The Prevention of Leaf-disease in Coffee.

REPORT

OF A

VISIT TO COORG

BY

JOHN CAMERON, F.L.S.,

Superintendent of Government Gardens in Mysore.

PRICE 8 ANNAS.

PUBLISHED FOR "PLANTING OPINION," MADRAS.

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PRELIMINARY CORRESPONDENCE.

Letter dated 15th August 1898 from the United Planters' Association of Southern India, Madras, to the Resident in Mysore, Bangalore.

I have the honor to inform you that it was resolved at the Annual Meeting of this Association, on 10th instant, that you should be requested to kindly apply to the Mysore Government on our behalf for the loan of the services of Mr. Cameron for the purpose of visiting Coorg and there conducting certain experiments and making investigations with a view to the improvement of coffee cultivation and the prevention of leaf-disease.

The Association has voted a sum of rupees five hundred to be appropriated as far as need be in paying Mr. Cameron's travelling expenses, and it is hoped that when application is made the Mysore Government will kindly depute him on special duty, to do what is desired.

It may be well for me to point out that the results of Mr. Cameron's experiments and investigations would be available for use in the Mysore Province. Coorg has been selected as the scene of operations because it offers particular facilities for the kind of work that is to be undertaken.

Requesting that you will kindly make the necessary application to the Mysore Government and support it with your influence,

"Copy."

(Sd.) HENRY CLARKE,
Registrar.

No. 1867 / Ft. F. 26-96.

OFFICE OF THE DEWAN OF MYSORE,
Dated BANGALORE, *7th September* 1898.

FROM

The Secretary to the Govt. of Mysore,
General and Revenue Departments,

To

The First Assistant to the Resident in Mysore.

SIR,

In reply to your letter No. 4283, dated the 26th August 1898, forwarding copy of a letter from the Secretary, United Planters' Association of Southern India, applying for the temporary loan of Mr. Cameron's services for conducting certain experiments and making

investigations in Coorg with a view to the improvement of coffee cultivation and the prevention of leaf-disease, I am directed to state that the Durbar have much pleasure in directing Mr. Cameron to include Coorg in his tour of inspection during the next cold weather and to conduct the investigation suggested by the United Planters' Association. Mr. Cameron will be requested to arrange details in direct communication with the Secretary to the Association. The Durbar hope that Mr. Cameron's absence in Coorg will not be for more than 2 or 3 weeks.

I have, etc.,

(Sd.) C. SREENIVASAIENGAR,

Secretary.

No. 1868. / Ft. F. 26-96. Dated 7th September 1898, En. 1.

MEMO.

Copy of the foregoing, together with copy of the letter from the Secretary to the Planters' Association, is forwarded to Mr. Cameron, Superintendent, Government Gardens, Bangalore, for information and guidance. Mr. Cameron may make suitable arrangements for the discharge during his absence of his duties in Bangalore.

"By order,"

(Sd.) C. SREENIVASAIENGAR,

Secretary.

No. 5117 / 297-98.

FROM

The First Assistant to the Resident in Mysore,

To

The Dewan of Mysore.

Dated BANGALORE, 29*th September* 1898.

SIR,

I am directed to acknowledge the receipt of your letter No. 1867 / Ft. F. 26-96 dated the 7th instant, stating that Mr. Cameron has been directed to include Coorg in his tour of inspection during the next cold weather and to conduct the investigations suggested by the United Planters' Association of Southern India. I am to forward a copy of a letter dated the 19th idem from the Secretary of that Association on the subject.

I have, etc.,

(Sd.) K. D. ERSKINE, CAPTAIN,

First Assistant Resident.

Letter dated Madras 19th September 1898, from the Secretary, United Planters' Association of Southern India, to the First Assistant Resident in Mysore.

I have the honor to acknowledge the receipt of your No. 4802 of 17th instant, forwarding copy of letter No. $\frac{1867}{\text{Ft. F. 26-96}}$ dated the 7th idem from the Secretary to the Government of Mysore, General and Revenue Departments, in reply to my letter of 26th ultimo, applying for the temporary loan of Mr. Cameron's services for conducting certain experiments and making investigations in Coorg with a view to the improvement of coffee cultivation and the prevention of leaf-diseases.

The ready compliance of the Mysore Durbar will be a source of great gratification to the members of the Association; and I venture to request you to convey its cordial thanks to the Durbar, together with an assurance that every effort shall be made to avoid trespassing unnecessarily upon Mr. Cameron's time.

"Copy."

(Sd.) HENRY CLARKE,
Registrar.

No. $\frac{2808}{\text{Ft. F. 26-96.}}$

OFFICE OF THE DEWAN OF MYSORE,
Dated BANGALORE, *5th October*, 1898.

Copies of the foregoing are forwarded to Mr. J. Cameron, Superintendent, Government Botanical Gardens, Bangalore, for information, in continuation of this office No. $\frac{1868}{\text{Ft. F. 26-96}}$ dated 7th September.

"By order,"
(Sd.) L. ANANTASAMI RAO,
For Secretary.

No. 120.

Dated BANGALORE, 27*th October*, 1898.

FROM

The Superintendent, Government Gardens,
Bangalore.

To

H. G. Parsons, Esq.,
Honorary Secretary,
Coorg Planters' Association.

SIR,

With reference to the enclosed copy of instructions received from this Government, I have the honor to inform you that I hope to

arrive at Hunsur, *en route* to Coorg, on the 14th proximo and would be ready to start from the former place on the morning of the 15th.

From the latter date my services shall be placed at the disposal of your Association for a period of at least a fortnight. Trusting that this arrangement will meet your convenience,

I have, etc.,
(Sd.) J. CAMERON, SUPT.,
Government Gardens,
Bangalore.

REPORT.

ARRIVAL IN COORG.

My arrival in the province on the 15th November was happily timed, as the N. E. monsoon had just subsided, and the country was, therefore, seen to the best advantage.

Coffee was also in its prime, crop beginning to ripen in the drier and more exposed parts of the planting zone.

Mr. Parsons, Honorary Secretary of the Coorg Planters' Association, who had kindly made all arrangements for my tour, met me at the Pollibetta Club, and accompanied me to his fine residence at "Beechlands," which subsequently became the base of operations in South Coorg, or what is locally known as the "Bamboo" district.

During the following fifteen days of inspection and touring, I must have passed through 50 miles of fine coffee in full bearing, most of it in the "Bamboo" being in one continuous stretch.

The crop this season is also considered well above the average. It is needless to say that this was an unique and impressive sight such as one does not forget. A sight such as the former rulers of Coorg had never dreamed of!

It is also my first experience of the kind, as on former occasions when visiting planting districts in Manjarabad, South Wynaad and the Niligiri Hills, the coffee was not in crop.

PHYSICAL ASPECT OF THE COUNTRY.

Coorg is a hilly plateau girt on the west and south by the western ghats, the highest boundary peaks being Subrahmanya in the north (5,548 feet), Tadiandamol in the west (5,68"2 feet), and the Brahmagiris in the south (4,500 feet). It is situated between north latitude 11° 55′ and 12° 50,′ and east longitude 75° 25′ and 76° 14,′ covering an area of 1,585 square miles. Mercara, the capital of the province, occupies a commanding site at an elevation of 3,800 feet. The view from the spot called "Rajah's Seat" is one of the finest I have ever seen. The

average elevation of the upper plateau is 3,500, but gently sloping towards the eastern frontier, where the elevation in some places does not exceed 2,700 feet. Minor mountains and hills intersect the whole country beautifully, and are mostly clothed with interesting trees of varying tint. In most parts of the "Bamboo" one feels rather over-shadowed by trees; but commanding situations, as at the Pollibetta Club, Mr. James Gerard's Bungalow, and Elk Hill, afford fine views of this part of the country.

In North Coorg, the finest views observed are at Peremboo Colly, Mr. Salisbury Trelawney's charming place, Mercara, and Hallery, where I was the guest of Mr. and Mrs. Sprott, and had the pleasure of meeting Mr. Frank Mangles, one of the most successful pioneers of planting in North Coorg.

The principal rivers and streams have an easterly course and flow right across the peninsular into the Bay of Bengal. These are the Kaveri,—rising on the Brahmagiri Range at a sacred spot called Tala-Kaveri, or head of the river,—Hemavate and Lakshamanatertha. The Barapole is the principal river flowing to the western coast. Mountain streams are abundant and rapid during the monsoon season, but at other times they are not so apparent, and the planters mostly complain of the difficulty they experience in watering flower gardens around their bungalows during the dry season.

But this is of course due to the bungalows being mostly situated on high ground, where there is less malaria to contend with. The little alpine province of Coorg is justly described as one of the prettiest spots in India.

GEOLOGICAL FORMATION.

The geological formation is eminently favourable to the creation of good soils. This is due both to the mineral constitution of the indigenous rocks and to their age and mechanism. In nearly every part of the country one sees an abundant outcrop of disintegrated rock in all stages of decay, and in coffee lands this valuable material is intimately incorporated with the tilth. It is, in my humble opinion, the backbone of both the soil and the planting industry. Would the latter have progressed for 40 years without this wealth of nutrient matter to support it?

