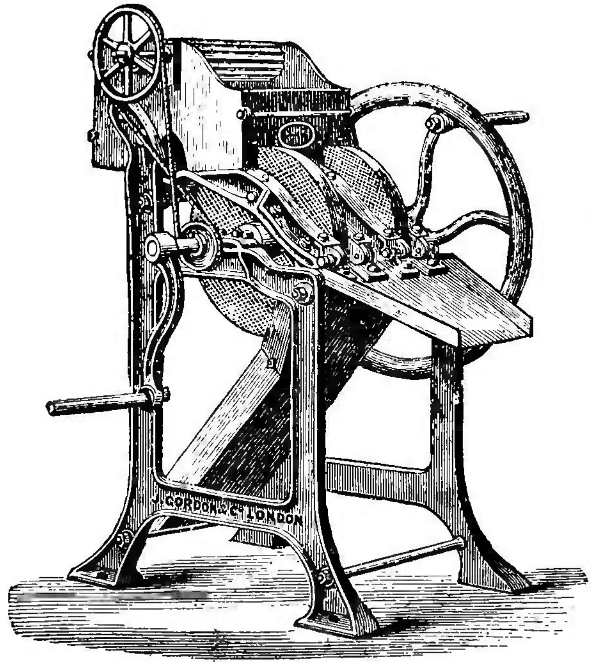
J. GORDON & Co. LONDON

NOTICE.

The attention of those interested in the cultivation of Coffee is particularly invited to the Guanos manufactured by MESSRS. J. JENSEN & CO., LIMITED, of 109, FENCHURCH STREET, LONDON. Jensen's Guanos are of great purity and excellence, and their beneficial effect upon Coffee has been proved. For further information on this subject see page 36.

COFFEE.

ITS CULTURE AND COMMERCE

IN ALL COUNTRIES.

BRANCH OF *COFFEA ARABICA*, WITH BERRIES AND FLOWERS.

[*Frontispiece.*

COFFEE:

ITS CULTURE AND COMMERCE

IN ALL COUNTRIES.

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PREFACE.

THE fragrant berry of the Coffee shrub has become a necessity of everyday life, and the healthy reaction against intoxicating liquors will bring it increasingly into use as a mildly stimulating beverage. Two facts tend to retard the increase in coffee consumption in this country—one is the licensed adulteration with a worthless, if not actually injurious substitute, and the other is the prevalent ignorance how to prepare an infusion for drinking. These we may hope to see removed in course of time. But there is no doubt coffee finds in tea a powerful rival. The latter is much more easily made ready for the cup, and affords a cheaper drink. Our Colonial and Indian coffee-planters are not, however, dependent on England alone for buyers; they grow for the whole wide world. Competing in the open market with Brazilian, Central American, and Native growths, always at a great disadvantage in the matter of labour, they mainly command a sale by the quality of their produce. This quality can only be maintained by constant attention and study. Thus it happens that coffee-growing has a most respectable literature of its own, which is being constantly added to, and as often run out of print. Despite the grumbling at the state of the coffee trade in some places, new estates are being opened in others, and fresh capital is being invested in this attractive branch of colonial planting. Hence the demand for a handy book dealing with the industry, not simply in local colours, but embracing the experience of cultivators in all parts of the world adapted to the crop. The present little volume is intended to supply that demand.

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COFFEE.

CHAPTER I.

THE PLANT.

COFFEE is the fruit of a series of plants belonging to the family *Rubiaceæ*. The genus known as *Coffea* is divided by botanists into some sixty species, of which about twenty-two are referred to America, fifteen to Africa, and seven to Asia. There is abundant reason for supposing, however, that the majority of these so-called species are mere varieties, due to different conditions of soil, climate, and cultivation. For all practical purposes, it will be sufficient to distinguish two species only, *Coffea Arabica* and *C. Liberica* (*Liberiana*).

The former is the well-known coffee-shrub. It attains a height of 15 to 20 ft., and its foliage resembles that of the Portugal laurel; the small, white blossom is not unlike that of the jessamine in form and scent; the berries are at first dark-green, changing, as they mature, to yellow, red, and, finally, deep crimson. Beneath the skin of the ripe berry, or "cherry," as it is called, is a mucilaginous, saccharine, glutinous "pulp," closely enveloping the "beans," usually a pair of oval, plano-convex seeds, though sometimes there is but one seed, called, from its shape, "peaberry"; these beans are coated with a cartilaginous membrane, known as "parchment," and beneath this by a very delicate, semitransparent, closely adhering jacket, termed the "silver-skin."

