendent of the Botanic Garden of British Guiana has completed his account of the ferns of Jamaica. The series of articles began in Bulletin 18, August 1890. They are most valuable to students of Jamaica ferns, both in the island and abroad ; their publication in the Bulletin has induced collectors to visit Jamaica both from Great Britain and America. Several new species have been discovered since Mr. Jenman began his work, and he has kindly promised to contribute descriptions of these, and to add some further notes.

Mr. William Harris has been engaged during a considerable portion of his time in continuing to collect specimens of native plants. He has just had the honour conferred upon him of being elected a Fellow of the Linnean Society of London.

Several new species and new varieties have been described from Jamaica plants ; and several that are known elsewhere, have been collected here for the first time during the year. The following is a list:—

New Species and Varieties described from Plants found in Jamaica.

Guttiferae—

Rheedia pendula, Urb. (Symbolae Antillanae, Vol. I.)

Malpighiaceae—

Malpighia glabra, L. var. lancifolia, Ndz. (Ind. lect. in Lyc. reg. Hos. Brunsb., 1899.)

M. glabra, L., var. antillana, Urb. and Ndz. (l. c.)
(This was previously referred to M. glabra, L. var. acuminata Juss. See list in Bulletin for 1895, page 217.)

M. fucata, Ker., var macrophylla (Desf.) Ndz. (l. c.)

M. martinicensis, Jacq., var. jamaicensis, Urb. & Ndz. (l. c.)

M. oxycocca, Griseb., var., megaphylla, Ndz. (l. c.)

M. oxycocca, Griseb., var. Grisebachiana, Ndz. (l. c.)

M. oxycocca, Griseb. var., biflora (L.) Ndz. (l. c.)

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* Bulletin, July-Sep., 1897, page 153.

† Bulletin, Aug., 1898, page 174.

Rhamneae—

Sarcomphalus laurinus, Griseb., var. Fawcettii, Kr. et Urb. (Notizbl. bot. Gart. Berl. I. n. 10).

Sapindaceae—

Serjania lævigata, Radlk. (Symb. Ant. I.)

Asclepiadeae—

Asclepias nivea, L., var. intermedia, Schltr. (Symb. Ant. I.)
Metastelma Harrisii, Schltr. (l.c.)
M. Hartii, Schltr. (l.c.)
M. Fawcettii, Schltr. (l.c.)
M. atrorubens, Schltr. (l.c.)

Amarantacae—

Telanthera flavogrisea, Urb. (l.c.)

Polygonaceae—

Coccoloba Harrisii, Lindau. (l.c.)

Urticaceae—

Urera tuberculata, Urb. (l.c.)
Pilea Parietaria, Bl., var. alpestris, Urb. (l.c.)
P. nigresceus, Urb. (l.c.)
P. Harrisii, Urb. (l.c.)

Orchideae—

Epidendrum Harrisii, Fawc. (l.c)

Fungi—

Uredineae—

Puccinia Urbaniana, P. Henn. (Hedwigia,) XXXVII, 1898.)
P. Emiliæ, P. Henn. (l.c.)
P. Synedrellæ, P. Henn. (l.c.)
Ravenelia Humphreyana, P. Henn. (l.c.)
Uredo Euphorbiæ nudifioræ, Henn. (l.c.)
U. bidenticola, P. Henn. (l.c.)
Aecidium Choristigatis, P. Henn. (l.c.)

Polyporaceae—

Polyporus Humphreyi, P. Henn, (l.c.)
Polystictus jamaicensis, P. Henn. (l.c.)
Dædalea jamaicensis, P. Henn. (l.c.)

Sphæropsidaceae—

Phyllosticta oxalidicola, P. Henn. (l.c.)

Hyphomycetes—

Cercospora Piscidiæ, P. Henn. (l.c.)

Species and Varieties new for Jamaica.

Asclepiadeae—

Gonolobus stapelioides, Ham.
G. rostratus, R. Br.
G. virescens, Ham.

Polygonaceae—

Rumex crispus, L.
Polygonum acuminatum, H. B. K., var. glabrescens, Meissn.
Coccoloba laurifolia, Jacq.
C. coronata, Jacq.;
C. nivea, Jacq.

Orchideae—

Maxillaria rufescens, Lindl.

Fungi :

Peronosporaceae—

Albugo Convolvulacearum, (Speg.) P. Henn. (l. c.)

Ustilaginacae—

Graphiola Phœnicis, (Mong.) Poit.

Uredineae—

Puccinia Spermacoces, Berk. et Curt.
Uredo Cannæ, Wint.
Aecidium Cestri, Mont.
A. Cissi, Wint.

Auriculariaceae—

Auricularia Auricula-Judæ (Linn.) Schrot.

Thelephoraceae—

Stereum lobatum, Fries.

Polyporaceae—

Polystictus sanguineus (Linn.) Mey.
P. fimbriatus, Fries (P. Warmingii, Berk.)
P. membranaceus, (Sw.) Fries.
P. hydnoides (Sw.) Fries.
Lenzites repanda, (Mont.) Fries.

Agaricaceae—

Lentinus tener, Klotzsch.
L. crinitus, (Linn.) Fries.

Sclerodermataceae—

Scleroderma verrucosum, (Bull.) Pers.

Coryneliaceae—

Corynelia clavata, (Linn.) Sacc.

Sphaeropsidaceae—

Darluca Filum, (Biv.) Cast.

The following have been added to the collections in addition to native plants :—

Phycotheca Boreali-Americana. Collins. Fascicles IX. X. XI.

Practical Instruction.

Apprentices from Gold Coast.

Two lads, Martinson and Brew, have been sent by the Government of the Gold Coast for a two years course of training in the Public Gardens of Jamaica. These boys were selected by examination, and had to work for a year in the Botanic Garden of their own colony to fit them for more easily and quickly assimilating the teaching here, and also to test their probable capacity for filling the positions for which they are intended as Curators of Botanic Stations on the Gold Coast, and instructors of their own people in agricultural methods. Their Government bear the expense of their board and lodging, and they are bound over under substantial security to repay the expenditure, if, through misconduct, they should be dismissed, or if they should leave the Colonial service, and engage in private pursuits.

Apprentices from Jamaica.

I am somewhat averse from taking apprentices under the existing Apprenticeship Law, but I have made an exception in the case of one, Thomas, who has had a good education and has already been working on a tobacco plantation under Cubans for two years. A lad who has been well educated, who has had previous training of this kind, and understands the responsibility of his situation as an Apprentice, is likely to succeed and fit himself to be manager on an estate.

Other boys who show signs of an intelligent interest in the work, and are capable of responding to teaching, are encouraged to read books and otherwise fit themselves for good positions.

Boys from Jamaica High School.

Three boys from the Jamaica High School come into the garden four mornings a week for actual garden work. Half an hour of this time is given up to attending a demonstration by the Superintendent or the Assistant Superintendent.

Report by Superintendent on Progress.

"Practical lessons and demonstrations on agricultural operations have been given in the Gardens at Hope, and regularly attended by the Industrial School boys, several of whom evince a great interest in agricultural work.

"Great pains have been taken to give reasons for each operation and explanations of those reasons; so that the boy, in being made to understand his work, has his interest awakened, with the result that a love for the work is developed.

"The chief subjects for lessons and demonstrations have been the cultivation of cocoa, coffee, oranges, grapes, pine-apples and tobacco; propagation by budding, grafting and cuttings; the raising of seedlings, and general routine work of nursery and plantation. Care has been taken to work into the lessons as many as possible of the principles of agriculture.

"The three boys from the High School, Simms, Johnson and Thomas, have worked in the garden for two hours in the mornings of four days a week since 31st January. I have noted their progress from time to time, and have concluded that the experiment has so far been a little disappointing; for, although particularly quick at learning the theoretical, they are far behind the Industrial School boys in the practical manipulation of plants, the use of tools, etc. They appear to be greatly interested in the lessons and demonstrations which are given daily to a class consisting of the Industrial School boys, the apprentices and themselves, but in comparing the practical work done by the whole class there appears to be in that of the High School boys a lack of regard for a plant as a living thing, somewhat suggestive of the idea that budding and grafting is much the same as carpentering; no doubt this will in time disappear, but it nevertheless tends to show the necessity of an earlier association with plants, earlier teaching in their functions the effects of different phenomena upon them, etc."

Planter's Opinion of the Value of the Training.

The following is a letter received from Mr. Robert L. Young, of Tobolski, Browns Town, on the work done for him by a lad from the Gardens: –

"Now that I have finished with the services of Rupert Lyon, pro tem. I write to thank you for your kindness in letting me have the use of him.

"The saving to me in the monetary line has been great, and it has demonstrated my evidence given before the Education Commission on the 8th March, namely the want of skilled labour at such a price as to be within the reach of all classes, and it is only through the Hope School and Gardens, that that want can be supplied.

"If the Government want to be of real practical use to the smaller penkeepers and settlers, with the bright outlook for good marketable fruits, now is their time to send about their properly trained apprentices, capable of budding, grafting, pruning, packing fruit, planting them properly, etc. Ninety-nine out of a hundred of our small settlers and others, think they can plant, &c., till they see it done by an expert. Especially in the case of oranges, it would be an object lesson to both labourers and owners themselves, this practical insight, as to how the work ought to be done, better than all the books ever printed.

"Take my own case in point, I wanted to put in five acres in best fruit obtainable, Washington Navel, Grape Fruit, etc. On application to the different nurseries I found I would have to pay for good budded trees, £5 10s. per 100 to say nothing of expense of transit. For five acres at 20 ft. apart I would require 550 trees costing me for trees alone £30 5s The land was laid out with sour stock trees, 300 buds procured from the Gardens say at 3s. 6d. per 100, the rest from some trees of my own. Lyon took 15 days at 1s. 6d. per day, and did over 600 buds at 1d. for each bud that took,—going over a second time those that failed. Total cost :—

300 Buds at 3s. 6d.	...	£0	10	6
15 Days at 1s. 6d.	...	1	2	6
600 Buds at 1d.	...	2	10	0
		£4	3	0

"This speaks for itself, and I am grateful to you for the saving to my pocket.

Yours faithfully,

ROBT. L. YOUNG."

Hope Industrial School.