The prevailing rocks consist of gneiss, syenite, and limestone;

and a reddish-coloured laterite is plentiful in many localities. The minerals from which a fertile soil is usually formed are strongly in evidence, *e.g.*, felspar (in several forms), mica, hornblende, and possibly augite. Such being the case, I conclude that the inorganic portion of the soil is mostly made up of varying proportions of these mineral ingredients. Of organic constituents, humus is the largest natural deposit. But in the planting districts the general use of special manures has tended to greatly alter the nature of the soil. It will thus be seen that the planter possesses all the crude elements for forming fertile soil of an enduring character, and, judging from the successful cultivation of one exhaustive crop for periods of 30 to 40 years, the nutrient ingredients of this natural soil must be available in proper proportion, although, in all probability they have not been expended lavishly. In his soil, I therefore think, the Coorg planter possesses a very sound investment. Those crumbling rocks will go on liberating (in some proportion to the pressure put upon them) nutrient material for thousands of years.

FLORA AND FAUNA.

Botanically, the whole country is most interesting. But to do justice to this section of natural history required time and equipment for which I was not prepared on this occasion. A list of such known plants as were observed *en route* is appended* to this paper, as also of specimens collected when there was an opportunity. Most attention was given to the arborescent flora, as bearing more directly on the special work in hand. Except in a few isolated instances, the trees in Coorg do not equal the splendid arborescent growth one sees in Manjarabad and other parts of the Mysore Malnad. But this is partly explained when it is remembered that extensive jungles of bamboo (hence the local designation) have been to a great extent replaced by secondary growth. Colonel Welch refers to the extensive and almost impenetrable growth of bamboo in his "Military Reminiscences," 1790—1829. The virgin forest has also been felled to a great extent to make room for special and exotic trees (secondary planting) now favoured for shading and otherwise promoting the growth of coffee. But except for the arborescent growth,

* [Will be published later.]

with a few orchids and parasites found upon it, the strictly industrial tract is not of great interest to the botanist. For profitable field work he prefers the primeval forest, the Devarakad, riverside and Cadanga, where the indigenous flora is more rampant. The latter position consists of primitive embankments or ancient lines of defence which are found at short intervals all over the country. Weeds of an exclusive kind were observed on several of these mounds, and are possibly due to a difference in the physical or mechanical condition of the soil. A wild or indigenous species of coffee is found in North Coorg. It was first brought to my notice by Mr. Wood, of "Ahtur" estate, who kindly procured me several specimens of the plant in fruit. The only indigenous species hitherto found in the south are *Coffea travancorensis*, W. & A., and *C. Wightiana*, W. & A., the latter being perhaps only a variety of the former. I consider this the most important find during the tour. But the most attractive plant seen in quantity, in North Coorg, is the beautiful *Barleria Gibsoni*. The flora of the Sampagi ghat is of a ravishing description, and it is difficult to decide whether wealth of vegetation or beauty of scenery is the most attractive in this glorious spot. Of the fauna I practically saw nothing during my tour. Some of the birds of plumage are exceedingly attractive, and some are very destructive to the coffee. Of the latter class the green barbet, *Thereiceryx viridis*, is one of the worst. Bees are plentiful, and a giant tree having many tiers of honeycombs suspended from its upper limbs is indeed a novel sight. I am told that it is difficult to induce jungle experts (Kurumbers or Kaders) to collect honey from isolated trees owing to the limited means for beating a hasty retreat, if necessity should require it.

SOUTH COORG.

Formerly this region was the home of the bamboo, where it was the admiration of every traveller. But it is now the home of coffee, extending over a continuous area of many square miles. In no other part of India does one find so much coffee cultivated within a limited area. With the exception of a few intervening Devarakads (temple lands) the bulk of the cultivation may be described as an unbroken tract. Wherever one looks, hillside and valley is an unbroken sheet of shining green with thickly clustered berry, the whole being shaded by stately

trees. Throughout the tract there is a close similarity in the nature of the shade, or over-growth, as also in the estate roads and boundaries ; so that a stranger has difficulty in finding his way about. The " Bamboo" is much the largest planting district in the province, and possesses about 70 estates belonging to Europeans. In extent these gardens vary from 80 to nearly 500 acres, but in some cases they are not fully planted in coffee. The fact of their being joined on to each other, as already stated, offers facilities for the easy spread of leaf disease and similar pests. The district differs from North Coorg in being 500 feet lower, with mostly an eastern or southern aspect. It is also warmer, somewhat drier, and more uniformly shaded throughout. The soil is rocky near the surface in some parts, while in others there are deep deposits of clay. As a rule the estates are very neatly kept, some of them being demarcated by thriving hedges of the shoe-flower, *Hibiscusrosa sinensis*. Pretty bungalows crest the lower hills, with flowers and other signs of social life about them.

NORTH COORG.

Here the country is of a bolder and wilder type, with mostly evergreen forest at intervals. Coffee estates are fewer in number and more isolated ; not in one continuous stretch as in the " Bamboo." It is a more exposed region and the rainfall is comparatively heavy. The natural soil appears to be excellent, and old coffee looks well upon it. I was astonished at the steepness of the land in some parts, but withal in good growth and bearing. The scenery in North Coorg is delightful. Owing to the heavier rainfall and colder aspect, estates are not so heavily shaded as in the south. Taking them all round, the crops were heavier here than in the " Bamboo." There were also fewer complaints of the ravages of the borer, an insect which prefers to bask in the southern sun. The mean annual rainfall for the whole province is 123 inches : but the distribution is unequal, being always heaviest on the west side of the country. In some parts of the " Bamboo" it does not exceed 50 inches.

With the foregoing attempt to show how the Coorg planter is situated in regard to climate, soil, and environment, I shall now proceed to discuss more in detail, some of the vital questions bearing on the future prosperity of the planting industry.

SHADING.

What constitutes the best shade to coffee is still a keenly contested point among planters, and while one warmly recommends the indigenous "Biti"—*Dalbergia latifolia*, another rejects this tree, and, for example, wholly places his trust in the exotic "Silver-Oak," *Grevillea robusta*. But for reasons which shall be explained further on, it is preferable, in my opinion, to employ a selection of trees to shade an estate; and most planters have adopted this plan either from necessity or choice. The trees mostly favoured for shading coffee are of two classes, *e.g.*, the indigenous and exotic. Their names are as follows:—

INDIGENOUS.

Ficus Glomerata	*Atti.*
Dalbergia latifolia	*Biti.*
Erythrina indica	*Palwan.*
Pterocarpus marsupium	*Honne.*
Lagerstrœmia lanceolata	*Nandi.*
Terminalia belerica...	*Tare.*
Acrocarpus fraxinifolius	*Howlige.*
Cedrela toona...	*Noge.*
Ficus bengalensis	*Alada.*
,, tuberculata	
,, Mysorensis	*Goni.*
,, Tjakela	*Cap basuri.*
,, Tsiela	*Bili basuri.*
,, Asperrima. (Inferior)	*Gargatti.*
Albizzia odoratissima	*Bilvara.*
Artocarpus integrifolia	*Halasu.*
,, hirsuta	*Kad halasu.*
Antiaris toxicaria	

Also some undetermined species.

EXOTIC.

Erythrina lithosperma	*Mostly young.*
Albizzia moluccana	
Grevillea robusta	
Cinchona succirubra.	*Not classed as shade.*
Pithecolobium saman.	

The correct amount of shade to be maintained on an estate is another matter for which a fixed rule cannot be laid down, as it must of necessity vary according to circumstances. In situations where the rainfall is heavy or regular, soil good, and

aspect cool, the shading should be comparatively light. But in the greater part of the "Bamboo" these conditions are somewhat reversed, and particularly in those parts where the soil is light, stony, and sunburnt, it is essential to have heavier shade. In furnishing this protection, however, care has to be taken not to remove an undue proportion of plant food from the staple cultivation, and in places where young shade trees are thickly planted there is the danger of doing this. During the early years of growth, trees of this class draw nearly their whole nourishment from the surface soil, and at all ages the surface roots of trees will contend for a share of its abundant food.

It is true that most saplings will soon establish their leading roots in the subsoil at depths far beyond the reach of the coffee bush, and as they increase in size, this tendency to draw nourishment from the substratum increases until in many fully developed forest trees surface rooting is reduced to a minimum. All other conditions being favourable, it is deep-rooting trees of this class that should be preferred to shade coffee. The only exceptions would be in the case of fig trees, which (probably from their quasi-parasitic nature) do not appear to exhaust the soil to the same extent as other shaders, and leguminous trees, which assist nitrification in the surface soil. On some of the estates visited, sapling trees ranging in age from five to fifteen years were so closely cultivated that the growth of timber almost appeared to be the primary object. On others, having a more advanced growth, the trees had been considerably thinned, while the remainder had been "lopped up," *e.g.*, pruned from the base upwards, so that the actual shade was far above the coffee. This, again, conveyed an idea of arboriculture, the trunks being so numerous and bare. Of course, the object aimed at of admitting air and light in this way is perfectly sound, but the fact remains that a plantation of young trees is rapidly consuming food which by right belongs to the coffee.

Where the initial mistake has been made of removing the indigenous deep-rooted shade—and it is pretty universal—replanting has been compulsory, as no one now thinks of growing coffee successfully without shade.

But in addition to losing much valuable time in secondary planting, it will be felt that the land is called upon to do double

service. This, however, is not the only disadvantage arising from the sudden exposure of forest soil long nurtured under shade. Such treatment causes a revulsion in the chemical action of the soil, and under strong sun-light the valuable process of nitrification is arrested. Possibly this may account for the infertility of long-abandoned coffee lands. It is, therefore, clearly to the planter's interest not to bare the land entirely, but rather by careful selection to retain and make use of the forest trees already in possession. The finest shade, with the least exhaustion to the soil, is provided by deep-rooted umbrageous trees growing at 60, 80, and even 100 feet apart. Specimens of this description are sufficiently abundant in the virgin forest, and planters should always utilise them when making new clearings. It is under shade of this sort, with perhaps a little secondary planting here and there to fill up gaps, where one sees the finest coffee. "Devaracadoo" in the south and "Hallery" in the north, may be quoted as good examples of mixed shade. These fine trees not only indicate the fertile nature of the soil but they also protect and manure it, while reserving the upper stratum for the growth of coffee.