The range of this species is at elevations of 1000 to 4000 ft., between latitudes 15° N. and 15° S., and its cultivation may be extended to 36° N. and 30° S., in localities where the temperature does not fall below 13° C. (55° F.). Perhaps the most favourable climate would be a temperature ranging from 15° to 27° C. (60° to 80° F.) in the shade; and as to humidity, there should be no month in the year entirely devoid of rain, the total of which may be 100 to 150 in. per annum—absence of extremes of temperature, with a constant supply of moisture. The shrub is cultivated chiefly in Brazil, Java, Ceylon, India, the Central American Republics, West Indies, Arabia, Natal, and recently in Australasia. It furnishes almost the whole of the coffee of commerce.

Increasing attention is, however, being devoted to *C. Liberica*. This species is a native of Liberia, and is distinguished from the ordinary shrub by much more vigorous growth, by affecting flat and coast lands as well as hill-sides, by attaining greater size and age, and by withstanding greater extremes of climate. It possesses additional advantages in that it is capable of improvement by cultivation, and, though as liable to disease as *C. Arabica*, seems to be affected in a minor degree. On the other hand, the produce is much coarser flavoured than ordinary coffee, though that is no drawback to its being used for admixture with better sorts, producing a cheap, yet genuine, beverage for the million. From experiments tried in Ceylon, great benefits are anticipated from grafting the fine-flavoured *C. Arabica* on stocks of the hardy *C. Liberica*.

Whether the Liberian coffee is or is not really proof against the destructive fungus or "leaf-disease" which affects the ordinary varieties of coffee, not only in Ceylon but also in Fiji, Java, the Straits Settlements, Brazil, and other coffee-growing countries, is a disputed point. One planter at least in Fiji asserts that it is not, and planters in Ceylon are not fully agreed that the tree possesses the immunity from this disease, which was one of its principal claims to notice when it first attracted attention. It is evident, however, that the tree is subject to the attacks of another kind of fungoid growth, similar to that which is found in badly-cultivated cocoa and sugar plantations in the West Indies. The experimental plantations of Liberian coffee in the Botanical Gardens in Trinidad are, according to Mr. Prestoe, the Government botanist, liable to this parasitic growth. Most of the trees are in perfect health, but some years ago a large Tonga bean-tree, in the prime of life, suddenly died, owing to the attack of the fungoid growth at the roots; and since then several of the Liberian coffee trees have been seriously affected, two being killed outright. This pest is liable to work its ravages for a long time unnoticed, but sometimes makes known its existence by developing huge spore-bearing plates of great thickness and solidity. Fortunately the pest has not the fecundity of the *Hemileia vastatrix*, and it is easily detected in the seed-bearing state; but, if measures for its destruction are not promptly taken whenever found, it may easily increase and multiply, and when once it has established itself in a locality it is difficult to get rid of it.

"The immunity enjoyed by Liberian coffee from the attacks of the blight insect (*Cemiostoma coffeellum*) is of the utmost importance to the welfare of Dominica and the neighbouring colonies, both English and French, for there is now nothing to prevent the islands of the Lesser Antilles from being once more large coffee-supplying countries. In Dominica the cultivation of coffee may be said to be re-established, although it is only as yet in its infancy, and the productiveness of the Liberian trees is a matter of astonishment to those of the older residents who remember the coffee estates of forty years ago." (Nicholls.)