The Commissioners who were appointed to enquire into the system of education in Jamaica, received satisfactory evidence of the value of the training in the school. One planter stated in evidence that his opinion was that one boy turned out of that institution is worth a dozen other boys in money value.

Another says:—"I went last month to the agricultural school at Hope, and I was astonished to see the cleverness of the boys who were there under training. Their labour was of a class that we cannot get here at any price. The headmen on our estates cannot do the work in pruning, budding and the like, that these boys were doing. The boys were town boys who were sent there through the Courts, but we want that education for our country boys, for they will come back and put that education into use."

The Commissioners recommend that the School should be enlarged and that "provision should be made for resident or non-resident boys." This suggestion they consider very important, as in this way "the best scientific instruction in agriculture can be given to boys of all classes in the island."

At the Conference at Barbados I read a paper dealing with the history of the School, and the methods of instruction adopted.*

Travelling Instructor.

Mr. Cradwick's valuable work as Travelling Instructor is being continued, and is much appreciated. At the Barbados Conference I gave an account of the work done in Jamaica.†

Agricultural Conference at Barbados.

In accordance with certain of the recommendations of the West Indian Royal Commission, an Imperial Department of Agriculture has been established in the West Indies in charge of Dr. Morris as Commissioner of Agriculture with head quarters at Barbados.

The Secretary of State for the Colonies directed that Dr. Morris's suggestion for a conference of the chief chemical and botanical officers in the West Indies should be carried out, and desired that representatives from Jamaica should take part in it.

The Conference was held at Barbados ‡ under the presidency of Dr. Morris on 7th and 9th January last. Mr. Francis Watts attended as the chemical representative from Jamaica, myself as the botanical representative, and Rev. Canon Simms as the exponent of views on higher agricultural education.

On the first day Dr. Morris delivered a presidental address, and the following papers were read:—

Sugar cane manurial experiments.—By Prof. d'Albuquerque.
Field treatment of the diseases of the sugar cane in the West Indies.—By J. R. Bovell.
Central Factories.—By F. Watts.
Cost of growing sugar canes in Barbados.—By J. R. Bovell.

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* Agricultural Instructions in Agricultural Schools in Jamaica. *W. India Bulletin*, I. 1, page 103.
† Practical Field Instruction in Jamaica. *W. I. Bulletin*, I, 1, page 108.
‡ West Indian Bulletin, I. 1.

On the second day the following papers were read :—

Agricultural Education.—By Rev. Canon Simms.
Agricultural Education in Agricultural Schools in Jamaica.—By W. Fawcett.
Practical Field instruction in Jamaica.—By W. Fawcett.
Suggestions for Agricultaral Development in the Leeward Islands.—By Dr. H. A. A. Nicholls.
Improvement in Agricultural Methods in the West Indies.—By J. H. Hart.
The Prevention of the Introduction and Spread of Fungoid and Insect Pest in the West Indies.—By W. Fawcett.
Brief Suggestions on Colonial Industries.—By Prof. Carmody.

Experiment Station Scheme.

At a meeting of the Jamaica Agricultural Society held on the 14th December last the following Resolution was passed :—

" That the delegates to the conference at Barbados be requested to urge on Dr. Morris the necessity of establishing an experiment station in Jamaica in connection with the existing Botanical and Agricultural Departments, as well as in the advancement of agricultural education, and the Governor be asked to represent to the Secretary of State for the Colonies the importance of such an experiment station and to request that this Colony be included in the scheme of grants in aid provided for the other West Indian Islands."

About the same time the Rev. Canon Simms received a letter from Dr. Morris, asking whether he could make use of the services of a lecturer on agriculture at the High School.

His Grace the Archbishop of the West Indies, Rev. Canon Simms, Mr. F. Watts and myself had the honour of an interview with the Governor on the subject of an Experiment Station, and His Excellency expressed his approval of it, and desired that Dr. Morris should be consulted about it at the forthcoming Conference.

Shortly after our return from the Conference a meeting took place of the following :—The Archbishop, Bishop Gordon, Hon. Dr. Pringle, Hon. J. T. Palache, Hon. T. Capper, Rev. Canon Simms, Mr. F. Watts, Mr. G. A. Douet, and myself, as Chairman.

Mr. Watts outlined a scheme whereby Dr. Morris's offer could be best utilised. It showed how the Department of Public Gardens and the Chemist's Departments while remaining independent, could unite in work more completely than at present.

Dr. Pringle and Mr. Palache, in acknowledging how well these two Departments and the Agricultural Society were working together, were of the opinion that the Society should not be left out in any scheme of development, but brought into still closer touch with the other two Departments.

It was therefore agreed to lay the subject unofficially before the Members of the Board.

A largely attended meeting of the Board and others was held at the end of January, and the general outlines of a scheme were agreed to.

The scheme was finally submitted to the Governor in February, and published later for the information of the Legislative Council. The following is a copy :—

Kingston, 18th February, 1899.

SIR,

Acting upon the instructions conveyed in your letter No. 9995-13280 of 29th December, we have the honour to submit, for the consideration of His Excellency the Governor, a scheme for the establishment of an Experiment Station and for the employment and instruction thereat of boys from the Industrial Schools and also of boys whose maintenance would be paid for by their parents.

2. The demand for agricultural instruction and training has recently found expression in a number of ways, and on the part of almost all classes of the community, and we therefore bring forward proposals, not only for the establishment of an experiment station for the study of agricultural problems and the training of boys from the Industrial Schools, but also for giving, in connection with the station, systematic and organised instruction in Agriculture, in a practical as well as a theoretical manner, in a form suited to the requirements of various other classes of the community.

3. Following the verbal instructions of H. E. the Governor at an interview accorded to a deputation from the Schools Commission, on December 28th, at which we were present, we have associated with us in the preparation of this scheme, the Rev. W. Simms, M.A.

4. It is well to record here the fact that we three were representatives of Jamaica at the Agricultural Conference held in Barbados under the auspices of the Imperial Department of Agriculture for the West Indies, on January 7th and 9th and that at this conference considerable attention was devoted to the consideration of the question of agricultural instruction in various forms. When in Barbados we had also an opportunity of consulting with Dr. Morris, the Commissioner of Agriculture and President of the Conference.

5. We are of opinion that the requirements of the Colony may be best met by the establishment of a station where first agricultural problems, with which the practical planter and penkeeper are constantly confronted, may be systematically studied; and where secondly, the services of those engaged in the management, as well as the material and the appliances of the station, may be utilised to great advantage in giving instruction to pupils drawn from the various classes of the community interested in agricutural pursuits.

6. It is unnecessary to dwell at great length on the advantages which should follow from the formation of an Agricultural Experiment Station, but we may point out that institutions of this character have proved to be the most useful means yet devised for aiding the practical agriculturists in the United States and Canada in which countries these stations have done much to promote and foster agricultural advancement.

7. Such a station for Jamaica should have for its object the study of the staple crops of the colony, the consideration of the conditions under which these are grown, and demonstrations of the results of different methods of cultivating, fertilising or manuring, or any operation connected with the crop

8. In addition to the study of crops grown largely for export, attention should be given to the products grown for local use, particularly, those used for food.

9. Improvements in the kind of plants grown and the study of improved varieties which may be introduced from without should also occupy the attention of the station workers.

10. Special efforts should be made to maintain demonstration plots, whereon should be shown as continuous object lessons, correct methods of cultivating crops of local importance.

11. It is desirable that attention should be given to the economic value of the different methods of working, of cultivating, manuring and general handling of crops, as well as the value of new varieties of plants ; and in the publication of the results, as far as possible, reference should always be made to the difference in the monetary value of these methods or varieties, for the information and guidance of practical planters : indeed this should be the key-note of a large proportion of the work of this kind,—the determination whether certain operations, or the introduction of certain varieties of plants will or will not pay.

12. The station will also afford facilites for the study of the enemies, pests and diseases attacking crops, a subject of growing importance and one for which there is very little provision in the colony to-day.

13. Such commercial considerations as the methods of preparing and packing products for export also come well within the province of the station work.

14. The care and management of farm animals and dairying demand attention : provision should be made for carrying on work on these lines in connection with the Station and a distinct and properly equipped Veterinary Department should be ultimately formed at the Station. At the outset, however, we are constrained by questions of economy and finance to suggest that this veterinary side shall be started in a small way only, trusting that as soon as the Station is found to be firmly established, veterinary questions will receive the attention they deserve, and that proper provision will be made for this work at an early date.

15. Publications setting forth the results obtained at the Station should afford useful information to those now employed in dealing with agricultural products.

16. Instruction in agricultural science and the arts of husbandry should also be afforded to the youths of the colony ; this instruction on the one hand should be framed to meet the requirements of the youths who are about to become planters, while on the other, it should include training for those to be actually engaged in tilling the soil and conducting manual agricultural operations. Instruction of a particular kind should be provided for those under training to be teachers in elementary schools, so that by their agency sound ideas on the subject of agriculture may be diffused throughout the country by means of the scholars whom they will have to teach.

17. This brief outline will serve to indicate in a general way various functions which we believe should be discharged by an Experiment Station in Jamaica.

18. We have given careful consideration to the many points involved in the questions relating to the best means of establishing such a Station, and we are of opinion that this may be secured in the following manner :—Provided that the necessary assistance is given, it appears to us that most of the work involved in our proposals may be superintended and carried out by means of the Department of Public Gardens and Plantations and the Chemical Department, and this without detriment to the working of these Departments.

19. In connection with the Hope Gardens and the Hope Industrial School there are upwards of one hundred acres of land available for such a Station as we contemplate. A plot of about 27 acres lying between the lands of the Jamaica High School and the Hope Gardens, and along one side of which runs the high road with the electric car line, appears to be a suitable site for occupation at the outset. This land is similar in character to much of that now occupied by the Hope Gardens, and is sufficiently fertile for the

purpose required, provided a supply of water can be obtained. An examination of the neighbourhood leads us to believe that this water may be obtained. This question we deal with subsequently. On this piece of land the necessary buildings should be erected and the land cleared and laid out in such a way as to be suitable for the cultivation of crops in the manner and for the objects already indicated.