They also drain the subsoil, and extract mineral solutions from the latter, which are indirectly conveyed to the surface soil in the fallen leaf and decayed roots. It is in this reciprocation of mineral food constituents that the use of a variety of good shade trees, in preference to a few, is chiefly commendable. But variety is also needed to produce the light and shade which is so necessary to effect the best results in growing coffee. When in the months of June and July the sun is often obscured for weeks together and the trees are dripping with superabundant water, it stands to reason that dense shade would do harm. Then, again, when tender growth is progressing during the hottest months of the year more shade would be necessary. In other words, conditions vary, as should also the amount of shade on a coffee estate. Different trees cast their leaves at different times of the year, hence the admission of light in a somewhat varying quantity. The greatest amount of exposure should extend from November, when the berry is ripening, until the flowering period, when the young fruit is set; the object being to insure the thorough ripening of the young wood. Naturally this is what happens, as with the cessation of rain the fall of

the leaf is hastened and the coffee bush becomes more exposed to the ripening influence of sun-light. I observed that the "Palwan"—*Erythrina indica*—is a favourite shade-tree with many planters, and is looked upon as a fertiliser of the soil. The evergreen species, *Erythrina lithosperma*, is also under trial, although in some cases it is not true to name, being thorny and a doubtful evergreen. *Dalbergia sissoo*, Roxb., is a new shade tree which I have recommended for planting in stony land.

Seed can be supplied in quantity from Bangalore, where the tree flourishes.

CULTIVATION OF COFFEE.

It is not my intention to write a treatise on the cultivation of coffee, as every planter is sufficiently skilled in the routine of his particular work, while many are clever experts in the whole industry. But there are certain details of an important nature, bearing on the results of cultivation, on which the opinion of an outsider might be of some value.

Lands selected for the cultivation of coffee are usually of three classes, *e.g.*, virgin forest, *Kumri* and *kanave;* and they are always the best of their kind, due allowance being made for other necessary conditions, such as rainfall, aspect, and shelter from prevailing winds. But forest soil is the best, as also the most enduring under shade. When fully exposed by the entire removal of shade, land of the latter class exhibits extraordinary fertility for a time, but under the influence of full sun-light it gradually becomes less fertile, and coffee eventually dies out. This is due to what might be called adverse circumstances, as, for ages, the soil had been accustomed to a wholly different course of treatment for which it was specially adapted. By its absorptive and retentive nature, a deep vegetable mould is peculiarly fitted for the dual support of forest trees and coffee, from which products there is an unceasing demand for moisture. But with the removal of this natural drainage (absorption by growth) the soil becomes wet, cold, and unfertile; while the influence of intense light induces denitrification and hence a state of at least partial sterility. It will thus be seen that shaded and exposed lands are differently constituted and that the one cannot be merged into the other without causing intermediate disadvantages to the cultivator. The planter now realises that entire felling is the biggest mistake he has made;

but he attributes the cause, and perhaps rightly, more to the absence of shade than to a depreciation of the soil. In planting up abandoned coffee-land the growth is often slow and unsatisfactory, even when supported by liberal tillage and manuring; also in putting in "supplies" the reaction caused by undue exposure is sometimes felt. These difficulties I mostly attribute to a want of tone in the soil, caused by the absence of sufficient shade. Secondary plantings of coffee seldom do much until the shade is well up, when, it will be observed, the natural condition of the soil becomes re-established.

When an estate is planted, and during the first few years of its existence, the tillage of the whole land should be deep and thorough. The more the land is opened and aerated at this period the better, as at a later stage of growth when the bushes nearly meet there is both less opportunity and less necessity for deep tillage, should the land be well drained. To recommend draining the side of a steep hill may sound paradoxical, but during my travels I observed such land evidently in need of drainage. Then, where it is not very steep, especially in low-lying ground, a proper system of drainage is a most important factor in the sweetening of the soil.

Humus is not only very absorbent of water but it also retains it like a sponge.

Wherever there is sufficient foothold for soil of this description, plants will obtain moisture and grow readily, a fact which is strikingly exemplified by the steep cultivation at "Abiall" and other estates in North Coorg. But while the drainage system is intended to remove surplus moisture, care must be taken not to increase "wash" on the upper slopes. On a few estates I observed that open drains, a foot or more in depth and only a few feet apart (sufficient to accommodate one row of coffee bushes), were perpendicularly aligned from top to bottom of the slope. Unless the land is very heavy—a stiff clay—I should consider this practice open to question. Drains eighteen inches deep, following a gently sloping contour across the face of the slope, would be better, and would to a great extent intercept wash. The proper distance apart would wholly depend on the nature of the soil.

But as far as can be judged, twelve and eighteen feet are reasonable distances for heavy and intermediate soils. Stagnant

water in the soil is a most hurtful thing, and should be removed at any cost.

"Renovation pits," or holes made at intervals for the deposit of weeds, are supposed by some to facilitate drainage. But this is a doubtful function, as the pits have no collateral outlet and soon become clogged with weeds and forest refuse. I should be inclined to call them *brood-beds* for the propagation of fungoid diseases. At anyrate they should not be allowed to supersede a proper drainage system when it is required. Many fig trees possess the advantage of being openers of the soil, a fact which would easily account for the luxuriant growth of coffee under them. The woody, lateral roots of these trees form vacuities and tunnels which readily admit liberal currents of oxygen for many yards around each trunk. This, now, brings me to the all-important question of digging in a plantation. Thorough tillage up to a given limit has already been advocated, and it is also admitted unconditionally that a moderately open tilth is beneficial at all times. But there are other conditions to be taken into account, and I hope to show presently that in the matter of digging, the planter has to decide between two evils. These are (1) the destruction of coffee roots and (2) the closing up of the soil to some extent. The coffee bush is naturally a surface feeder, a position of root-growth which is further strengthened by subdued light and the prevailing practice of manuring on the surface, or very near to it. On productive estates I observed that fine meshes of young roots pervaded the upper soil everywhere, and I contend that the periodical removal of these feeders by injudicious *mamati*-digging would do the estate an incalculable amount of harm. Certainly much more than would be done by leaving the land undisturbed for a season. For routine tillage on an established tote, the *mamati* should be entirely discarded in favour of the fork; which opens the soil lightly without cutting many surface roots. A good argument advanced in support of *mamati*-digging is its efficiency in removing the encroaching roots of trees, which would otherwise take possession of the land. In reply to this, I must refer the reader to what has been written about deep-rooting trees being preferred to all others where coffee is largely grown. When surface-rooting trees are retained for shade (unless they possess special merits, as it has been shewn

may be the case) the evil cannot be remedied by surface digging without injuring the coffee, as it is unlikely that in using a *mamati* the ordinary cooly would take the trouble, even if he possessed the skill, to discriminate between the young roots of trees and the roots of coffee. It is rather by the thoroughness of preliminary operations, effectual drainage, and occasional surface forking that the planter can hope to oxygenise his land and thereby maintain its fertility and sweetness. But I can fully sympathise with those who are pestered by the surface roots of voracious trees, and if some implement could be invented to draw these out without doing much damage to the coffee roots it would be a good thing. Lopping off the principal root-limbs and leaving them with their ramifications to rot in the land is not a bad practice. Care must be taken, however, not to kill the tree or needful shade would be lost.

It may here be asked why so much importance is attached to coffee roots being near the surface. The answer is, that all fruit-bearing plants should have their roots well under the influence of light and heat to insure the best results in the production of fruit. This is all the more necessary in the case of coffee, where the soil is thickly covered by a mantle of vegetation. The food-stuffs required for the formation of fruit are not usually procurable in the subsoil, hence the advantage of shallow cultivation. Surface rooting is therefore desirable, although, to support vegetative growth during periods of drought, it is necessary to encourage fairly deep-rooting development also. But in this connection the admission of light, and regulation of growth, is controlled to some extent by careful pruning. I say "careful" advisedly, as the system of pruning which I have seen on some estates (not on the occasion of this tour) leaves much to be desired. It is a truism that bad pruning is worse than none, while hacking and reckless mutilation is often followed by troublesome diseases, such as rotting and canker. The object in pruning coffee is to equalise and encourage the growth of healthy bearing-wood. Anything not capable of giving crop, unless indirectly leading to the formation of crop-bearing shoots, should be removed by clean cutting. If this is done with care, shortly after picking, the soil, bush, and planter will each benefit by the operation. The organic and inorganic substances which combine to form plant food are

well known to the intelligent cultivator. What he is more concerned about is whether these substances are present in proportionate quantity and soluble form, as if they are not, the soil will be unproductive. The mere fact that certain constituents are found in a soil is no criterion of its fertility. And when it is remembered that mechanically, chemically, and biologically, soils are subject to ever varying conditions, this is not to be wondered at. Uncertainty as to the natural capabilities of the soil has led to much investigation, and the truths revealed by agricultural research in recent years are not only very encouraging but of the highest importance to the cultivator. He now understands how the defects in a soil can be remedied at the least cost. Indeed a bad soil can soon be converted into a good one.

It has already been stated that the Coorg soils are naturally good, therefore the planting industry was commenced on favourable terms; and bumper crops, obtained without much cultivation, were the order of the day for many years. But as time went on the shrub became less productive, and coffee pests of sorts commenced to attack the cultivation. It was then realised that the natural soil was becoming deficient in something which only heavy manuring could restore, and henceforward, manuring estates became a necessity. What the planter is chiefly interested in at the present day is how to restore to the land, in the cheapest and most efficient form, what his crops remove from it.