"The Arabian coffee may be described as a small *shrub;* the Liberian species, on the other hand, would appear to be a small *tree*, for in Africa it is said to attain a height of over thirty feet. Instead of a single stem, it has five or six stems growing out of the ground, and in some instances as many as ten. This habit has a most important bearing on the cultivation, for when one of the stems becomes old and sterile it may be removed, not only without any injury to the crop, but with actual benefit to the productiveness of the plant. Thus plantations of Liberian coffee may be continually invigorated by the judicious pruning away of some of the main stems; whereas in removing the main stem of the ordinary coffee a sucker has to be trained up in its place, and one or two crops are lost. The appearance of the Liberian coffee is very unlike that of the Arabian, for, in addition to the subdivisions of the main stem, the leaves are at least twice the size of those of the other species. An average Liberian coffee-leaf is 11 in. long and 4 in. wide in its broadest part; whilst the measurements of an average leaf of the so-called creole coffee are respectively 5 in. and $1\frac{3}{4}$ in. On examining a young Liberian plant about a year old, 23 in. high, with no lateral branches yet formed, and with fourteen pairs of leaves (several of the lower pairs having fallen), I found two of the leaves to have measurements slightly in excess of the above, and the uppermost internode was 4 in. in length. The leaves of the Liberian coffee bear in size and shape a resemblance to those of the cocoa tree, and the old peasants on first seeing the 'new English coffee,' as they call it, are greatly astonished at the bigness of the plant. The flowering of the Liberian coffee planted in Dominica commences in January or February, and goes on for several months, and consequently the curious sight is seen of flower-buds, flowers, and fruit in all stages of growth on the same branch. To those accustomed to the habit of the 'old' coffee this appears most curious, and it certainly is a striking peculiarity. As might be imagined from the size of the tree, the flowers, the berries, and the beans are much larger than those of the ordinary coffee. The berries, which are borne in wonderful profusion, are twice the size of those of *Coffea Arabica*, and the bean itself is of equal proportions. I have counted as many as sixteen berries in the axil of a af, but it is more usual to find from six to ten. An important distinction between the Arabian and Liberian coffee is that the ripe berries of the latter do not fall from the tree, but remain firmly fixed in their positions for an indefinite time." (Nicholls.)

A branch of *Coffea arabica* with berries and flowers is shown in the Frontispiece.

CHAPTER II.

THE ESTATE.

THE points which determine the value of a plot for coffee culture are :—1. Elevation ; 2. Aspect ; 3. Shelter from wind ; 4. Shelter from wash ; 5. Temperature ; 6. Rainfall ; 7. Proximity to a river ; 8. Character and richness of soil. Most of these are necessarily subject to variation according to locality.

Shelter from wind is perhaps of paramount importance, and should not be sacrificed for richer soil, as the latter can be artificially obtained much quicker than the former. In wooded country, the estate may be laid out in blocks of fifty acres, encircled by natural belts of forest. Flat land must be avoided ; a wet soil is fatal to coffee, and flat lands would entail great expenditure for drainage. Steep slopes, on the other hand, are objectionable, on account of the wash occasioned by rains carrying away soil and manure, and exposing the roots of the shrubs. The surface soil must be fairly good ; the subsoil may be poor, but must never be stiff clay ; the shrub is essentially a lateral feeder.

As a general rule, virgin forest land has been found most suitable to break up for coffee estates ; it has become naturally enriched by decayed vegetable matters, and the burning to which it is subjected frees it from insects and from weeds. Exceptional patches of land that has once been under cultivation and then allowed to run wild have formed good properties ; but the soil is rarely rich, is generally exposed, and always entails great trouble and expense to keep down the weeds. A temperate climate within the tropics is to be preferred on all scores ; a certain degree of warmth and humidity combined is essential. An atmosphere resembling t of an English hot-house produces the finest crops, 1aps; but it is inimical to the planter, and favourable to ds. The most suitable climate is precisely that which 'opeans prefer. Frost, even though it be only at night, for a short period, is fatal. The presence of water, pre-bly a perennial stream, is essential for watering the ng plants, and for the "pulping" process.

[ull observes that "great warmth of climate is not abso-ly essential to the mere existence of the plant; our object, vever, goes much further than this, being to cultivate it a climate where it will not only *live*, but flourish and 1g forth fruit abundantly, and experience has clearly wn that this is only to be found within the tropics. It ot, however, to be understood that a high temperature is uired in order that the most favourable conditions may be ught about. What *is* necessary is a climate characterised neither extreme of heat or cold, and possessing a fair unt of humidity all the year round. To be more precise ould specify 60° and 80° F. in the shade as the limits of perature; and with regard to humidity, I would stipulate t there should be no month in the year entirely without 1fall, and that from 100 to 150 inches should be distri-ed throughout the twelve.