20. To give effect to the scheme it is desirable that the Government Laboratory should be removed from Kingston to Hope. By this means one properly equipped laboratory would be provided and capable of performing the duties required on the part of the general Government as well as those more particularly arising from Station work, while the Chemical officers will be able to take part in the supervision of such portions of the Station work as falls within their cognizance and also to take part in the work of teaching and instructing.

21. As the Hope Gardens adjoin this site, the officers of the Botanical Department can assist in the work of the Station without any such extensive changes being necessary as are involved in the removal of the Government Laboratory.

22. In addition to the requirements of the laboratory it will be necessary to provide accommodation for students, for this a large lecture-room, to serve also as a general meeting-room, a laboratory or working room, one or two small class rooms together with two or three small rooms as offices for the Agricultural Instructor, the Entomologist and the Secretary appear to be all that will be wanted at first. To erect a building containing this accommodation would probably cost £1,200 to £1,500. It has, however, been suggested to us that it may be possible to obtain from the Trustees of University College the use of a portion of the building provided for college purposes. An inspection of the buildings leads us to believe that accommodation may be found in University College for nearly all the work of the Experiment Station so far as it deals with the work of students, that a lecture-room and students' laboratory may be accommodated there as well as the offices for the Agriculturist, the Entomologist and the Secretary. This being the case, it will only be necessary to erect buildings to accommodate the Government Laboratory with perhaps two additional rooms. By adopting this plan it will probably be possible to reduce the outlay on buildings to about £900.

23. Having indicated the general objects of the Station, together with the requirements in the matter of land and buildings, it remains to arrange for the management and carrying out of the work.

24. Instead of creating a separate staff of officers for the Station, it appears to us to be desirable that existing officers and institutions should be made use of as much as possible ; such a course we believe, will prove most beneficial, not only to the Station, but also to the Departments co-operating in the work. The removal of the Government Laboratory to Hope, as we suggest, will bring together the scientific officers of the colony whose work bears upon agriculture. It will also enable the Department to undertake work arising from the Station. In order that this may be done it will be necessary to provide additional assistants. So far as we can see at present, an assistant will be required in the Chemical Department and one in the Department of Public Gardens and Plantations. When thus equipped these two Departments should be able to undertake the duties of conducting investigations on crops, both in the field and laboratory, as well as the teaching required by the various classes and grade of pupils. Those subjects, for which the Department are unable to provide, such as Entomology and Veterinary work, may be dealt with in the first instance by officers from other Departments or by outside lecturers : in this connection it is probable that the Curator of the Museum of the Jamaica Institute may render valuable assistance.

25. The newly formed Imperial Department of Agriculture for the West

Indies has its attention largely directed towards agricultural developments of the nature of those we are advocating, but the operations of this Department have not been extended to Jamaica beyond the offer of an annual grant for providing an Agricultural Instructor and for small Agricultural Scholarships. We feel most strongly that providing an Agricultural Instructor without some such basis of practical work and teaching as we propose will prove an inefficient means of dealing with the agricultural problems now confronting us. This view we were enabled to lay before Dr. Morris during our visit to Barbados, and to point out to him the desirability of utilising any grant of officers or of money in connection with some such organized method of working as we now put forward, a view in which he concurred.

26. Seeing that the Imperial Department of Agriculture has already proffered assistance in agricultural teaching, we suggest that it should be appealed to for help on a broader basis, namely to provide the services of the additional men required for carrying these plans into effect. To put this in a definite form we think that a request might be made for £300 a year for an assistant chemist, £200 towards providing for an Assistant to Director Public Gardens and Plantations, and £150 to provide for the services of other lecturers and instructors, thus making an appeal for an annual grant of £650 instead of the £350 which is offered for agricultural instruction in another way.

27. The Imperial Department in addition to providing an instructor, proposed to offer scholarships to assist pupils in attaining instruction: these scholarships we believe, would be extended to the amplified form of agricultural instruction provided for by these plans. We have not included them in the sum of £650 here referred to for services of assistants and instructors.

28. The boys of the Industrial Schools may be employed to advantage in carrying on the cultural operations of the Station: this work will form the best means of training them to perform agricultural work of a practical kind, and as all the various crops raised will require to be grown with the greatest care and with specific objects in view, their training would be eminently practical and thorough. Beyond the mere tilling of the soil the boys would have the duty, under proper supervision, of reaping and handling all the crops grown on the station including such crops as Yams, Potatoes, Corn, Sugar-cane, Tobacco, Coffee, Oranges and Cocoa.

29. To give effect to this some changes will be necessary in the present Industrial School and Reformatory. As now existing there is the Reformatory at Stony Hill and the Industrial School at Stony Hill—these two Institutions being amalgamated and worked together, and also the Industrial School at Hope. There appears to be very little difference or distincion at present between the Industrial School and the Reformatory, except that only boys classed as belonging to the Industrial School were sent to Hope. The establishment of the two arose we understand, from a desire to separate those boys who are placed in a Reformatory in consequence of having committed some offence which renders them liable to be committed to prison, from those boys who are under no proper control, waifs and strays or destitute, but who have no stigma of crime attached to them, and are in consequence sent to the Industrial School. As matters now stand, it does not appear that at Stony Hill any difference in treatment or any distinction is made save in name only. The two classes of boys are not separated in the Stony Hill institution nor is there any difference in their training or treatment.

30. Under these circumstances it seems to us desirable to abolish this distinction and to have one institution to be called an Industrial School, to which should be committed juvenile offenders and vagabonds. But in order to prevent the ill-effects which would arise from the presence in the school of boys of decided criminal tendency, likely to interfere with the well-being of the school while they derive little benefit from its influence themselves, provision should be made whereby boys of this kind may be committed, either at first or later, to a prison for juvenile offenders.

31. It may be urged that this plan deprives certain boys who are neither juvenile offenders nor vagabonds of the advantages to be gained from an Industrial School. To our minds it is a mistake to endeavour to draw the present distinction where no real separation of the classes exists, and we suggest below a means whereby the requirements of respectable boys of the peasant class may be provided for.

32. Should this proposed alteration be made, it will be well to preserve the present arrangements at Stony Hill, under the designation of the Industrial School, and the boys should continue to be trained much as at present. The instruction in various trades now carried on appears to be valuable and calculated to turn out boys useful as tradesmen in after life. The boys are now taught to work as carpenters, blacksmiths, masons and tailors: some training in field work in agriculture is given to a number of the boys at Stony Hill, while all the boys at Hope Industrial School are trained in field work and agriculture.

33. Those boys for whom an agricultural training is thought desirable, should be placed at the Hope Industrial School, which would then become a branch of the Stony Hill establishment set apart for the training of a particular class of boys in agriculture just as certain classes are trained in other occupations—carpenters, blacksmiths, masons, at Stony Hill. The discipline should be the same at both establishments, and to ensure this there should be at Hope an Officer in charge who is able to maintain efficient control over the whole affairs of this branch of the Industrial School; he should be an Assistant Superintendent. The rest of the staff should be arranged upon similar lines to those at Stony Hill. We think this should comprise a schoolmaster and four warders; or one warder for every 12 boys.

34. Provision may be made for the accommodation of 50 Boys at Hope with but little alteration of the existing buildings. The boys now take their meals and attend school in the same room in which they sleep: it would be an advantage in many respects if a separate room were provided to serve as a school-room and dining-room. Portions of the dormitories are now partitioned off for officers' quarters: these partitions might be removed and other quarters found for the officers: by means of minor alterations such as these, 50 boys may be accommodated. If a larger number of boys are to receive agricultural training at Hope new buildings must be erected.

35. If the course which we now recommend is adopted, it would be well to reorganize the whole of the arrangements at Hope by regarding the present staff and inmates as a portion of the Stony Hill establishment, even if they are not temporarily drafted there. The officers in charge at Hope should be definitely appointed to their duties, and boys suitable for agricultural training should be selected for the school; boys who are too young or otherwise unfitted for useful employment in agricultural work should be retained at Stony Hill.

36. In going to work at the Experiment Station, or elsewhere, the boys should go in detachments, each under the control of a competent warder, who will remain in charge of his detachment to maintain order and will accompany the boys back to the school. An efficient drilling will greatly facilitate the maintenance of discipline in the field and the orderly transfer of the boys to and from the school and the Experiment Station.

37. Up to this point we have outlined the functions of an Experiment Station and have pointed out an available site and the manner in which the work of the Station may be managed, together with a provision for the cultivation of crops by the inmates of the Industrial School.

38. Apart from the agricultural instruction to be given to boys of the Industrial School class, it is essential that higher instruction in agriculture should be given to those who are ultimately to have charge of estates and pens in the colony: these are to be found in the Secondary and High Schools. Much benefit would accrue to the colony if those

boys who are destined for an agricultural career were to receive during their final year at school, or perhaps longer, instruction in such subjects as may be brought to bear more or less directly upon agriculture, such as chemistry, geology, plant and animal physiology, instead of, as at present, devoting their time largely to classical studies. If at the same time those boys receive some practical instruction in agricultural arts and be made familiar with the methods of raising and handling crops, the ultimate gain to the community would be great. Youths thus trained cannot fail to be more observant, more receptive of new ideas, more apt in utilizing them, and more fertile in invention than those who are thrust into planting life with no specific preparation or training.

39. To accomplish this, the Experiment Station should provide a course of instruction in agricultural subjects which may be taken by boys of the higher schools as part of their school work, and while still under school discipline. We have outlined such a course of instruction occupying three hours a day; these three hours would be spent at the Station, the remaining time would be occupied in School work in the ordinary schools in the usual manner. The course would extend over one year, but we consider it very desirable, or almost necessary, that the pupils should devote two years to this work:—

40. The course of instruction which we suggest is as follows:—

Agricultural Chemistry—including theory of agriculture. Two lectures a week each of 1 hour's duration.

Practical Chemistry—Two lessons or demonstrations a week each of 2 hours' duration.

Practical instruction in agricultural methods and practice, (a) in the field,—three lessons or demonstrations a week each of 2 hours' duration; (b) in the laboratory or class room in extension of the field and lecture work,—one lesson a week of 1½ to 2 hours' duration.

Plant Physiology and Botany, as applied to agriculture.
One lesson a week of one hour's duration.

Veterinary instruction—Two terms.
One lecture a week of one hour's duration.