Agricultural chemists tell us that only *three* principal substances need be applied in the form of artificial manures. These are *nitrogen*, *phosphoric acid* and *potash*.

WEEDING.

The incursion of weeds on cultivated land has always been looked upon as thriftless husbandry, and generally speaking, we should take that view of it in coffee cultivation also, as the demand made upon the land by tree and coffee roots is already more than it can bear. But the primness of a flower-garden is not required on the estate, and in some exposed soils of a stony nature I instinctively felt that a light covering of weeds would have done good, by cooling the over-heated surface. The prevailing weed in the plantations is *Blumea Wightiana*, DC. (Kan "Gabbu Soppu"). It is an annual herb of rapid growth,

and abounds everywhere in two varieties, determined by white and purple flowers respectively. Considerable expense is incurred annually in the destruction of weeds, but the outlay is compensated to some extent by the green manure which is thus secured to the soil.

If weeds of annual duration, such as *Blumea*, have their tops cut off before flowering, they will do no harm to the coffee and comparatively little to the soil. I was favourably impressed by the clean cultivation which mostly prevails all over Coorg.

MANURES.

Valuation of Manures.

The manurial substances at the planter's disposal are of several kinds and may be roughly classed as follows :—

(*a*) Manures having both a direct and indirect action on the soil.

Cattle manure of all sorts.
Green manure of all sorts.
Sewage.
Composts.
Humus top-dressing.
Bones, when largely applied.
Guano do.

(*b*) Such as act indirectly.

Lime.
Marl.
Chalk.
Gypsum.
Salt.

Lime is of the highest importance to coffee land, as in addition to acting beneficially on humus, it is the salifiable base for the process of nitrification.

(*c*) Manures having a direct and comparatively quick action.

Bone-meal, dissolved, and in sulphuric acid, Guano, including fish guano, and flesh guano such as Mr. Petrie Hay prepares at Hunsur.
Oilcake—Poonac, castor, honge, etc.
Nitrate of Soda.
Superphosphates.
Sulphate of Ammonia.
Sulphate of Potash.
Muriate of Potash.
Mineral Phosphates.
Kainit.

A most valuable fertiliser of this class, recently discovered in the *débris* of steel factories in Europe, is *basic slag*.

Of the above named manures I shall now attempt, briefly, to show which are most valuable in providing *nitrogen*, *phosphoric acid*, and *potash*; leaving the cultivator to use his own discretion in a final selection. But manure in name and the substance in reality are often quite different things, and in the case of portable manures at least, I would strongly advise careful analysis.

Nitrogenous Manures.

Nitrogen in its different forms may be said to be present in everything. But for purposes of cultivation we mostly require it in the forms of *nitric acid* and *ammonia*, of which there is often a deficiency in impoverished or over-cultivated soils. It is, therefore, in the application of substances rich in nitrates and nitrites that we are likely to maintain this indispensable constituent in a form suitable to the growth of plants. The fixation of free nitrogen from the air through the combined action of leguminous plants and bacteria is a recent discovery of great value to the agriculturist. Nitrogen abounds in humus, and is found in varying quantity in all decaying organic substances.

The artificial manures which contain it in the largest proportion are nitrate of soda, sulphate of ammonia, Peruvian guano, bones, fish and flesh guanos and oilcakes.

All these are now used on coffee estates.

Phosphate Manures.

Next in importance to nitrogen, as a soil constituent, comes phosphoric acid. But as the latter enters largely into the composition of the coffee bean it is really of almost first importance to the planter. It is fortunate, therefore, that the crumbling rocks of Coorg are well charged with this useful acid, apatite, carbonate of lime, and the decaying felspars being the usual basis for it. Bare, arid tracts with occasional stunted vegetation indicate its scarcity, as plants are unable to grow without it. Coprolites abound in it. In nature, Phosphoric acid is mostly insoluble, occurring as phosphates of lime, alumina, and iron, etc. For convenient restoration to the land we have numerous artificial manures, such as guano, bones, basic slag and all the mineral phosphates. But for quick effect on growth,

the soluble superphosphates are the best, especially the double superphosphates manufactured at Wetzlar in Germany.

Potash Manures.

Although not so important to growth and reproduction as the preceding constituents, still, potash is an indispensable factor in the raising of crops. It is naturally abundant in old rocks—especially felspar—in decaying vegetable matter and in the salt-water of the ocean. It is the principal ingredient of the ash when a plant is burnt. Mr. Sprott, of Hallery, burns the noxious *Lantana Camara*, to utilise its potash on the estate. In a country situated as Coorg is, one would think that Potash would never be wanting : dense vegetation, sea influence, and crumbling felspar rocks being natural conditions. Still, the application of this mineral by artificial means has proved highly beneficial, and it can only be surmised that the natural product is in some way slow or defective in action. Sulphate and muriate (chloride) of potash are the two artificial forms in which this mineral is quickly restored to the soil. Dried blood is also good for the same purpose.

Application of Manures.

Having now classified the important manures under their respective headings, it is necessary to say a few words regarding their application to different kinds of land. Soils poor in organic matter are usually the most benefited by the application of nitrogenous manures. But some of the latter, such as nitrates, ammonia salts, and a few organic forms of nitrogen act so quickly on the soil that they should only be applied as top-dressings at the time the crop most requires them. Of this class, nitrate of soda is the most volatile. But bones, guanos of sorts, and oilcake are of slow action, and should be applied some months before they are actually required as food to the plant. Powerful fertilisers, as nitrate of soda and sulphate of ammonia, should always be applied in limited quantity, and, if possible, on two occasions during the growing season. Nitrate of soda is of most value in a comparatively dry season, heavy rain having the tendency to wash it down into the subsoil.

Sandy soils are usually improved by the application of potash. Damp heavy soils, as also such as are rich in organic matter (humus), should have phosphatic manures in preference to all others.

Manures of a quickly soluble nature are best suited to a dry climate, while those of slow decomposition are just the reverse. Mineral phosphates and basic slag require time to ferment in the soil, and should, therefore, be applied several months before they require to be in action.

Superphosphate on the other hand acts speedily, and should be applied as a light top-dressing at two or three intervals during the period of active growth. It will thus be seen that special fertilisers can only benefit crops while active growth is progressing, and when the soil is sufficiently moist to induce chemical action. In the case of nitrate manures the same conditions are necessary to enable the micro-organisms in the soil and roots to work satisfactorily in the production of nitric acid, through the wonderful process called nitrification. It is now known that a fertile soil teems with bacteria, as also the roots of many trees, shrubs, and herbs of the natural order *Leguminosæ*.

Indigenous Manures.

It was pleasing to hear that a few manurial products of the country are growing in favour. These are, in addition to oil-cake, which is universally and deservedly popular, *lime*, *fish guano* from the Malabar coast, and a substance which I shall call *flesh guano*, prepared by Mr. Petrie Hay at the Hunsur works. It consists of the dried fleshy material which is separated from greenish bones in going through the mill, and as now prepared by Mr. Hay forms a rich compost. If this manure could be prepared on a large scale, and in a somewhat different manner, it would be in great demand as an organic fertiliser. In this connection it may be asked if the millions of carcases (cattle and horses, etc.), annually put away in obscure places could not be applied to a more useful purpose? Being rich in nitrogen and phosphorus, the fish guano of the western coast should be liberally used on estates.

The lime procurable about Hunsur, and in some parts of Coorg itself, is supposed to be of questionable quality for manurial purposes. But this is a matter which chemical analysis would easily decide. In all probability it is better in some quarries than in others. There are two classes of land in Coorg which could be vastly improved by a liberal use of lime. These are the inert forest tracts and clay deposits. The mechanical and

chemical action of lime on these rich soils would, in my opinion, be of the greatest value to the planter. Of course, phosphates in the shape of bone meal or otherwise, would, to some extent, have the same effect, but they are more expensive and have practically no mechanical action on the soil. Although not a direct food giver, it must be remembered that good lime is a great manufacturer of plant food.

The free admixture of decaying rocky material, containing felspars, etc., is another means of improving the mechanical condition of heavy soils. Indian cattle manure is much poorer in quality than the farmyard dung of western countries, where much pains are taken to make and preserve the latter. But where cattle are folded and littered on the estate, the manure is of better quality. The bracken fern, *Pteris aquilina*, which contains a good percentage of alkaline matter in its constitution, is an excellent material for littering cattle. The location of this herb is said to indicate the presence of a calcareous soil. It is strange that soils of this class are often improved by light topdressing of chalk and gypsum. In dealing with soils of different sorts, it is necessary to apply such manures as are best adapted to each condition, and the quantity to be applied has to be regulated on the same principle.

Practical experience is much the safest guide, and it is not difficult to conduct such experiments on a small scale in different classes of land.

NURSERIES AND SEED SELECTION.

Preliminary operations on the estate require much care, forethought, and energy; none more so than the selection of sites and formation of nurseries where the young coffee is to be successfully reared. It goes without saying that nursery land should be of the best quality, while specially prepared composts are necessary to provide soluble food for the little seedlings. But this in itself can only maintain and nourish young life. Mere culturable operations cannot prevent or remedy constitutional defects arising from external causes. Thus, although the situation, aspect, and soil of a nursery may be everything that can be desired, it does not follow that the seedlings raised in it are always the best of their kind. For constitutional vigour we have to study race, pedigree, and the quality of individual

seeds. This constitutes what is called "selection" of the latter, and when carefully practised is usually the means of improving races or strains of cultivated plants. It is true, purity of strain is sustained by isolation so long as a plant retains its pristine vigour, but it has been observed in the case of many industrial plants that isolation accompanied by much seed-bearing has gradually led to degeneracy and loss of constitutional vigour. To prevent this the seed-bearer should not be allowed to produce more than a limited number of seeds, while the nourishment given should be in proportion to the important work such a plant has to perform. In coffee, seed-bearing can easily be regulated by removing 50 to 80 per cent. of the flower buds, leaving such as are favourably situated on the lower half of the primary.