At an elevation of between 4000 and 5000 feet above -level, in Ceylon, one sees, supposing the situation to be unduly exposed to wind, fields of dark, ever-green, uriant coffee-trees, so well clothed with foliage that not a are yard of bare ground is visible for acres. Such situa-1s have what may fairly be called an *exceedingly* humid nate: probably hardly a week passes without rainfall, ile at certain seasons this occurs without intermission for eks together; even after a fair bright noon-day a dense ite mist will frequently settle down towards evening apping all in obscurity, and saturating vegetation with isture. The temperature here will probably seldom rise ve 70° in the shade, at other times falling as low as '. The general result is, that although the trees have a gloriously healthy appearance, they bear hardly any crop.

"Turn from this picture to the Wynaad, say to an estate some few miles inland from the Ghauts, with an aspect facing eastward towards the Mysore plateau, and at an elevation of something less than 3000 feet. Here will be found a climate possessing great heat, and entirely deprived of rainfall during a considerable part of the year. True, there are showers in the spring months, while a perfect deluge may be looked for while the monsoon lasts, during the months from June to August inclusive, but it is strictly correct to say that there are several months every year during which not a drop of rain falls—droughts of four or even five months being not unusual. The effect of this ordeal upon the coffee is at once apparent; the plant, although not by nature deciduous, beginning first to droop, and finally losing nearly all or much of its foliage year after year, until eventually it falls a prey to the effects of exhaustion in one form or other.

"The foregoing have been brought forward as two opposite representatives of climate; the first being characterised by too great a degree of humidity for successful coffee cultivation, as is shown by the fact that although the plants produce a redundance of wood and foliage, their productiveness ends there, the crop being at all times nearly absent, or very deficient; while, in the second case, the long dry season tends ultimately, though gradually, to kill the plants. It would, therefore, seem natural to infer that somewhere between the two we shall meet with the exact climate most conducive to the growth, productiveness, and longevity of the coffee plant; and this appears to be fully borne out by experience.

"The favourite and most fruitful coffee districts in Ceylon some years ago were, and probably still are, those situated at an elevation ranging from 2500 to 3500 feet, although there are coffee estates under cultivation at all elevations, from about 500 to over 5000 feet, while native gardens may be met with, sometimes bearing good crops, along the coast actually at sea-level. In these cases, however, the plants will invariably be found growing under the shade of the jack, coconut, or other suitable trees, without which protection all chance of their thriving permanently would be out of the question. These native gardens are, moreover, limited in extent, and are generally richly manured, and often well watered during the dry season.

"Coffee can always bear a considerable warmth of climate, provided the humidity be proportionate; indeed a hot climate will probably produce the heaviest crops, *provided it be sufficiently humid.* Such a climate, however, will probably prove very malarious and inimical to the health of the planter and his labourers—a drawback not to be disregarded; while the growth of weeds will also probably be so rapid as to cause a considerable increase of outlay in cultivation and abnormal deterioration of the soil. So great is the influence of climate upon the growth of weeds, that while in some districts two monthly weedings will be found necessary, in other and colder situations one such operation every five or six weeks will be found sufficient.

"High, wet situations, again, prove in many instances strongholds of the blight known as 'black bug,' which may probably be taken as some indication that the trees are deficient in healthy tone and vigour.

"From the foregoing, it will be seen that the questions of elevation and climate are so intimately connected that it is impossible to treat them apart; elevation alone being capable of rendering cool and temperate a climate within the 'torrid zone' or tropics—and a temperate climate within the tropics being indispensable to the successful cultivation of coffee. This is so far fortunate for those engaged in the pursuit, and is no doubt one of the principal reasons of its being so favourably regarded by young Britons on the look-out for a sphere of enterprise abroad. In fact, the climate which is most favourable for coffee, is that in which an Englishman will find little to complain of, except in some cases malariousness.