Agricultural Entomology: insect life, injurious and beneficial insects. One term. One lecture a week of one hours' duration.

Book-keeping should be taught in the schools, instruction being given in the methods suitable for use on plantations.

Mensuration, land measuring, &c., should be taught partly in the schools and partly by practice at the Station.

41. The lectures and classes of this course would be open to any member of the community on payment of a moderate fee; students would be permitted to attend courses of instruction in any one or more subjects according to their requirements. In this way the usefulness of the instruction given would be extended to persons other than pupils of the High Schools. It is probable that some persons would gladly avail themselves of this means of acquiring information in the different branches of agriculture to be taught. Appropriate fees for this course of instruction should be fixed, but there is no ground for anticipating that any very considerable sum would be derived from this source.

42. For the instruction in agriculture of the students of the training colleges, through whose agency the teaching of agricultural subjects in Elementary Schools must be accomplished, a special course of instruction should be provided. This should comprise a course of instruction in the general principles of agriculture, including the rudiments of agricultural chemistry, p ant physiology, properties of soils and the nature and uses of crops of local mportance. In addition to instruction by lectures, special attention shoul be

given to instruction and practice in agricultural operations in the field. The student should be practically taught the nature and requirements of crops commonly cultivated in the colony and the best means of dealing with them. They should be practically instructed in, and learn to carry out the methods of preparing the soil, the selecting and planting of the seed and the reaping and curing of the mature crop. They should also be practically instructed in budding, grafting, pruning, and kindred operations. Some practical instruction in horticulture should also be given.

43. In the instruction given to the students of the training colleges particular attention should be directed to offering them information calculated to be useful to them in their capabilities as teachers in Elementary Schools, and further, great care should be given so to instruct them in the methods of teaching agricultural subjects that they may be able to turn their acquired knowledge to the best possible advantage when instructing pupils in the Elementary Schools.

44. This instruction may be given best in the final year of the students' training and for this purpose these students should spend one day a week at the Experiment Station, spending the whole working day there. This may be readily arranged after consulting with those in charge of the Training Colleges, and it does not appear necessary at this point to enter more particularly into details, the outline we have given serving to indicate the general scope of the teaching and the time which should be devoted to it. Some contribution towards the expenses of this work should be made on the part of the Training Colleges.

45. In addition to the courses of instruction already suggested, short courses on special subjects of local interest and importance may be arranged with advantage. In this manner from time to time lectures and demonstrations might be given on the methods of growing, curing and manufacturing such products of Coffee, Cocoa, Sugar, Bananas, Orange, Fibres and Indian Rubber. These courses should be, more or less, of a technical character calculated to afford information to men already engaged in, or about to engage in, industries connected with these subjects.

46. We are instructed to suggest methods whereby instruction in agriculture may be given to boys of the peasant class who may be able to afford to pay small sums for the instruction which they receive.

47. It appears to us that the first requirement for the proper performance of this duty will be some provision whereby boys under training may reside near the Station. If buildings are provided for this purpose, we would purpose that what may perhaps be called an Elementary School for Agricultural Training may be formed upon the following lines:—

48. A fixed number of boys whose ages may be from 14 to 16 years should be received into the School, and some care and control should be exercised in the manner of their admission. Proper forms of application for admission should be drawn up, and these applications should be signed by some person of standing, such as the Custos for the Parish of the applicant It would be well that the Resident Magistrates should not sign these applications lest there should arise some confusion in the minds of the peasantry between this school and the Industrial School to which the Magistrates have power to commit children. These applications should be considered by the Station Board, and candidates carefully chosen to fill any vacancies existing in the School.

49. A Superintendent will be required for the School, together with a sufficient number of assistants to preserve discipline and order, not less than one assistant to every 12 or 15 boys will be necessary.

50. The instruction to be given to these boys must largely consist in training them in the art of husbandry in different branches ; they should be taught as fully as possible how all the various cultural operations of a farm or estate are conducted ; they should learn to till the soil and to prepare it for various crops ; to plant, tend and reap these crops, to bud, graft and

prune fruit trees and to prepare products for use or for market, such as starches, cocoa, tobacco and other crops grown locally.

51. The greater portion of this instruction should be given on the field, and should consist largely in so exercising the boys that they may efficiently perform these operations of tilling the soil and of manufacturing crops, much time would thus be devoted to bodily and manual training. Four or five hours a day might be given to work of this kind. Some agricultural instruction of a kind suited to the requirements of this class of pupils might be given in the form of teaching in-doors, and a certain time probably about two hours a day—should be devoted to ordinary school studies, such as arithmetic, reading and writing, arranged to meet the requirements of the scholars.

52. The practical agricultural teaching would be under the direction of the Experiment Station Staff, who would be assisted in the supervision and carrying on of the field work by the staff attached to the school itself.

53. The length of time these boys should be under training might be one or two years.

54. The boys would be lodged and fed at the expense of the Station; they should clothe themselves, and probably it may be found desirable that they should be required to do this in a uniform manner, from material provided by the school at a moderate cost. They would be required to pay a small sum for their training.

55. School discipline would have to be maintained and any serious infraction of order or discipline should render the pupil liable to removal from the School by the Station Board.

56. While maintaining the necessary order every care should be taken to avoid any confusion in the public mind between this School and the Industrial School. Perhaps no better method of securing this can be found than rendering the admission of a pupil a matter of some formality, and also rendering him liable to be removed, if his conduct is not satisfactory. The school buildings should be quite distinct and separated as widely as possible from the Industrial School.

57. The Elementary Agricultural School might, to some extent, provide for a limited number of respectable boys of the poorer class, the Government bearing the whole cost of their maintenance. This course appears preferable to sending such boys to the Reformatory or Industrial School, as is now the case.

58. The arrangement and working of such a school will require the exercise of considerable thought and judgment, as well as considerable monetary outlay. Taking these facts into consideration, we believe it will be wisest to establish the Experiment Station on a firm basis before attempting to start the Elementary Agricultural School: after the Station has been working satisfactorily for perhaps two years, then steps may be taken for the formation of this school. For these reasons we do not now suggest any financial provision for this part of the scheme.

59. The affairs of the Station will involve a considerable amount of secretarial work, in conducting the necessary correspondence locally and abroad, in the preparation and publication of reports on investigations, the compiling of statistics and generally in maintaining that intimate contact with the agricultural public which is so desirable.

60. In this work the Jamaica Agricultural Society may render useful aid if arrangements are made whereby the secretarial work of the Station can be undertaken by the Secretary of the Society and his assistants. Such a course would seem to bring the Society into similar relationship with the Station as is proposed in the case of the Botanical and Chemical Departments, a plan which we think likely to prove beneficial to all concerned. To carry out this another Assistant would probably be required. From what we can gather,

we believe this will meet with the hearty approval of the Board of Management of the Society.

61. The results of the investigations conducted at the Station would be published in the Bulletin of the Botanical Department and the Journal of the Jamaica Agricultural Society, in this way there would be no need for the issue of a new Journal.

62. The management of the affairs of the Station should be entrusted to a board which should be charged with the administration of the funds provided for the Station work. The Board should also direct the nature of the work to be undertaken at the Station, the courses of instruction to be given, and should generally control the agricultural instruction provided for the various classes and grades of pupils and students to whom we have referred.

63. It appears to us that the Board might well be constituted as follows :—

Ex Officio Members—

(1) The Director of Public Gardens and Plantations.
(2) The Government Analytical and Agricultural Chemist.
(3) The Head Master of the Jamaica High School.
(4) The Secretary of the Agricultural Society.
(5) The Commissioner of Agriculture of the Imperial Department of Agriculture for the West Indies.

Members nominated by the Governor.—

(6) An Elected Member of the Legislative Council.
(7) A person who is not an Elected Member of the Legislative Council

64. Water supply. This question is of fundamental importance and an adequate supply of water must be assured before other operations are undertaken on the Hope site. The rainfall at the Hope Gardens averages 52 inches a year, during the dry season of 1896-97 the rainfall was only 31½ inches. It will not be necessary to obtain a water supply capable of continuously irrigating the whole of the Station land, but a sufficient supply should be secured to enable growing crops to be kept in a healthy condition during dry seasons. Some cultivation is still maintained in the district without the aid of irrigation. But it would be unsatisfactory if Experiment Station work were undertaken without some water supply to supplement rainfall.

65. The Hope Gardens derive their supply from the Hope Water Works, for this a sum of £131 11s. a year is paid. A further sum of £54 is paid for the water supplied to the Hope Industrial School.

66. It is not dersirable that the Experiment Station should seek to obtain its water supply from the same source, and several other methods of securing a supply have suggested themselves :—

(1) The construction of ponds or reservoirs within the Hope Gardens for the conservation of the waste water now running at intervals from Hope Water Works and for collecting and storing storm water.

(2) A supply of water may possibly be obtained by means of wells sunk into the alluvial strata underlying the proposed station.

(3) A small and fairly constant stream of water exists on the hillside above Hope Gardens on land belonging to the heirs of the Duke of Buckingham and Chandos: we believe that the use of this water might be secured for the Station at a reasonable price. In order to utilise this supply means must be taken to convey the water from the hillside to the Station by appropriate channels, we have had an inspection of the ground made from which we

are led to expect that this water can be conveyed to the Station without much difficulty and at a cost of about £300. We suggest that attention should be given to this source of supply and that steps should be taken to secure the right to use the water and to convey it to the Station site.

(4) If this scheme does not prove practicable we believe that the needs of the Station may be met by storing water in ponds or reservoirs either in the Hope Gardens or on the adjoining lands where there are several gullies down which water flows during rains, in which gullies, ponds may be formed at moderate expense. Though doubtless a system of ponds or reservoirs must limit the area to be irrigated, it must be remembered that constant irrigation will not be required, irrigation would be required to aid crops during drought or to illustrate the general principles of irrigation. There would in this case also be expenditure.

67. To carry these plans into effect we estimate that the following expenditure will be necessary, in addition to the votes provided for the several Departments concerned. As we have pointed out we think that Imperial aslsistance may be asked for in order to provide for the staff, the other requirements to be met out of local funds.