But without taking special measures, a first picking of the finest beans from all over the estate will also be found useful for the propagation of nursery stock. And if such pickings are exchanged with planters situated in different localities, the results are likely to be better still. In nurseries and seed-farms in Europe, the raising and selection of seed forms a special department of work to which the greatest attention is paid. Small seeds are carefully examined under the microscope, so that only the very best may be chosen for sowing. Thus by eliminating the inferior and encouraging the cultivation of the best at one's disposal, an improved strain of plants will be gradually formed.

VARIETIES OF COFFEE SEEN IN COORG.

The species observed were only three in number, *e.g.*

1. *Coffea Wightiana*, W. & A., Indigenous.
2. ,, *Liberica*, Hiern., West Africa
3. ,, *arabica*, Linn, Abyssinia.

No. 1 is somewhat sparsely found in North Coorg, and is never admitted into cultivation, I believe. It is a whippy-looking shrub 3—5 feet, leaves thinner, smaller, and more pointed than in *C. arabica*. The reddish-purple berry is also small, but contains two miniature beans of perfect form. There were very few berries on the specimens kindly gathered for me by Mr. Wood. The flower was not seen, but I am told it is much smaller than the flower of *C. arabica*. Of No. 2 Mr. Parsons possesses two, if not three, varieties at Beechlands, the most important being the one known as "Johore-Liberian." On

this estate the cultivation of Liberians has been pursued for many years, and I had the pleasure of seeing a large number of fine specimens both in flower and fruit. There are also some seedlings in the nurseries with a distinctly hybrid look about them. Indeed it will be a wonder if natural hybrids are not freely produced on this estate before long. Mr. Parsons also deserves credit for the experiments he has made with grafted coffee. Although results in the latter are not great, the persistence in experiment shows the proper spirit of enterprise.

No. 3 affords the staple coffee of the province, as it does of South India generally. There are several well-marked varieties in cultivation known by the local names of "Coorg," "Chick," "Nalknad" and "Golden drop." Another variety, intermediate between "Chick" and "Coorg," evidently a natural cross, is abundant on the Hallery estate, where it was pointed out to me by Messrs. Mangles and Sprott.

Specimens of the "Golden drop" coffee, were seen at Mr. John Logan's place in South Coorg and also at Santagherry in North Coorg, where Mr. H. F. Davy is Superintendent. Instead of being red when ripe, the cherry in this variety is of a bright golden colour. But the most important variation in coffee is that which improves the size, colour, weight, and quality of the bean, conditions which the planter is no doubt on the alert to discover. It is not likely, however, that much improvement in this direction will occur without greatly enhanced vigour in the plant. In other words, the present strain of coffee should be improved by artificial fertilisation.

CROSSING AND HYBRIDISING.

In my last report on the Lal Bagh, at Bangalore, I have written as follows on the subject of hybrid coffee.

"The possession of hybrid plants on several estates in Southern India now appears to be an undisputed fact. These new forms are reported to combine, more or less, the characteristics of *Coffea Liberica* and *Coffea arabica*, and are only found in localities where the two species have been cultivated and propagated together. They have not been introduced by the planters as new varieties, and were unknown prior to the introduction of the west African species, *Coffea Liberica*. "It is therefore reasonably inferred that these intermediate plants are true hybrids. The most remarkable thing about them is their immunity from coffee-leaf disease, a condition which

can only be attributed to enhanced vitality in the constitution of the hybrid. This is a discovery of much importance to the planter, and will encourage him to pursue the operation of crossing on methodical lines, with a view to raising improved strains of seed, as has already been done in most of the chief products of agriculture and horticulture in Europe. What should be aimed at now is the systematic crossing and re-crossing of different species and well marked varieties until a really good hybrid or cross is produced. With this object, a small coffee-plot has been planted in the Lal Bagh. It consists of 135 bushes in two species and one variety as named in the margin. Most of the plants were of a good size when put down, and it is almost certain that a few of the Liberian and Maragogipe specimens will flower early next year, when crossing operations will be commenced.

Coffea Liberica (Liberian)
,, *Arabica* (Arabian)
,, *Arabica* (*var.* Maragogipe).

On the occasion of the Planters' Conference at Bangalore last August, the writer had the honor of being invited to attend the discussion on "Scientific Investigation," when the opportunity was taken before the representative planters of Southern India to advocate the advantages of crossing and hybridising coffee with a view to invigorating growth and increasing productiveness.

The same advice has been given in official correspondence with planters, and the institution is generally doing what it can to promote the welfare of the planting industry. Hybrids, or supposed hybrids, have been reported from the marginally noted estates."

Oosoor Estate,	Manjarabad.
Ubban ,,	,,
Koppa ,,	Kadur Dist.
Panora Peak	S. Wynaad
Kalpatti	do.
Beechlands	S. Coorg.

It is now some years since the operations of crossing and hybridising were first advocated by me, and as time advances, I feel more convinced that in these operations, carefully conducted, we possess a potent means of resuscitating worn-out estates. Without a rotation of crop it stands to reason that coffee will become less productive, unless some radical change is brought about to modify or alter its condition. Change of constitution in a plant really means change of action on the soil as well, and where the effete plant must eventually languish, even under the best of treatment, the newly born one will flourish. Coffee-planting is a special industry which cannot conveniently or profitably be rotated with other cultures; therefore, to keep the plant going for an indefinite period we must change its nature a little, so as to be in harmony with its environment. Judging

from the foregoing remarks, and from what has actually taken place on estates where *Coffea Liberica* is established with the older species, there is no doubt but the shrubs, in both cases, are predisposed to cross fertilisation. That important point being settled, it now remains to discuss how a good hybrid or cross is most likely to be produced. This I have already done when lecturing at Mercara and Pollibetta, but it will refresh the planters' memory to reproduce the more salient points here, while the information given under Appendix 1 affords the *modus operandi* of the work in some detail. A definition of the terms "cross" and "hybrid" will be found in the same place. As far as I am aware (but this is open to correction), no artificial cross or hybrid has yet been produced in the genus *Coffea*. At any rate not in this country, and the new or varying forms referred to above are all nature-crosses.

But artificial crossing, done with a definite object, has been productive of many useful and beautiful plants in Europe. Indeed it may be said that horticulture (and agriculture) is to a great extent revolutionised by this means. It is therefore not a fad but a potent reality in the improvement of both economic and ornamental plants. In crossing, the object chiefly aimed at is to reproduce the desirable qualities of two distinct individuals, of different kinds, in the body of one individual. It is not always easy to do this, but it can be and has been done extensively; and is well worth trying as a perfectly feasible means of improving an important and growing industry such as coffee-planting. A hybrid produced from two distinct species is called a "primary hybrid," and succeeding generations, if intercrossed, may become secondary and tertiary hybrids, etc.

When the characters of both parents are pretty evenly blended in the hybrid, the latter may be called the "mean" of the former. But it often happens that the prevailing characters are more approximate to one parent than to the other, in which case we have what is known as a "goneoclinic hybrid." Another way of producing the latter is to cross a hybrid with one of the parent stocks. Ternary hybrids are the indirect offspring of three different species.

It is in the production of the two latter forms (goneoclinic and ternary) that the greatest achievements in hybridisation have been made.

The hybrids naturally produced at Oossoor seem to possess the vegetative vigour of the maternal parent, *Coffea Liberica*, but are deficient in the productive quality of the paternal plant, *Coffea arabica*. To remedy this defect, a cross should now be tried between the latter and the hybrid, as the pollen of *C. arabica* would possibly be more potent in the second degree. In nature there are numerous and beautiful inventions to facilitate the crossing of flowers, but in a paper of this scope it is inexpedient to attempt more than a brief reference to what transpires in the short-lived coffee flower. The latter is structurally hermaphrodite, but not functionally so in every case, as I have observed small insects crawling over the mature stigma before the anthers had dehisced, having pollen from other flowers attached to their legs. I cannot say to what extent this provision is made for cross-fertilisation, but as the flowers open progressively for 24 hours and are visited by swarms of insects at the time of opening and during the receptive period, it is probable that a large percentage of the whole are cross-fertilised.

The active life of the individual flower is of short duration, and possibly within the first hour of its existence it has been fertilised, cross-fertilised, or sterilised. It belongs to the entomophilous class of flowers which are pollinated through the agency of insects, such as small bees, midges, beetles, small moths, and weevils, etc. Dull cloudy days with a lowering of temperature are unfavourable to fertilisation, hence a bright warm day is desirable when the blossom is out.

REVERSION OF HYBRIDS.

This is a matter which troubles the planter a good deal, and possibly causes him to pause before undertaking a series of precarious experiments which involve much time and may lead to nothing in the end. It may, therefore, be said at once that established hybrids of similar strain (slight variations being of little account) do not revert to the parental stock if they are not pollinated by the latter. To maintain purity of strain in a hybrid is simply a matter of protection. Trivial crossing between members of a select group of hybrids—all being very nearly related—is perhaps beneficial on the whole and cannot easily be prevented.