"Many drawbacks it may become a necessity to submit to,

ıt there is one which must be sedulously avoided, i.e. a
.eak and exposed aspect, this being one of those evils that
ın neither be mitigated nor remedied. The monsoons which
.ow incessantly for three or four months together, are
ısailants which coffee bushes cannot withstand. Not un-
equently large fields of wind-blown coffee have had event-
ılly to be abandoned in despair, after years of persevering
ıd expensive culture. Wind injures the plants in various
ays. Sometimes its effects are at once recognisable in the
.nched, stunted, and almost frost-bitten look both of the
ood and leaves, the former being hard and small, the latter
·umpled, dwarfed, and tipped with yellow. In other cases,
ıe trees will be found denuded of leaves, on the side on
hich they are assailed, forming on the opposite one a growth
ımewhat like that of boxwood. In situations where the
ıil is soft and yielding, the wind, even if failing to strip the
ees of leaves, does equal mischief by working the stems in
ıe ground, so that in a short time a funnel is formed round
ıe neck of the plant, and this being continually chafed, in
:ocess of time the bark is worn off, the roots are loosened,
ıd the plant dies. A plant thus affected is said to be
wind-wrung.' Should it, however, be rescued before the
ırk is entirely worn off, the plant will sometimes recover,
ıough its growth will of course have been seriously inter-
red with, and it will be extremely liable to be attacked by
ɔug,' 'worm,' or any other blight prevalent in the locality.
"In wind-blown situations, however, if the mischief is not
ıo pronounced, partially remedial measures may be adopted.
his is the more fortunate, that when a block of forest is far
.land it is not always easy to ascertain from its aspect how
.r it may be sheltered from certain prevailing winds;
.deed, a very small clearance of forest lying adjacent, will
:casionally alter the direction of the wind so much, that it
ill only remain to remedy as far as possible what could not
ıve been anticipated. Thus, an estate which for many
ɜars may have remained quite sheltered, has been known
ıddenly to become seriously affected by a belt of jungle

having been cleared on a neighbouring estate, or by a new estate having been opened in the neighbourhood. That wind should prove an enemy to the coffee plant is hardly surprising, it being inimical to every species of vegetation. The only exception I ever heard of to the general rule, is the Doombegas-tree of the Ceylon forests, which is said to flourish most luxuriantly in situations where the atmosphere is habitually the most boisterous; the abundance of this tree may, if this be so, possibly be some criterion as to the degree of shelter enjoyed by any particular locality. As the strongest and most continuous wind comes from the south-west, it will be evident that this aspect is the worst that can be chosen; neither would it be wise to select one directly opposite, this being exposed for some months of the year to the north-east monsoon. Northerly or easterly facings are perhaps the best, not being directly exposed to violent wind for any lengthened period, the latter also getting the benefit of *the morning sun*, a circumstance to which experience attaches much importance.

"The next point to be considered is what is technically termed the 'lay' of the land. That there are estates situated on surfaces greatly differing in character, yet all apparently yielding results equally satisfactory, might at first sight appear to argue this subject as unimportant; but similarly an inference might be drawn that elevation was of slight consequence, from the fact that some estates situated at 1000 feet above the sea and others situated at 5000 appear to be equally profitable, which, however, simply arises from one drawback being often compensated for by some equivalent advantage of another description.

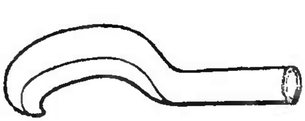
"Among the many different dispositions which the uneven, ever-varying surface of a mountain district presents, I will describe some which appear to be the most favourable for a coffee estate. Slopes are, of course, more or less the general feature observable, and they are to be recommended owing to their incapacity to retain sufficient moisture to render the soil stiff or sour. They are also favourable, owing to the soil having become enriched by the deposit of decayed vegetable matter which the rains must have left on their surface from the hills above; though once the land has been cleared this liability to 'wash' becomes a drawback, as matter that might have been retained while the surface was covered with a close and minute vegetation, or by a layer of decayed leaves, is in danger of being floated off, once the soil is bare and disturbed. A level plain lying at the base of high hills, will be likely to contain a rich surface soil, more especially if the hills which command it have been clothed with forest vegetation, as the product of the decayed leaves, &c., falling during ages, will have been partially at least washed down and deposited on it, forming in course of time a deep rich loam. There is also the advantage that the soil thus made is retained, while should there be sufficient declivity to admit of the superfluous moisture escaping, nothing will remain to be desired. One will sometimes come upon a tolerably level stretch of land along the banks of some mountain stream, and this would be a particularly desirable formation, any danger of stiffness of soil arising from want of drainage being thus obviated. Marshy land is quite fatal to the coffee plant, while a soil stiff and heavy in wet weather will be hard and impervious in the dry season, either condition being equally unfavourable. An estate formed by the opposite sides of a gently sloping valley, provided the outlets are not towards the unfavourable aspects before described, would promise well, as each side would shelter the other, and the stream, which would in all probability flow down the centre, might be made available for curing operations.