Assistant Chemist .	£300	
Department of Public Gardens and Plantations	200	
Other lectures .	150	£650
Labour, Teaching, Supplies, etc.	375	375
*Buildings .	900	
Fitting Student's Laboratory .	50	
Removal of Government Laboratory	50	
Water Supply .	300	1,300
		2,325

68. Of this sum we believe that £650 may be obtained from Imperial funds, while of the remainder, £1,300 is not a recurrent annual expenditure, but merely incurred for building. If this expenditure can be spread over a period of, say ten years, it may be met by an annual expenditure of £150 to £170 per annum. This, together with the £375 estimated to be spent in tools and supplies, makes £525 to £545 a year to be provided for locally.

In framing this estimate any expenditure on account of the Industrial School has been left to form a charge on the existing Reformatory and Industrial School Vote.

We have, &c.,

FRANCIS WATTS.
W. FAWCETT.
WM. SIMMS.

GOVERNMENT CINCHONA PLANTATIONS.

The extraordinary rise in the price of quinine and cinchona bark in the beginning of the year 1899 had led to a review being taken of the present condition of the Government Cinchona Plantations, and a consideration of the practicability of manufacturing quinine as in India.

* In the event of some accommodation being provided in University College.

The work of counting the trees has been most arduous. No cultivation has been carried on where the trees are growing for 13 years, and the jungle that has sprung up is impenetrable except by the use of the cutlass.

A report in detail will be found below of the number of Cinchona trees that can now be barked,and the amonnt of bark that can be taken. It appears that 22,470 trees can be barked at once, and on two portions of the Plantation young self-sown seedlings of Crown Bark trees (Cinchona officinalis) are springing up in immense numbers, and only want the care of the forester to develop and mature.

In order to clear up some misapprehension it may be well to offer some explanatory remarks. The land belonging to the Government on parts of which Cinchona trees were planted, is on the southern slopes of the Blue Mountains, extending from the ridge at an elevation of about 6,000 feet downwards to about 3,000 feet. The Superintendent's House is situated at about the centre at an elevation of about 4,800 ft.

The Cinchona trees were planted in different places on the higher slopes. Various other cultures have been under experiment viz :—Fruit trees, including Orange and other varieties of Citrus ; timber trees for supplying local timber supply, for shelter belts, and for general forestry purposes ; Rubber trees, Tea, Olives, Jalap, Vegetables, China grass, grasses and other fodder plants ; plants for green dressing, and other economic plants. These have been planted out at various elevations throughout the range from the lowest to the highest.

The name " Cinchona" was applied to the whole Government property which includes several old estates, but lately the name " Hill Gardens" has been substituted in order to indicate the change in the work. The name " Hill Gardens" includes both the Cinchona Plantation and the Experimental Plots.

The Cinchona Plantation had accomplished the aim of its founder, Governor Sir J. P. Grant ; had paid for itself ; and practically closed its accounts in 1887, shortly after my arrival in the Island. Henceforth experimental work was carried on in other directions. In all my Annual Reports for 12 years, and especially in those for the years 1891-93, 1893-94, and 1895-96, I have endeavoured to show the necessity for an experimental garden at a high elevation, and the good work that is being carried on there,

There is no necessary connection between the Plantation and the Experimental Garden, and if the Cinchona Plantation were again taken in hand and worked, these should be a distinct understanding that the fortunes of the two establishments should not be linked so closely that any failure on the part of the plantation to pay its way, would involve the abandonment of the Garden.

With reference to the question whether the Cinchona plantation is capable of paying its expenses, it will be necessary to consider the two ways in which a Government Plantation may be worked. The bark may either be harvested and put on the market as bark, or the quinine and other alkaloids may be extracted from the bark, and then sold. The former has been the plan adopted by the Government in Java on the Government plantations. The other plan is the one in use by the Government of India, whose humane policy all along has been to put it in the power of the poorest natives to buy quinine in their need.

The bark that could be at once harvested amounts to 40,000 lbs. But in order to keep up a constant supply only half of this amount should be taken every year, viz. 20,000 lbs.

The cost in 1887 of barking, drying and carriage to Kingston from the plantation was a trifle over 3d per lb. The freight was about $1\frac{1}{20}$d. per lb. So that the bark should realise at least 5d. per lb. to avoid loss.

In the present state of the market it would be a risk to harvest bark and send it to London.

In estimating whether the Government would recoup their expenditure, if a factory for the manufacture of quinine were started, there are several points to consider, viz.: annual expenses of a factory, what amount of quinine must be manufactured to avoid loss, could the Government dispose of this amount of quinine, could the plantation supply the amount of bark required.

As to the factory, I consulted Mr. Francis Watts, whilst he was still Government Chemist here, and he calculated roughly that it would take £1,200 per annum to run a factory, this sum including salary of managing Chemist, interest and sinking fund for buildings, chemicals, labourers in factory, etc.

To estimate the amount of quinine that must be sold to cover this expenditure it is advisable to take the lowest figure to which quinine would ever be likely to fall in the future, and probably it would not be safe to put that higher than at 1s. per ounce. To balance the expenditure of £1,200 therefore it would be necessary to sell annually 24,000 ounces at 1s. per ounce.

The Medical Department in Jamaica only used 3,761 oz., in 1898 or about one-sixth of the total that must be sold.

The plantation could at the present time supply 20,000lbs. of bark, which ought to yield 10,000 ounces of sulphate of quinine. It is very doubtful whether the planters could supply the deficiency now to the full extent, but if there were a demand for bark, no doubt both Government and planters would extend their plantations as they are doing in India.

These calculations all depend on the price at which the quinine could be sold, and as quinine has risen and is likely to remain at a much higher figure than last year, the basis of calculation is perhaps taken too low.

If a factory turns out only 10,000 ounces per annum, and costs £1,200 per annum to run it, the price per ounce should be 2/5 in order to avoid loss.

It must be remembered however that the success of a factory depends quite as much on the amount of the manufactured article turned out, as on the price received for it. At the Ootacamund factory 234lbs. of quinine were made in 1889-90, 1,356 lbs., in 1890-91, 3,344 lbs., 1891-92, and so on to 6,336 lbs., in 1897-98. It would not cost much more to produce 30,000 ounces than 10,000 ounces.

Report by the Superintendent, Hill Gardens on the Government Cinchona Plantations, showing number of trees, and estimated quantity of bark which may be obtained.

" *Lower Buzza Plantation.* This plantation is in heavy bush, many of the old trees are dying, and no young ones are springing up. It is planted entirely with Cinchona succirubra.

Number of trees 830.

Estimated quantity of bark shavings 8,000 lbs.

" " whole bark 16,000 lbs.

" *Upper Buzza Plantation.*—This Plantation is in the same condition as Lower Buzza. The old trees are dying here also, and no young plants are growing.

The Plantation consists of Cinchona succirubra, C. Calisaya, C. officinalis and C. hybrid.

Number of trees 680.

Estimated quantity of bark shavings 4,800 lbs.

" " whole bark 9,600 lbs.

" *Sullivan's Piece Plantation.* This Plantation is in very heavy bush and fern. It is planted with Cinchona officinalis, C. calisaya, C. hybrid and a miscellaneous collection. Large numbers of C. officinalis are growing in this Plantation from self sown seeds.

Number of trees 1,238.

Estimated quantity of bark shavings, 5,000 lbs.

" " whole bark 10,000 lbs.

" *Harvey's Field Plantation.*—Planted with Cinchona officinalis, C. calisaya, C. succirubra and C. hybrid.

This Plantation is in very heavy bush and fern. The Coniferae planted here have killed a great many of the Cinchona trees. No seedlings are growing in this plantation.

Number of trees 822.

Estimated quantity of bark shavings 3,700 lbs.

" " of whole bark 7,400 lbs.

" *Latimer Plantation.* Planted with Cinchona succirubra, C. hybrid, and a few C. Officinalis.

Plantation in very heavy bush; no young plants are growing, but, on the contrary, a very large number of the old trees are fast dying.

Number of trees 1,750.

Estimated quantity of bark shavings 25,000 lbs.

" " of whole bark 50,000 lbs.

" *White Piece Plantation.* Planted with Cinchona calisaya, C. succirubra and C. hybrid. The Plantation is in very heavy bush; many of the old trees are dying, and no young ones are growing.

Number of trees 650.

Estimated quantity of bark shavings 4,000 lbs.

" " of whole bark 8,000 lbs.

" *Monkey Hill Plantation.* Planted with Cinchona officinalis. It is in very heavy bush and fern. Large numbers of self sown seedlings are springing up in this plantation.

Number of trees 16,500.
Estimated quantity of bark shavings 72,500 lbs.
" " of whole bark 145,000 lbs.

" *Summary.*

The number of trees are as follows:—

Cinchona officinalis	...	17,260
C. succirubra	...	2,280
C. calisaya	...	1,050
C. hybrid	...	1,452
Miscellaneous	...	428
Total number of trees		22,470

Bark Shavings.

		Green bark.	Dry bark.
Cinchona officinalis	..	78,750 lbs.	26,275 lbs.
C. succirubra	...	32,000 "	10,700 "
C. calisaya	...	4,250 "	1,420 "
C. hybrid	...	8,250 "	2,750 "
Miscellaneous	...	1,750 "	600 "
		125,000lbs.	41,745lbs.

The above estimate is for bark shavings, but if it is decided to cut down the trees and bark the trunks, the amount of bark which would probably be obtained would be about double the quantities named above as follows:—

Whole Bark.

		Green Bark.	Dry Bark.
Cinchona officinalis	...	158,500 lbs.	52,520 lbs.
C. succirubra	...	64,000 "	21,400 "
C. calisaya	...	8,000 "	2,450 "
C. hybrid	...	16,000 "	5,500 "
Miscellaneous	...	3,500 "	1,200 "
		251,000 lbs.	83,400 lbs.

" *General condition of the Plantations.* No cultivation has been carried on for about 15 years, and consequently fern, bush and climbers of sorts have sprung up everywhere, so that it is necessary to cut tracks in every direction through this dense jungle growth to be able to get near the trees.

The original field roads are almost obliterated, and it is impossible to use them in their present condition, but the principal ones might be restored at a cost of 6d. to 9d. per chain, or between £2 and £3 per mile, and as there are about 7½ miles of these roads, the cost of restoring them would be under £20."