Then, when a really suitable hybrid has been produced, the proper course is isolation from all other varieties of coffee, with

a view to inbreeding and seed production. I hope I have made this sufficiently clear, as on these final precautions must rest the success of the whole operation of crossing.

INARCHING.

This form of grafting, like the other, retards vegetative growth and promotes the development of fruit.

The coffee-grafts at Bangalore behave in exactly the same way as mango-grafts; *e.g.*, plant stunted and spreading, fruit large, and not so plentiful as in the seedling. *C. arabica* on *C. Liberica* is the only combination of any value at head-quarters. Seedlings from the latter have been distributed for trial, and are being cultivated under my own observation. It is possible that some constitutional vigour may be gained from a mechanical connection of this kind, especially where the grafts are interbred. In other respects I do not think that grafted coffee is of much practical value. Some beans exhibited from the inarched bushes here were admired for their size and colour. The operation is chiefly useful in dwarfing vegetative growth, causing early fruiting, and reproducing the true qualities of particular kinds of plants.

COFFEE PESTS.

"We should be happy that it is an industry that involves a certain amount of trouble. Otherwise it would be taken out of our hands altogether." Such is the pithy and hopeful remark made by an able and experienced planter on the occasion of the last Conference of the United Planter's Association at Bangalore. A statement of this sort indicates the true energy which underlies all the actions of British enterprise.

In the latter case obstacles are of little moment, and may be of real advantage in keeping out the faint-hearted. The same spirit prevails in Coorg, although borer, leaf-rot, leaf-disease, bug and other pests, have each done their best to diminish the planters profits—uncertain crops and foreign competition being a further tax on his patience. Leaf-disease, which is most dreaded, was not very prevalent on any of the estates visited. *Hemileia Vastatrix*, the fungoid parasite which causes leaf disease, by partially or wholly disorganising the functions of the leaf, made its appearances in Coorg in the early seventies, after committing great havoc in the planting districts of Ceylon.

The peculiarity of the fungus is that it persistently follows the coffee bush all over the country and is more or less prevalent wherever coffee is grown. A virulent attack on the experimental plot in the Gardens (Lal Bagh), has just been temporarily checked by burning every infected leaf and coating the ground with a thick layer of quicklime.

Combustion, whether active or passive, is the natural enemy of fungoid organisms; and when Mr. Marshall Ward recommended burning everything that could be burnt with safety on the estate, he gave good advice. During the pruning and wood-ripening season, tons of leaves and twigs could be disposed of in this way, although it is admitted that a coffee zone such as the "Bamboo" provides but little space for kindling fires. It is the annual recurrence of the scourge which makes it so disastrous, and anything that would harass it or deprive it of nourishment at critical periods would have the effect of saving the host to a large extent.

Spraying operations were observed at Hallery, where Mr. Sprott thinks he has gained some advantage over the fungus. The mixture in use is 3 lbs. sulphate of copper and the same quantity of lime dissolved in 25 gallons of water.

The Californian remedies for fungoid and other pests are given at the close of this paragraph.

The Life-history of

Hemileia Vastatrix was thoroughly worked out by Mr. Marshall Ward in 1881, and readers cannot do better than refer to his scientific reports, written for the Ceylon Government on the subject about that time.

The Director of Kew Gardens gave it as his opinion, in 1892, that *Hemileia Vastatrix* is a species endemic to the Island of Ceylon. This great authority further adds,—"Like thousands of other microscopic leaf fungi, it probably maintained its existence in an unconspicuous manner in some native Rubiaceous plant (*i.e.*, belonging to the same family as the coffee). It was probably only by a kind of accident that about 1869 it found a suitable host in cultivated coffee, and thus was enabled to develop itself on a scale which speedily made it a scourge." Since the latter date, when first observed, the parasite has followed its host unremittingly to every coffee region of the old world.

Change of food would possibly arrest its progress sooner than anything. Slight constitutional change in the host might bring this about, and the process of hybridising would be of much value if it secured even partial immunity to the coffee plant from the attack of *Hemileia*. That such a thing is possible has already been proved by the raising of certain varieties of potato which are wholly immune from *Phytophthora infestans*, the most hurtful fungoid parasite of that esculent.

THE BORER.

The next pest to be briefly considered is the borer (*Xylotrechus quadrupes*), which is indigenous to the country. In fact, there are several borers, and the remedies here recommended will apply to them all. It is only in the more exposed parts of South Coorg that the ravages of these insects are much felt, and even there the conditions are far more hopeful than they were thirty years ago. At that time the wholesale destruction of forest trees, accompanied by undue exposure and indifferent cultivation, aggravated the attack and was the indirect cause of enormous loss to the planter. But it is now understood that sufficient shade and moisture, supplemented by good tillage, are conditions inimical to the spread of borer. The rush for extension which prevailed a few years ago, when prices went up, must be held responsible to a large extent for the maintenance, if not increase, of coffee pests. A large area (in fragments here and there) of unsuitable land was placed under cultivation, and by a process of forcing in some cases and comparative neglect in others it was hoped to increase the average outturn of bean. But a cycle of dry seasons shortly followed, and the new openings were mostly found to be infested with leaf-disease and borer, which rapidly spread to healthy tracts that had not suffered before to the same extent. The occupation of such lands by coffee is therefore a standing danger to the whole local industry. I can imagine nothing more disheartening to a really good planter than to have neighbours who will act recklessly in the selection and treatment of land, to the jeopardy of the whole community. In addition to depth of soil, moisture, and shade, the presence of numbers of insectivorous birds is recommended for the extinction of borer. Of these, woodpeckers, jays, thrushes, mynas, hoopoos, sparrows, larks, jungle fowl, the crow pheasant and many others are insect eaters. When the

larvæ can be got at, which is not very frequently, the direct application of neem oil is the surest remedy. If poured into the holes and tunnels caused by the insect, it will either bring out the latter quickly or cause its death inside. In this connection I may mention that neem oilcake, which is manufactured at Hunsur, might have a remedial effect if applied to land affected by borer. Rubbing the coffee stems at intervals with the oil would be a good practice.

LEAF-ROT.

Pellicularia Koleroga, or "leaf-rot," is an epiphytal fungus which envelopes the coffee leaf during the monsoon and subsequently kills it. Continuous or heavy rainfall, density of shade, drip, and stagnation of drainage, are the causes of this fungoid growth. A modification of the above conditions with the use of fire to destroy all affected leaves, and the application of flowers of sulphur in the early stages of attack are the best known remedies. Bordeaux mixture and other fungicides should also be tried. For the eradication of bug and scale insects, the importation of a useful species of lady-bird is under trial. The brown scale-insect, *Dactylopius adonidum*, is prevalent on many of the jungle trees, where it is farmed by ants for the secretion known as "honey dew." It is usually accompanied by the black fungus *Trisporium Gardneri*, Berk. Kerosine emulsion is a good remedy for these pests.

REMEDIES FOR PLANT DISEASES.

Extract from spraying calendar, Central Experimental Farm, Ottawa.

FUNGICIDES.

Diluted Bordeaux Mixture.

Copper Sulphate	4 lbs.
Quick lime	4 „
Paris Green (for leaf-eating insects)... ...	4 oz.
Water (1 barrel)	40—50 gallons.

Dissolve the copper sulphate (bluestone) by suspending it in a wooden or earthen vessel containing 4 or 5 or more gallons of water. Slake the lime in another vessel. If the lime, when slaked, is lumpy or granular, it should be strained through coarse sacking or a fine sieve. Pour the copper sulphate solution into a barrel, or it may be dissolved in this in the first place, half fill the barrel with water, add the slaked lime, fill the barrel with water and stir thoroughly. It is then ready for use.

Stock solutions of dissolved copper sulphate and of lime may be prepared and kept in separate covered barrels thrughout the spraying season. The quanties of bluestone, lime and water should be carefully noted.

Copper Sulphate Solution.

Copper Sulphate (bluestone)	1 lb.
Water	25 gallons.

As soon as dissolved it is ready for use. For use before the buds open only.

Ammoniacal Copper Carbonate.

Copper Carbonate	5 oz.
Ammonia	2 qts.
Water (1 barrel)	40—50 gallons.

Dissolve the copper carbonate in the ammonia. The ammonia and concentrated solution should be kept in glass or stone jars, tightly corked. It is ready for use as soon as diluted with the 50 gallons of water. To be used when Bordeaux cannot be applied on account of staining the fruit. Full particulars given in Experimental Farm Bulletin No. 23.

Corrosive Sublimate.

For potato scab soak the tubers for 1½ hours in a solution of 2 oz. in 16 gallons of water. When dry cut up for planting. Corrosive sublimate is a fatal poison if taken internally. It also corrodes metals. The solution should therefore be made in wooden vessels.

All treated seed should be planted, and any solution left over should be poured into a hole in the ground.

INSECTICIDES.

Kerosine Emulsion.

Kerosine (coal oil)	2 gallons.
Rain water	1 ,,
Soap	½ lb.

Dissolve soap in water by boiling; take from fire, and while hot, turn in kerosine and churn briskly for 5 minutes. To be diluted before use with 9 parts of water.

For bark lice and other sucking insects.

Paris Green.

Paris green	1 lb.
Lime (fresh)	1 ,,
Water	200 gallons

For dry application—1 lb. Paris green with 50 lbs. land plaster, slaked lime or any other perfectly dry powder.

For insects which eat foliage.

Hellebore.

White Hellebore	...	...	...	...	1 oz.
Water	...	...	...	...	2 gallons.

Or to be dusted undiluted over attacked plants.

Pyrethrum (or Insect Powder.)

Pyrethrum powder	...	...	...	...	1 oz.
Water	...	...	...	...	3 gallons.