"To sum up, from my own experience I would recommend a preference, when practicable, for moderately gentle slopes towards the base of a hill range, intersected by numerous ravines, or 'nullahs,' with running streams, and facing as much as possible in an easterly or northerly direction. Such a lay as this will not only be found entirely suitable, but, fortunately, is one generally not difficult to meet with in countries whose scenery is mountainous. Steep slopes are to be avoided, in consequence of the great difficulty at all times of entirely preventing the soil being washed away by the rains. Gradual slopes on the other hand are preferable to flats.

"The question of soil is one which admits of a good deal of discussion, though this need not be made a primary difficulty of by any one about to open an estate of ordinary dimensions. Commonly speaking, when the soil is dark in colour, loose, and full of roots, it is rich in organic matter, and therefore good for coffee, which is a hardy plant not on the whole difficult to please in this particular. Planters whose estates yield heavy crops, and at the same time happen to have a light red or yellowish soil, will probably argue in favour of that particular colour, others may have seen the best results in conjunction with a chocolate-coloured soil, others again with black. The best criterion, however, as to the quality of the soil is the luxuriousness or otherwise of the vegetation it produces in its original state. For instance, in forests which, in addition to a large growth of timber, have a dense close underwood, and which abound in creepers, mosses, ferns, &c., it may be safely concluded the soil is good.

"In making an excavation in land, it will be generally noticed that the first stratum is of a dark colour, and that the shade lightens as we proceed in depth, until it gradually becomes a yellowish composition of sand, gravel, or clay, as the case may be; the thickness, then, of the upper stratum, which is the real *soil*, is the gauge of the probable productiveness of the land." (Hull.)

FIG. 1.



Cattie.

Clearing and Burning.—When forest land is taken into cultivation, the first step is to effectually clear it of timber and underwood. The latter is first cut, by means of the "cattie," shown in Fig. 1; the large trees are then felled on the top, and their branches are lopped off, so as to compact the pile, otherwise the burn will be only partial. A fine day, after the night's dew has evaporated, is chosen for putting fire to the prostrate mass. The advantages of a thorough burn are, that subsequent operations are greatly facilitated, and that weeds and insects are destroyed; the disadvantage is that the upper soil is burnt, and rendered unfit for filling into the holes. This injury might, to a great extent, be obviated by "lining" and "pitting" the land beforehand. By this means, the surface soil would be mostly covered over with the earth taken out of the pits, and thus protected from the fire.

On the other hand, of course, the lines could not be marked out with accuracy or regularity, and the estate would subsequently suffer to some extent in appearance, though it is a question how far this drawback is worth considering, in comparison with the advantage gained. When there is not sufficient timber to make a good burn, the bush is felled, and burnt in heaps, after which the ground is carefully gone over for the purpose of rooting up the tree-stumps which remain. These are sometimes so difficult to eradicate that they are left to decay, care being taken to knock off shoots as fast as they appear. It is, however, a bad plan, and one seldom followed, as the rotting stumps harbour vermin of all kinds. After burning, the wood ashes should be scattered evenly over the ground as a manure.

To secure a gang of coolies is not always by any means an easy matter; indeed "the labour difficulty" is one of the most serious problems the planter has to encounter. It is a constant source of anxiety in whatever coffee district he finds himself, and fortunate will he be if at any time during his career he is able to secure the exact number of men he wants at the time he wants them. Hence the great importance of having an estate of moderate size, and the immense advantage of a mixed system of culture, combining other crops demanding less labour for their production with the coffee crop. Better a small estate worked well than a large one neglected for want of workers.

Dwellings.—Having secured coolies, and furnished them with tools, "the first undertaking," says Hull, "will be the erection of dwellings for the planter and his people; and, for this purpose, a small piece of land should be specially cleared in the first instance. This spot should be chosen with the greatest care and deliberation. It should be in a dry, healthful, and tolerably-elevated situation, be provided with a good supply of pure, wholesome water, and be conveniently placed with regard to the future estate and the nearest public road.