Hope Gardens.

Several paragraphs from the report of Mr. Wm. Cradwick, Superintendent of Hope Gardens, have been incorporated in the General Report. The following are special to the Garden :—

The work of raising, propagating and distributing economic and ornamental plants has been carried on as well as funds would allow.

The plants have been arranged in the Nursery alphabetically to facilitate selection. Several other alterations and improvements have been carried out. An ugly plant-stage has been removed. Two grass plots in front of the nursery have been done away with, thus widening the road and enabling carriages to turn easily. The Rockery in the Fern-house has been rebuilt and altered in form, giving more room for walking about. A new glass propagating-house has been erected and has proved a great success. A packing-shed 60ft. by 15ft has also been built at the expense of the Garden.

The Orchids continue to be a source of great pleasure to the public, a continual supply of bloom being maintained throughout the year ; the following is a list of those which have flowered, those marked with an asterisk for the first time :

Aerides odoratum
Brassavola glauca
Brassia caudata
Broughtonia lilacina
" sanguinea
Calanthe Veitchii
Catasetum macrocarpum (tridentatum)
Cattleya Bowringiana
" labiata
" " var Dowiana
" " " Gaskelliana
" " " Mendellii
" " " Mossiae
" " " Trianae
*" " " Warneri
*" " " Warscewiczii
" Leopoldii
*" Loddigesii, var. Harrisoniae
" Skinneri
" Walkeriana, var. Schroederiana
Coelogyne Dayana
Coryanthes maculata
*Cypripedium Harrisonianum
" Lawrenceanum
Dendrobium aggregatum
" albo-sanguineum
" bigibbum, var. superbum
" chrysanthum
" crassinode
" Draconis
" Farmerii

Dendrobium fimbriatum, var. oculatum
" formosum var. giganteum
" nobile
*" glomeratum
" pendulum (Wardianum)
" Phalaenopsis
" Pierardi
*" primulinum
" pulchellum (Dalhousianum)
" undulatum
" veratrifolium
Diacrium bicornutum
Epidendrum alatum
" atrosanguineum roseum
" atropurpureum (macrochilum)
" ciliare
" cucullatum
" fragrans
" nutans
" Stamfordianum
" venosum
Gongora gratulabunda
Lacaena bicolor
Laelia anceps
" harpophylla
" purpurata
" rubescens
" tenebrosa
Oncidium altissimum
" ampliatum
" " var. majus
" Cebolleta
*" hastatum, var. flavescens
*" incurvum
Oncidium Kramerianum
" Lanceanum
" luridum
" Papilio
Maxillaria rufescens
Peristeria elata
Phalænopsis amabilis
" esmeralda
" Sanderiana
" Schilleriana
Rhyncostylis retusa
" " var. præmorsa
Schomburgkia Lyonsii
" Tibicinis
Selenipedium Sedenii, var. candidulum
Stanhopea eburnea
*Stauropsis lissochiloides (Vanda Batemannii)
*Vanda Bensonii

*Vanda cœrulea
*Vanda tricolor

PLANTS DISTRIBUTED.

Sold.

Economic Plants :—			
Sweet Oranges	...	20,401	
Navel Oranges	...	244	
Tangerine	...	401	
Grape Fruit	...	15,851	
Sour Oranges	...	5,287	
Rough Lemons	...	7,200	49,384
Ramie	...	...	39,200
Cane Tops	...	...	17,498
Kola	..	...	12,355
Cocoa	...	...	5,756
Nutmegs	...	...	2,944
Coffee	...	...	1,941
Pine Apple Suckers	...	...	1,595
Rubber	...	...	1,509
Grape Vines	...	...	1,383
Miscellaneous	...	...	4,832
Total	...	...	138,397
Ornamental Plants	...	...	18,378
Cocoa Pods	395		

Free Grants.

Economic Plants :—			
Miscellaneous including Timber and Shade Trees			5,033
Ramie Roots	...	...	515
Eucalyptus	...	...	841
Melaleuca leucadendron		...	712
			7,101
Ornamental Plants		...	2,753
Total number of Economic Plants		...	145,498
" " Ornamental Plants		...	21,131
" " Plants distributed*		...	166,629

GARDEN CORRESPONDENCE.

Letters received	3,382
" despatched	5,921

Visitors to Gardens.

1st April to 31st December, 1898	...	10,144
1st January to 31st March, 1899	...	17,994
Total	...	28,138

The elevation of the garden above sea-level is 700 feet.

The average mean annual temperature is 77.3 F and the average annual rainfall 52.48 inches for eighteen years. The amount of rain that fell during the year was 57.55 inches.

The wettest months were May, July, August, October; and the driest, April, December, January, February, March.

The mean temperature for the year was 76.6 F. The Meteorological tables for the different months are given on page 240.

Castleton Garden.

The following paragraphs are mainly from the Report of Mr. W. J. Thompson, Superintendent :—

The reduction of the Vote from £400 to £300 has prevented much progress being made.

A new walk, nine feet wide, has been made from the rose Garden to the Palmetum. About 20 chains of the main walk have been raised several inches, and gravelled. The walk east of the Palmetum has been reformed, widened to 9 feet, and raised several inches. The wooden planks put down 3 years ago to bridge over the gutter running through the garden had become rotton, and were replaced by slabs of concrete.

The gates have been repainted; two new iron gates have been bought and fixed in place of old wooden gates. The fences have been repaired in places, but they are still in bad condition on each side of the main road.

A new Garden seat has been made, and the rest repaired. Several Orchid baskets, and numerous labels have been made, and old ones repaired.

The lawns, verges and pastures have been kept in fair condition. The beds and borders have been forked several times, but very little manure could be added, as the reduced vote would not allow of expenditure on cutting grass for stock.

Trees and shrubs have been pruned. The young plants and new plants put out during the previous year have been looked after carefully, and are making good growth.

The important work of labelling all the plants in the Garden has been continued.

The Lily tank has been cleaned out, and new plants of Victoria regia put in. The Nymphaeas, etc., have been repotted.

The Para Rubber tree (*Hevea sp*) planted about 14 years ago, fruited for the first time this year, and plants have been raised from the seed. Number of plants have also been raised from the seed of the

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Besides 4,196 from Castleton.

Central American Rubber(*Castilloa elastica*) and Ceara Rubber (*Manihot Glaziovii*)

The celebrated palm, *Mauritia flexuosa*, fruited for the first time. An account of this palm is given in the Bulletin for October-December, 1894.

The young Durian plants and Coco-de-Mer palms are growing freely.

The Brazil Nut trees (*Bertholletia excelsa*) which grew so little for several years, are now shooting out, due to clearing away trees round them.

The usual attention has been given to collecting seeds for sowing and for distribution and exchange.

As plants are more conveniently distributed from Hope as a centre, not so many have been sent direct to their destination from Castleton as last year, viz.: 4,196, the sum realised being £36 17s. 2d. More have been sent to Hope for distribution, viz.: 10,830, valued by Mr. Thompson at £147 9s. 9d.

Mr. Thompson was on leave for part of the year, and Mr. Wm. Harris kindly undertook the very onerous task of acting for him, riding across country and back from Cinchona once a week, a distance each way of about 30 miles.

The elevation of the garden above sea-level is 496 feet.

The average mean annual temperature is 76 ° F., and the average annual rainfall 113·11 inches for twenty-seven years. The amount of rain that fell during the year was 108·51 inches.

The wettest months were May, July, August, November and January and the driest were December, February, March.

The mean temperature for the year was 74.8 F. The Meteorological tables for the different months are given on page 241.

Hill Gardens.

The following Report is by Mr. Wm. Harris, F.L.S., Superintendent.

Cinchona.*—The vote for this Garden having been reduced to a very small sum, it was not possible, to do anything during the past year beyond keeping the Garden and immediate surroundings clean and tidy.

The pastures, fences and Plantation roads, which had hitherto been kept up out of the Garden Vote, received little or no attention during the year, and the consequence is that they are all in bad order.

The usual Garden work, such as pruning shrubs, forking beds and borders, mowing lawns, cutting edges, propagating and watering plants, was carried on during the year as far as the very limited means at our disposal would allow.

A plant of Wistaria chinensis, presented by Dr. Plaxton, flowered in March 1899, for the first time.

Annuals.—At various times during the year we had fine displays of, *Dianthus*, *Phlox*, *Lobelia*, *Mignonette*, and such like, in addition to the usual exhibits of *Pelargoniums*, *Fuchsias*, *Gloxinias*, *Amaryllis*, &c.

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*For Report on Cinchona Plantations see Page 224.

Ginseng.—One hundred and twenty-five roots, and two ounces of seed of Ginseng (*Aralia quinquefolia*) were received from Mr. George Stanton, Apulia Station, U.S.A., in January last. The seed was sown at Cinchona in a specially prepared bed, and the roots were planted in four different places as follows:—40 at Morse's Gap: 25 above New-haven Gap: 25 below Newhaven Gap: 20 at Young Oak plantation above St. Helen's Gap; and 10 at Blue Mountain Peak.

Five roots were dead when received. Ginseng is cultivated to some extent in the United States and the roots are exported to China where they find a ready market, and fetch from $2.00 to $4.00 per lb., according to size and quality. This root is highly esteemed by Chinese physicians, who fancy that it resembles the human form, and consider that it wards off all diseases, restores exhausted animal powers, and makes old people young. It consequently has enormous value with them, and is said to be sometimes worth its weight in gold at Pekin. It is slightly bitter and aromatic, but of no repute amongst European medical men.

Resource Orange Grove.—The Vote for this Garden was reduced by one half and work was altogether suspended for several weeks during the year. There are about 20 acres under cultivation, and extensive Nurseries; the money allowed was not sufficient to keep the Grove and Nurseries in good order, and altogether we were crippled through want of means.

There are about 2½ miles of wire fencing and 1½ miles of roads to maintain; and the Grove requires constant care and attention even to keep the weeds down.

Manuring.—During the year all the young trees were manured, and the soil round each was forked several times and kept open. Cow peas and Congo peas were grown as green manuring, and were forked into the soil with beneficial results.