For dry application—mix thoroughly 1 part by weight of insect powder with 4 of cheap flour, and keep in a close vessel for 24 hours before dusting over plants attacked.

Extract from the "Mysore Gazette," June 25, 1896.

[The following are some reliable formulæ for the treatment of fungi and insect pests. They have been taken from the Report of the Agricultural Experiment Station of the University of California, and are reprinted here for the benefit of the many inquirers in this country to whom the original reports are not, perhaps, accessible. It should be very constantly borne in mind that "Paris Green" and "London Purple" contain the powerful poison arsenic, and should therefore be used with the greatest caution, especially in the case of plants any part of which is used in the preparation of food or drink.

The same caution applies, though with less emphasis, to "Bordeaux mixture," which contains an irritant copper salt.]

For Powdery Mildews use sulphur, dusting it on the plants.

For Fungi in general use Bordeaux mixture, made as follows: For every 10 gallons take 1 lb. of lime and 1 lb. of bluestone. Dissolve these separately in hotwater and mix when cool adding the rest of the water. Spray on the plants. Or spray with Ammoniacal copper carbonate solution, made as follows: Dissolve 1 oz. of copper carbonate in 6 oz. of ammonia and add 10 gallons of water.

For Fungi and scale insects use lime, salt and sulphur mixture, a winter wash composed of lime 8 lbs., salt 3 lbs. and sulphur 4 lbs. for each 12 gallons of water. mix $\frac{1}{4}$ of the water, $\frac{1}{4}$ of lime, and all the sulphur, and boil for $1\frac{1}{2}$ hours; put the salt with the rest of the lime and slake with hot water; add to the above and boil $\frac{1}{2}$ hour longer; add the remainder of the water and apply as a spray.

For scale insects use resin soap as follows: For 100 gallons for summer use take resin 18 lbs., caustic soda (98 percent.) $3\frac{1}{2}$ lbs., and fish oil $2\frac{1}{2}$ pints; for winter use, resin 30 lbs., the caustic soda $6\frac{1}{4}$ lbs. and fish oil $4\frac{1}{2}$ pints.

The material is put in a kettle and covered with 4 or 5 inches of water. The lid is put on and the mixture boiled two hours

or more, and then the rest of the water is added, a little at a time. Spray on the plants. Or use the gas treatment: cover the plant with an oiled tent, and for each 100 cubic feet of contents place in a bowl beneath the tent $\frac{2}{3}$ oz. of water, $\frac{1}{3}$ oz. of suphuric acid (oil of vitriol), and $\frac{1}{3}$ oz. of potassium cyanide (58 per cent.). Be careful not to inhale the poisonous gas, not to allow it to escape from the tent for $\frac{1}{2}$ hour. The leaves may be injured if used during the middle of the day For insects in general use kerosine emulsion, as follows: Make a soap solution of $\frac{1}{2}$ lb. of soap to a gallon of water. Heat it to boiling and add 2 gallons of kerosine. Pump it through the spray pump, with good pressure, for 5 or 10 minutes. For use add 10 times as much water as you have of emulsion. Apply as a spray. Sour milk may be used instead of the soap solution. The emulsion is made more effective by the addition of a very small amount of arsenic to the soap solution, or of buhach to the kerosine.

For fruit or leaf-eating insects use Paris Green or London Purple as a powder at the rate of 1 to 5 lbs. to the acre, distributed by walking or riding over the field, carrying a pole, at both ends of which are hung muslin bags containing the poison. As a spray use 1 lb. to 200 gallons of water. In spraying these arsenites the nozzle should be held at some distance from the plant and no more should be applied after the leaves begin to drip. Do not use these on crops where the poison would be injurious to health.

CATCH-CROPPING.

In advanced agriculture much stress is now laid on the desirability of keeping land clothed with crops, direct exposure to sunlight being considered more exhaustive than when the surface is protected. In this connection, I am of opinion that all inferior land attached to estates should be utilised for raising green crops either for its own improvement or to provide green manure to the coffee land. And of the latter, much which is practically unsuitable for coffee might be usefully employed in the cultivation of accessory products. Green manures are so beneficial to poor land that no favourable opportunity of growing them should be lost. The leguminous plants best suited for this purpose are *Mucuna pruriens* var. *utilis;* the Florida velvet bean; *Trigonella Fœnum-Græcum*—Fenugreek; *Medicago Sativa*—Lucerne; *Indigophera enneaphylla, I. pentaphylla,* and other forms of wild indigo; *Cicer arietinum*—Bengal gram; *Phaseolus Mungo*—green gram; *Dolichos Lablab*—cow gram, and others. The first named is a new plant of which

I have distributed some seed in Coorg and elsewhere. In the early operations of planting, especially if the shade is light, the addition of a green crop occasionally would be of benefit to the soil. Catch-cropping in the proper sense, means the sowing of a quickly-growing crop directly after the staple one has been removed, with the principal object of conserving nitrates and other plant constituents which would otherwise be lost from exposure. But coffee is a permanent crop which soon protects the surface soil from undue radiation, so that after the first few years the conditions are very different to what prevails in the cultivation of arable land at home.

OTHER PRODUCTS.

It is beyond the scope of this paper to offer hints for cultivation or to enter into detail on the commercial value of secondary products. Moreover, it cannot be said absolutely that any new culture will succeed until it has been sufficiently tried in various ways. In the "Bamboo" there is no room for other cultures, unless, as has been suggested, the inferior parts of the coffee zone are surrendered for experimental and fertilising purposes. So long as coffee is profitably worked the planter is wise in giving it exclusive attention. Pepper seems to do admirably in some parts, and it seems a pity that more is not grown. But in North Coorg there are facilities for starting new industries such as tea, fibre, and paper factories.

Mr. Parsons showed me a new tea opening in the Sampaghi Ghat which looks promising in the initial stage. The nurseries are in splendid condition and do great credit to the management. Cardamons should do well in the evergreen forest, although very little is produced. Other likely products are Camphor, Vanilla, China grass, Nutmeg, Rubbers (Pará, Indian, Central American,) Castilloa, and Ceará. The demand for *Cinchona succirubra* has gone up considerably and may be worth noting. Indian paper-grass, *Ischæmum augustifolium*—better known in the North as "Bhabar grass,"—would possibly do well on the grassy slopes of North Coorg. The consumption of paper is so great that the Indian supply is quite unequal to it.

In a cool station like Mercara, the Australian *Coniferæ* would succeed, as also the Moreton Bay Chestnut, *Schinus molle*, *Salix*

Babylonica, and numerous other ornamental trees which would add to the interest and beauty of the place. I am of opinion that mahogany would also grow well.

SUMMARY.

In conclusion, I shall briefly emphasise what has gone before, thus endeavouring to show in the fewest possible words what is best for the planting industry. To attain success, it must be admitted candidly that the industry has entered the forcing stage, a condition which has been hastened, in most cases, by indiscretionary treatment of the land in the beginning. What was wasted and taken from nature as a free gift, has now to be returned with more than compound interest, and it will take a long time, if ever accomplished, to readjust the debt. The planter who can return to the land a liberal percentage of his profits, will sustain the forcing system for many years to come, even if no other factor arises to infuse new life into the industry. But I am strongly sanguine that in hybridisation a factor will arise, and that the renovation of coffee is not wholly a matter of soil enrichment. In any case, good cultivation is a *sine qua non* of future management.

The application of proper manure in correct quantity and at the most serviceable time, are things which should be assiduously learned from practical experience.

A table showing quantities of different manures to be applied per acre for different crops is not of the slightest use to the planter, who possesses but one product on many different kinds of soil.

Next in importance to hybridisation and proper culture, the interchange and special selection of seed must take a high place. The coffee fields of the whole planet must be studied with a view to improvement being made by selection, a work which, I am glad to observe, is already being promoted by the Editor of *Planting Opinion*.

There are no magic remedies either for the prevention of pests or the improvement of coffee, but if the methods recommended in this report are correctly and patiently practised, the results, in the long run, should be satisfactory.

It now only remains for me to thank the planters of Coorg, especially the Honorary Secretary of the Association, for the help and courtesy which was everywhere accorded to me.

I have the honor to remain,

Sir,

Your most obedient servant,

J. CAMERON,

Superintendent,

Mysore Govt. Botanical Gardens,

Bangalore.

APPENDIX I.

Extract from "Planting Opinion."

Fertilization of the Coffee flower.

(By J. C.)

A good many planters who will recognise the above initials know that I am keen on the crossing of coffee. Wishing them and others to be equally keen in a work which may eventually lead to the advantage of the whole planting community, I venture to offer a few hints as to how the details of the crossing may be put in motion. The process of fertilization, if confined to individuals of the same species, will only result in producing "varieties" of the individuals concerned. But when it is extended to different species of the same genus, then an intermediate class of plants called "hybrids" are produced.

As this may not be quite clear to all, I shall give a practical illustration. When two bushes of *C. arabica* are growing near to each other and flowering simultaneously, they will be observed to attract many insects of the winged class. It is a marvel where these insects come from in such numbers and at such short notice. But there they are, the whole day, hurrying to and fro from one bush to the other, until, perhaps every newly-opened flower has been visited.

Now, although these insects have been most industrious in their own interests, collecting food and building material, the chances are that they have unconsciously rendered a signal service to the coffee also, by carrying pollen from the flowers of one bush to that of the other. If they have done this inadvertently or otherwise, the insects have effected cross-fertilization to the extent of producing varieties, or new forms of the two bushes concerned. By excluding the services of the insects altogether, the same results, and even more effectual ones, can be secured by delicate manual operations. But of this further on. The difference between the fertilizing work of insects and that of man consists in its being promiscuous and haphazard in the one case and systematic in the other.

Now if individuals of two distinct species, such as *C. arabica* and *C. liberica*, were to blossom together in the manner described above, exactly the same activity of insect life would be observed, with, perhaps similar results, only that in this case the progeny would be more than a "variety," it would be a "hybrid." Planters know that year after year their nurseries are stocked with seedlings raised from local seed of which a small percentage appear to be new varieties, or at least

different from their fellows. They know also that nature is herself responsible for such variation. If the life-history of a number of seedlings was carefully traced, it would be found that while a few differed in the form, size, and texture of the leaf, others in the size and quality of the fruit or habit of growth, the major part would be nearly identical with the prevailing variety on the estate. This is all right where the prevailing strain is good. But where the product for which a plant is cultivated shows signs of exhaustion, or has become deficient in quality or quantity, the strain is said to have "run-down," and in all such cases too much individualism in reproduction is undesirable. It is in all probability to prevent this running down of strain or breed that nature insists on cross-fertilization.

Coffea arabica, or Arabian coffee, of which there are several well-defined local varieties known by such names as "Chick," Coorg and "Nalknad," has been almost exclusively cultivated in this country from the time the industry was started, and it is only within recent years that one or two new varieties and species have been introduced and cultivated on the estates. This fact will explain the absence of hybrids over such an extensive area, there being no material to make hybrids from. Yet, within the past few years, some hybrids have made their appearance, shortly following the introduction of Liberian coffee, a distinctly new species. And, barring the fact that two distinct species have been placed in juxtaposition to each other, the hybrids are the work of nature. But in the instances referred to, man must get the credit of having materially helped nature by providing a new species for the latter to work upon.

If he would, therefore, do more in this direction, the chances are that worn-out strains of coffee would soon be replaced by better kinds.

This leads me on to the suggestion that approved varieties and new species of coffee should be freely introduced from other countries. The field for experiment would then be much widened, as planters would have sufficient material to work upon.

The cultivated forms of coffee in different parts of the world are already so far advanced of the indigenous or wild bush that it would probably be mere waste of effort to bring the latter into experiments, the object of which is to secure further improvement in productiveness and quality. Collections of species and varieties should, therefore, be confined, in the first instance at least, to well known jâts already in cultivation. These I shall leave the planter, being the best judge, to select for himself. Now supposing that some enterprising planter has already secured such a collection of coffee-bearing plants, how is he to dispose of them to the best advantage?

This is a question that I shall endeavour to answer in my next.

With one or two new species of coffee at one's disposal, and a like number of distinctly marked varieties, such as the "Maragogipe," which is an introduced variety (from Brazil) of *Coffea arabica*, an experimental plot could be started on the following lines :—

(*a*) Situation, as regards aspect, soil, water and shade, to be the best the estate can afford. Occasional irrigation will possibly be required to induce the different bushes to blossom together, so that the possession of a perennial water-supply would be a convenience.

(*b*) The crossing-plot need not exceed one-eighth or at greatest one-fourth of an acre in extent, while it is possible that equal results may be obtained by working systematically on a few bushes.

(*c*) In planting up the crossing-plot, an equal number of healthy seedlings of the estate coffee should be thoroughly mixed with the new kinds, so that winged insects may have full play on the whole. But in addition to the general and haphazard operations performed by the insects, a few bushes should be carefully isolated for hand-fertilization. For the latter purpose a few skeleton frames covered with fine muslin would be a sufficient protection, if placed over the bushes before the flowers opened. Plant in a square plot at 6 × 6 feet, so that air may circulate around the bushes freely. The preliminary details which I have emphasised under the sub-headings *a*, *b* and *c* will keep the planter employed for at least two years, or, to be strictly accurate, until a maiden crop of flowers is produced in the crossing-plot.

Then, at this latter stage, the work of fertilization will actually begin, should several distinct kinds of coffee flower simultaneously. Unprotected bushes will be pollinated through the agency of insects chiefly, while the protected ones will be self-pollinated, should no precautions be taken to prevent it. Where bushes are intended for hand-fertilization, it will be necessary in the early stages of reproductive growth to rub off a great many of the young flower buds, so that the inflorescence of an individual may be reduced to a manageable number of flowers. For that matter, the flowers could be reduced to what is borne on a single primary, or to a few clusters of the same. The necessity for this apparently ruthless treatment is contained in the fact that, during the short time the stigma is receptive of foreign pollen, the fertilizer could only pollinate a limited number of flowers with any degree of certainty. It is, therefore, wiser to make sure of getting a few good crosses than to attempt a larger number indiscriminately. Let us now suppose

that the operation is about to take place. Having provided himself with the marginally noted requisites, and selected a protected bush to become the seed-bearer, the fertiliser places himself under the protective frame and eagerly watches for the opening of the first flower. Directly the flower opens (usually early in the morning), there will be seen, slightly projecting from its delicate-white throat (tube of the corolla) a bifid or two horned stigma supported by 5—7 arrow-headed anthers on short stalks. At the time of opening, the stigma, which is seen well in advance of the anthers, glistens with a sticky substance which holds fast any powdery matter, such as pollen, that may fall on to it. What the fertilizer has to do at this stage is to dust a little foreign pollen on to it by means of his camel's-hair brush. This done, he instantly, and as deftly as possible, cuts away the 5—7 anthers behind the stigma. But as the anthers are usually closed at this early period, they could perhaps do no harm if they were left. Everything would depend on the behaviour, so to speak, of the stigma towards the new pollen by which it has been fertilized.

A fine camel's-hair brush; small, sharp penknife; small sharp pair of scissors; pocket lens; flowering branch from male parent, with pollen.

The process as described above has to be done with every flower until the primary or clusters of flowers reserved for crossing have been exhausted. A register is then made of the parentage on both sides, and after a day or two the bush is liberated from its protecting covering.

I have examined many coffee flowers at the moment of opening, in most cases the stigma projects in advance of the anthers and the style lengthens rapidly. By this means the spreading horns of the stigma afford a good platform for small bees and other insects to rest upon when searching for honey. Then flitting from one stigma to another they deposit quantities of pollen, which readily adheres to their hairy limbs. Crossing operations being completed, the next step would be to select a suitable piece of land for the cultivation and trial of seedlings raised from the crossing-plot. It is in this final stage of the experiment that the exact result of cross-fertilization would become apparent, and not before.

But the operator needs to possess patience, for among 10,000 seedlings cultivated there may not be one showing real improvement in every respect.

With our limited experience in crossing, it is uncertain what would happen, although there is reason to believe that cross-fertilization would induce beneficial variation in the growth and production of coffee.

The land required for testing seedlings of mixed parentage should be of the best quality, and the cultivation should be on a liberal scale also. Area is a matter for the planter himself to decide, as it depends wholly on the extent of his operations. I do not, however, advocate large areas for mere experimental work. When the seedlings give their maiden crop, it will be seen approximately what merits they possess from a productive point of view. But other merits, which may be roughly termed constitutional, will only become apparent after a lapse of time and under different modes of treatment.

I can readily imagine that a judicious selection of the fittest would prove a most difficult task, even to an expert.

The operations discussed from the beginning until now, when the second generation has borne its first crop of fruit, covers a period of about six years. This is a long time, and some men would doubtless say "is the trouble worth the candle? especially as there is nothing to prove that much good would come out of it." In answer to such a remark, I am pretty firmly convinced that good would come out of it and have already planted up a small crossing-plot with the view of raising hybrids. The plot consists "of 130 bushes, and includes *C. arabica, C. liberica* and the variety—Maragogipe." A few of the bushes are already well advanced in growth, so that the first batch of crossed seedlings may fruit within five years from date. But when matured bushes can be cross-fertilized this season, the results might be known within four years, which is not very long for a young planter to wait. My object, so far, has been to explain the *modus operandi* of fertilization rather than to discuss side-issues bearing on its application to the genus *Coffeæ*. But now, I may refer briefly to argumentative views on the latter question. As the coffee bush possesses a hermaphrodite flower, it may be held by some that crossing is neither possible nor desirable. But it does not follow that a flower is self-pollinated because it contains both sexes. In numerous hermaphrodite flowers the sexes attain maturity at different periods, and in all such cases self-pollination is effectually prevented. That dichogamy prevails to some extent in the coffee-flower is certain, as I have often observed stigmas in the receptive stage when the anthers had not dehisced. I am unable to say, however, if this is a general condition, or if it only happens in occasional flowers. A flower may thus be structurally hermaphrodite and functionally unisexual. Then, the sweet-scented coffee-flower offers great attraction to insects, which is a pretty sure sign that the dispersion of pollen is favoured by Nature. Indeed, the condition of the pollen is such as would adhere readily to the hairy limbs of insects. It is not of the fine powdery kind (so-called

dust of flowers) that would be suspended in the air or lightly carried by the wind.

Considered, therefore, from a morphological standpoint there is little doubt but the genus *Coffeæ* is subject to cross-fertilization, and that its flowers are entomophilous. Lastly, I wish to dispel the idea that established coffee can be influenced one way or the other by operations of crossing, the results of which are only discovered in a subsequent generation.

But it is highly necessary that the planter should strictly conserve his testing-ground, and not allow any unknown seed to be utilised for estate purposes. The golden rule in the testing or experimental ground is to destroy all inferior forms as quickly as possible.

New strains of seeds reserved for trial could be treated separately until such time as their merits are fully established. This is all I have to say on the fertilization of the coffee flower at present.

HIGGINBOTHAM AND CO., MADRAS AND BANGALORE—1899.