Budding.—The work of budding was carried on during the greater part of the year to enable us to determine which are the best months to perform this operation. So far as our experience goes, buds put in during July and August were the most successful though we find that budding may be done with a fair amount of success during about nine months of the year, omitting the months of May, October and November when heavy rains usually fall. On the other hand, drought of long duration has a very injurious effect on young buds, and unless they are particularly plump, and the stock plants are in a vigorous condition, they are unable to hold out against two or three weeks of dry weather. If it can possibly be arranged, it is best to bud, in the hills at any rate, during fine weather when occasional light showers fall.

Insect Pests.—Scale-insects have given some trouble, and the most effectual remedy tried so far is the Kerosine and Soft Soap mixture recommended in the Bulletin for December 1898, page 271. Black ants are also very troublesome at times, and although various methods have been employed to drive them away, nothing has been so successful as the Bitterwood solution recommended in the Bulletin for Jany. 1896, page 12. Several sprayings or dressings with this solution may be necessary, as ants are very persistent pests and do not readily give up a stronghold, but repeated applications become distasteful to them, and they eventually yield.

Himalayan Grass.—This grass is entirely successful at Resource, and it is proposed to divide the roots and plant them through the Plantation during the next rainy season, simply leaving a space round each young tree. The grass will keep down the weeds, prevent wash by heavy rains and it will be excellent fodder for cutting, It grows in tufts and we do not anticipate any difficulty in keeping it within bounds.

Bermuda Lily.—The bulbs of the Bermuda Lily were lifted in July and August last, gradually dried, and sent to Hope to be packed and despatched to their owner. They were not a success from a commercial point of view, that is, the bulbs did not increase in size and quantity as it was hoped they would do, but horticulturally they were everything that could possibly be desired. With just ordinary field cultivation they were in flower, more or less, all the year round, and from March to June the field was simply a sheet of magnificent blooms.

Glasshouse.—One of the two glass roofed propagating shells, 50 feet in length, was taken down during the year and transferred to Hope, where it has been re-erected for the purpose of affording protection to tender plants.

Coffee.—A large number of Blue Mountain Coffee plants has been raised at Resource, and these are meeting with ready sale amongst Coffee planters who are very glad to get selected, and transplanted nursery plants.

Timber Trees.—As in previous years, large numbers of Juniper Cedar, and West Indian Cedar plants have been raised from seed and distributed free to applicants in the hills.

Sugar Canes.—In the year 1895-96, many of the best varieties of Sugar-cane grown at Hope Gardens were planted at Resource, to ascertain which were suitable for cultivation in the hills. During the last two years tops of these varieties were distributed free to small settlers in the district who grow canes to make "new sugar."

PLANTS DISTRIBUTED.—SOLD.

Economic Plants.—		
Oranges	...	4,511
Grape Fruit	...	2,650
Shaddock and Limes	...	130
Rough Lemons	...	3,512
Camphor	...	222
Miscellaneous	...	292
Ornamental plants	...	1,838

FREE GRANTS.

Tea Plants	...	6,148
W. I. Cedar	...	721

Juniper Cedar	...	3,760
Eucalyptus	...	522
Strawberry Plants	...	248
Sugar Cane Tops	...	1,000
Cassava stems	...	410
Miscellaneous	...	190
Total Economic plants distributed	...	24,156
Total Ornamental plants distributed	...	1,998
Total number of plants distributed	...	26,154

The following seeds were also distributed :—

800 Tea
25,000 Rough Lemon
50,000 Grape Fruit—best kind
27 lbs. Cinchona
9,500 Blue Mountain Coffee
45 pkts. Miscellaneous seeds

and of Tree Tomatoes, 233 dozens, weighing 435 lbs.

The elevation of the Hill Garden, where the instruments are placed is 4,907 feet above sea level. The average mean temperature there is 62.6 F. and the average annual rainfall 102.85 inches for 28 years. The amount of rain that fell during the year was 120.81 inches. May, October and January were the wettest months, and July, December and February the driest. The mean temperature was 62.4 F. The Meteorological tables for the different months are given on page 239. The rainfall at the Orange Garden, Resource was 78.58 inches for the year.

Kingston Public Garden.

The following Report is by Mr. J. Campbell, Superintendent :—

The usual gardening operations were carried on during the year. All the beds, and borders, throughout the Garden were manured, forked, and pruned on several occasions, the verges and edges were regularly cut and trimmed. The daily raking of the lawns and clearing same, sweeping of pathways, and carting away of rubbish, has been assiduously attended to, that the Garden may represent a tidy appearance. The trimming of trees, and divesting them of dried branches has been attended to.

The large and only Ficus Benjamina tree in the Garden, has shown signs of failure, but having heavily manured it, and covered it over with earth, first forking the ground, it has since improved, and is now flourishing. The lawns have been planted with Bahama grass, and since the fence has been erected, show great improvement.

The inner fences and gates enclosing the lawns have been painted, also the Band Stand railings, with enclosed benches. The bridges have been repaired.

As the Kingston General Commissioners have introduced drains, and underground aqueducts in the streets to receive the storm water, abolishing the old system which received the water from several streets and allowed it to pass through the Garden in the aqueduct, it would now be advisable to remove the bridges, and have the aqueduct filled up. It would evidently be an improvement and would be a saving in the future for upkeep of bridges, etc.

I may state that all the pathways require gravelling, but the centre pathway leading from the north to the south gates requires macadamizing so as to raise the surface, as it is getting below the level of the Garden, at present it is washed by water from upper King Street during a heavy down-pour of rain. The Garden forms an attraction for crowds of people on Sundays as a recreation ground, also on the evening when the Kingston V. M. Band plays, but the hour generally is unsuitable for many, I would suggest that the Band play alternately one evening at 5 o'clock and the other evening at the usual hour.

Infringements of the Garden Regulations have been few during the past year.

The elevation of the garden above sea-level is 60 feet.

The average mean annual temperature is 79.1 F., and the average annual rainfall 35.1 inches for twenty-nine years. The amount of rain that fell during the year was 33.99 inches.

The wettest months were May, June, October, and the driest April December, January, February.

The mean temperature for the year was 83.8 F. The Meteorological tables for the different months are given on page 243.

King's House Garden and Grounds.

The following Report is by the Superintendent, Mr. Wm. Walker:

During the past year garden operations have been carried on with satisfactory results. The borders on each side of the avenue have been repeatedly dug and kept constantly watered, and now they are well mulched with stable manure, which has a very beneficial effect on the plants, keeping them moist and in a good healthy condition. I have struck a quantity of Crotons and other plants, which I am now transplanting to the borders in open places where they are most required. The large Palms at the back of borders have been attended to with water, and are doing well.

The Coralilla and a large quantity of overgrown creepers, etc., have been removed from the steps leading from the lawn to the house, and replaced by Roses, Stephanotis, Ipomæa, Clerodendron, Cissus discolor, etc., which have made rapid growth, and are now making a fine appearance.

Three Rockeries have been made near the house, and planted with ferns obtained from the Spanish Town Road, with Balsams, Coxcombs, Phlox Drummondii, Geraniums, Calliopsis, etc., etc., they are doing exceedingly well, and have a very gay and bright appearance.

The Pine ground has been manured and well forked up and is showing well for fruit.

The Vines have been pruned and are now breaking well for a good crop.

The Rosaries have been well attended to with manure and water, but they are old and worn out, and, if possible, I should strongly recommend that new ones be established.

The Kitchen Garden made last year, lapsed for a time, owing to want of labour, it is now in crop again and promises a good return. A batch of bananas was planted which are taking well.

The paths have been kept clean, the lawns and tennis courts have been constantly watered and cut and are in good order.

In the Nursery most of the orchids have been rebasketed and there has been a fairly good show of bloom. Pots are required very much for repotting the palms and different plants.

The elevation of the Garden above sea-level is 400 feet.

The average mean temperature is 78.2 F., and the average annual rainfall 47.81 inches for nineteen years. The amount of rain that fell during the year was 40.99 inches.

The wettest months were May, June, October, and the driest November, December, January, February, March.

The mean temperature for the year was 75.4 F. The Meteorological Tables for the different months are given on page 242.

Bath Garden.

The Overseer, Mr. A. H. Groves, reports some improvements in the Garden, as follows:—

The path to the Gate was wet and muddy, but the Parochial Board have made a trench to carry off the water and a gravelled walk. The Board have also deepened the trench along the lane on the west of the Garden, and if the south trench were also attended to, there would be no cause for complaint about the drainage of the Garden.

The usual work of weeding, cleaning, removing rubbish, etc., has been attended to regularly.

In a previous report I pointed out how expensive it was to remove the sweepings, etc. I accordingly established a manure depôt in the Garden, from which I got a good supply of manure. I had, however, to cease depositing the rubbish there, the Inspector of Nuisances having declared it objectionable. I have therefore removed the rubbish beyond the limits of the town, or, when the weather will permit, burn it on the spot.

The Garden has been well forked, and Crotons and flowering plants have been planted in almost all the available spots. The wires of the fence around the Garden have been restrained, benches repaired and painted, and walks regravelled.

The following tools were bought, viz., two agricultural forks.

A few of the rubber plants sent by the Director have been planted in the Garden and a few distributed to persons here. The grafted East Indian Mango is not thriving well, despite all attention to it.

I have had felled a large Spathodea, and trimmed nearly all the trees, thereby letting in more light and air.

I may add that goats and sometimes pigs, trespass on, or stray into the Garden. They come in under the fence where the trenches are kept open to drain the Garden. I communicated with the Parochial Board on the subject.

The elevation of the Garden is 170 feet; the mean temperature 78° F.

William Fawcett,
Director.

APPENDIX—METEOROLOGICAL TABLES.—HILL GARDENS.

Months.	Belle Vue Cinchona—Elevation 4.907 feet														Resource Elevation 3,700 ft.
	* Pressure.		(Temperature.) Degrees Fahrenheit.					Dew Point.		Humidity.		Wind.			
	7 a.m.	3 p.m.	7 a.m.	3 p m	Max.	Min.	Range.	7 a.m.	3 p.m.	7 a.m.	3 p m.	Direction.	Force—Miles.	Rainfall—Inches.	Rainfall—Inches.
1898.	In.	In.	°	°	°	°	°	°	°						
April ..	25.237	25.195	59.1	64.1	67.2	54.8	12.4	54.5	59.3	83	84	E'ly	13.0	4.25	2.55
May ..	.203	.176	61.4	65.0	68 2	57.5	10.7	57.0	62.0	80	85	SE	23.5	44.31	23.10
June ..	.232	.210	62.1	66.2	70.0	58 5	11.5	56.8	61 8	81	85	E'ly	41.5	8.73	6,60
July ..	.299	.199	62.9	67.3	71.0	58.6	12.4	57.5	62.3	81	83	E'ly	26.1	3.78	2,52
August ..	.225	.208	62 9	66.4	70.0	58.5	11.5	57.5	62.4	82	86	E'ly	17.8	5.21	6.05
September ..	.202	.173	61.9	65.5	69.7	58.2	11.5	57.7	52.9	85	90	SE	17.3	8.55	6.08
October ..	.186	.152	61.6	65.5	68.7	58.5	10.2	58.6	62.2	88	88	SE	21.4	16.79	13.50
November ..	.150	.112	59.7	64 6	68.5	56.5	12.0	56.6	61 3	84	88	E	16.3	6.76	5.56
December ..	.250	.216	58.4	64.2	67.6	54.5	13.1	54.1	60.7	84	87	E	11.1	1.69	0.75
1899.															
January ..	.256	.208	57.1	63.6	67.4	54.3	13.1	53.8	59.6	88	84	E	27.2	14.54	5.75
February ..	.260	.219	57.3	64.0	67.7	53.9	13.8	51.6	59.0	85	83	E	16.7	1.04	1.62
March ..	.235	195	56.9	61,9	65.6	53 5	12.1	52.9	58.0	86	85	E	38 7	5.16	4.50
Means ..	25.228	25.118	60.1	64.8	68.4	56.4	12.0	55.7	60 .9	84	85	E	22. 5	120 81	78.58 Total
					Means-62°.4										

* The Barometer pressure are reduced to the standards at Kew, 32°, and gravity at Lat. 45°.

HOPE GARDENS.—Elevation 700 feet.

Month.	Temperature. Degrees Fahrenheit.					Dew Point.		Humidity.		Rainfall.—Inches
	7 a.m.	3 p.m.	Max.	Min.	Range.	7 a.m.	3 p.m.	7 a.m.	3 p.m.	
1898.	°	°	°	°	°	°	°			
April	70.7	82.8	85.6	64.0	18.9	62.2	68.1	75	60	1.07
May	74.2	82.0	86.6	67.9	18.7	69.0	71.4	84	69	15.74
June	74.0	82.7	87.0	68.0	19.0	68.4	71.0	81	67	5.07
July	73.7	84.3	88.6	68.2	20.4	68.3	71.7	81	67	5.59
August	73.3	82.1	87.5	68.6	18.9	68.7	72.5	87	74	5.34
September	72.5	81.8	87.5	68.4	19.1	67.8	72.9	84	74	4.48
October	72.5	81.0	86.0	68.8	17.2	70.2	73.6	90	79	13.30
November	69.8	78.4	86.0	67.7	18.3	66.6	74.3	90	87	2.43
December	67.1	81.3	85.3	64.2	21.1	63.1	70.5	87	71	0.74
1899.										
January	64.8	78.1	85.0	65.4	19.6	61.3	70.4	87	76	1.47
February	*	...	...	...	...	...	...	..	.	0.83
March	69.9	79.9	83.3	65.7	17.6	61.7	65.7	75	62	1.49
Means for 11 months	71.1	81.3	86.2	67.0	19.0	66.1	71.1	84	71	57.55
			Mean—76°.6							Total.

*Owing to certain mistakes made by the Observer in taking the readings, the mean temperatures, etc., for February are not recorded

CASTLETON GARDENS.—Elevation 496 feet.

Month.	*Pressure. 7 a.m.	*Pressure. 3 p.m.	Temperature. Degrees Fahrenheit. 7 a.m.	3 p.m.	Max.	Min.	Range.	Dew Point. 7 a.m.	Dew Point. 3 p.m.	Humidity. 7 a.m.	Humidity. 3 p.m.	Rainfall.—Inches
1898.	In.	In.	°	°	°	°	°	°	°			
April	29.999	29.916	69.1	82.2	86.4	63.2	23.2	65.7	77.2	89	81	7 47
May	.900	.853	73.1	81.6	83.8	66.3	17.5	69.4	738	86	78	23.60
June	.964	.887	71.7	82.7	88.1	67.0	21.1	69.0	74 3	88	75	6.52
July	.958	.898	70.9	82.0	87.4	66.3	21.1	68.7	75.0	90	78	9.63
August	.958	.905	71.7	81.7	87.7	66 0	21 7	69.0	74.9	90	78	10.99
September	.888	.825	71.0	81.4	86.9	65.8	21 1	69.1	74.3	88	80	7.76
October	.920	.774	70.9	80.9	83.4	66 4	17.0	69.2	74.3	92	82	8.64
November	.941	.860	70.0	80.0	85.3	64.8	20 5	64.2	72.3	91	76	9.52
December	.986	.933	65 5	79.5	84.9	62.0	22.9	62.0	71.7	88	74	4.29
1899.												
January	30.020	.935	65.7	78.8	83.9	61.3	22.6	63.1	70.5	89	72	10.37
February	.017	.940	63.5	81.4	85.9	59.5	26.4	60.6	65.7	90	70	3.[illegible]6
March	.019	.925	64.4	80.8	84.3	60.9	23.4	62.1	69.2	90	70	6.16
Means	29.964	29.887	68.9	81.0	85 6	64.1	21.5	66.0	72.7	89	76	108.51
					Mean —74°.8							Total.

* The Barometer pressures are reduced to the standards of Kew, 32°, gravity at Lat 45°, and mean sea-level.

KING'S HOUSE GARDENS.—Elevation 400 feet.

Month.	Temperature. Degrees Fahrenheit.					Dew Point.		Humidity.		Rainfall.—Inches
	7 a.m.	3 p.m.	Max.	Min.	Range.	7 a.m.	3 p.m.	7 a.m.	3 p.m.	
1898.	°	°	°	°	°	°	°			
April	71.4	84.8	88.9	66.6	22.3	67.3	75.7	87	74	1.56
May	73.8	83.2	89.0	65.0	24.0	70.0	75.1	87	76	10.14
June	74.7	86.2	89.9	64.5	25.4	71.2	79.2	87	79	5.35
July	74.4	85.3	90.4	64.5	25.9	71.6	77.8	93	79	2.02
August	74.1	84.3	90.1	63.7	16.4	71.5	78.1	91	81	3.47
September	73.0	84.1	89.6	63.7	25 9	71.2	76.6	93	79	2.89
October	73.2	82 3	87.7	64.1	23.6	70.9	76.9	93	84	9.92
November	71.3	82.2	87.7	61.8	25.9	68.3	75.7	90	81	1.40
December	69.0	82.4	87.6	58.3	29.3	59.9	74.3	73	76	0.20
1899.										
January	67.7	81.9	87.0	58.4	28.6	64.6	74.7	90	87	1.52
February	66.9	82.9	88.7	57.6	31.1	63.4	73.0	87	71	1.18
March	68.6	82.2	87.8	56.7	31.1	65.2	74.5	87	76	1.43
Means	71.5	83.5	88.7	62.1	26.6	67.9	76.0	88	78	40.99
			Mean—75°.4							Total.

Kingston Public Gardens.—Elevation 50 feet.

Month.	*Pressure. 7 a.m.	*Pressure. 3 p.m.	Temperature. Degrees Fahrenheit. 7 a.m.	3 p.m.	Max.	Min.	Range.	Dew Point. 7 a.m.	Dew Point. 3 p.m.	Humidity. 7 a.m.	Humidity. 3 p.m.	Wind. Direction.	Wind. Force--mls	Rainfall.—Inches
1898.	In.	In.	°	°	°	°	°	°	°					
April	29.987	29.952	72.9	82.7	85.9	69.7	16.2	66.0	68.3	79	62	N	49.5	0 17
May	29.917	29.867	77.1	83.6	86.0	72.4	13.6	70.6	71.9	81	69	N	43.4	9.96
June	29.940	29.898	77.4	84.9	87.8	73.1	14.7	69.5	71 1	77	64	N	61.1	3.39
July	29.943	29.898	77.0	85 6	88.7	72.8	15.9	69.1	71.3	77	63	N	60.3	1.63
August	29.935	29.888	75.5	84.0	88.1	73 4	14 7	69.4	72.3	82	69	N	46.6	1.86
September	-9.891	29 840	75.5	84.1	87.9	72.7	15 2	70.1	72.4	86	68	N	34.3	2.95
October	29.876	29.820	74.9	83.2	86.4	73 0	13.4	70.8	72.3	86	71	N	28 2	9.77
November	29.898	29.828	72.5	84.1	87.7	71.1	16.6	67.5	70.5	85	64	N	28.2	1.03
December	29.998	29.924	70.0	82.9	87.0	68.8	18.2	68.4	68.4	83	62	N	37.8	0.14
1899.														
January	29.992	29.924	69.8	82.3	85.7	68.5	17.2	64.3	68.5	83	64	N	50.1	0.78
February	30.010	29.935	69.5	82 6	85.9	67.8	18.1	62.9	67.0	80	60	N	76.4	0.49
March	29.997	29.931	70.1	81.2	84.5	68.2	16.3	64.0	67.2	81	63	N	104.2	33.99
Means	29.948	29.892	70.5	83.4	85 8	70.9	15.9	67.4	70.1	81	65	N	51.6	108.51
					Mean —83°.8									Total.

* The Barometer pressures are reduced to the standards of Kew, 32°, gravity at Lat 45°, and mean sea-level.

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OF THE

BOTANICAL DEPARTMENT, JAMAICA.

EDITED BY

WILLIAM FAWCETT, B.Sc., F.L.S.

Director of Public Gardens and Plantations.

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New Series.] JUNE, 1899. Vol. VI Part VI

BULLETIN

OF THE

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New Series AUGUST, 1899. Vol. VI Part VIII

BULLETIN

OF THE

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' Series OCTOBER, 1899 Vol. VI / Part X

BULLETIN

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BULLETIN

OF THE

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