"To make the clearing, a party of men or boys, provided with bill-hooks, should be first sent in to cut down all the underwood and saplings, these being followed the day after by men with axes to fell the heavy timber. In felling trees, it should never be forgotten that though two or three men with axes can, in a few hours, bring down a monarch of the forest, the growth of many centuries, the act, should it afterwards prove to have been ill-advised, though it may be regretted, can never be remedied or repaired. This is a consideration of the greatest importance, and the more so that an opinion is now beginning to be generally adopted that in certain districts the wholesale felling of the forest has been altogether a mistake from the cultivator's point of view, and that plantations now become extinct would have been flourishing to this day had the forest shade been at least partially retained, instead of having been ruthlessly done away with by means of axe and fire. As a matter of health, comfort, and taste also, it is most desirable to leave, at any rate, some of the more picturesque and symmetrically-formed trees standing about the spot chosen for the planter's bungalow and coolie lines.

"Five or six weeks after the felling and lopping, that is, as soon as sufficiently dry, the *débris* should be set on fire, so as to get the ground clear. The 'coolie lines' may be run up in a very short time, from the natural materials abundantly at hand on all sides. It is very important to provide the coolies with proper shelter and accommodation, and the planter should remember that although *he* may be willing to undergo hardship and to 'rough it,' the coolies should be made as comfortable as possible according to their accustomed mode of life. The great thing is to guard against sickness and keep the gang in good heart from the outset. They will then give the estate a good name, say it is *lucky*, and labour difficulties will subsequently be much diminished. It is not, however, necessary to put up coolie huts of any expensive or even permanent character at this period. The great object is to have well-drained and well-ventilated dwellings, capable of keeping out any amount of wind and rain.

"In localities where the bamboo flourishes, the erection of a house is a simple and expeditious matter. The process would surprise a European artisan, inasmuch as no nails are required, nor indeed anything in the way of material but such as the adjacent jungle affords. Bamboos are seldom used for the principal supports for the house, owing to their liability to destruction by minute borers; though, indeed, bamboo posts, *if cut down near the roots*, and previously left to soak some time in water, will be found exceedingly strong and durable. The natives always cut bamboos for building purposes when the moon is on the wane, as they then contain less sap, and are, consequently, less liable to early decay. The walls of native houses in bamboo districts are made of bamboo laths some two inches wide, interwoven basket-fashion, the interstices being afterwards plastered up with mud. In every jungle there are different fibres or 'jungle ropes' to be procured (and which are well known to the natives), with which all fastenings can be effected; while grass will no doubt be found in the neighbourhood for thatching purposes.

"Coolie lines are usually in the form of one long building partitioned off into different apartments; each apartment being 10 or 12 ft. square, opening into the general verandah, which should be 5 or 6 ft. in width, and extend along the entire building. Two or more persons will generally occupy ne room of the above dimensions, provided they are of the ame caste; it is much the best plan, however, to leave the oolies to make these little dispositions and arrangements mong themselves. Each married couple should of course be llowed to appropriate a room to themselves.

"A temporary bungalow for the superintendent will be he next undertaking. This will probably be no more than simple parallelogram partitioned off into three rooms, or erhaps only into two, with a verandah along the front, a ortion of which at each end can be enclosed to serve as tore-room, or pantry and bath-room. A porch may be added s a finishing touch, giving architectural effect to the strucure! A building of this kind may be made comfortable nough with a little care and ingenuity, and if good stout osts are used, and the walls are kept well plastered with nud, and afterwards (as also the clay floors) regularly washed vith liquefied cow-dung, will stand for many years. This s a consideration, inasmuch as when the 'pucka bungalow s subsequently put up, the original one can still be utilised s a stable, store, or out-house.

"In districts where the felling and clearing can be done y contract, the manager will be in a position to employ his ermanent gang of coolies in the erection of the above uildings, while the contractors are proceeding with their perations." (Hull.)

Lining.—Soon after the burn, the estate is "lined out" for ne reception of the plants. The two following methods are n vogue:—

(1) A base line is laid down, as nearly as possible straight p and down the slope; a cross line is set off exactly at right ngles; on this line, stakes are driven into the ground at the istances determined upon for the position of the plants; to ach stake, a rope is fixed, and stretched parallel with the ase line and as straight as possible; small stakes are rovided along these lines; a rope is finally held across nem at succeeding stages of equal width, as guided by easuring poles, and the small stakes are put in where the

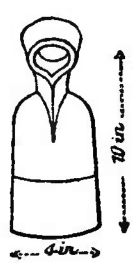
movable rope crosses the fixed ones, each stake indicating the site for a plant.

(2) A rope is furnished with bits of scarlet rag at th distances fixed upon between the plants; it is stretche across the plot, and stakes are inserted at each rag; the rop is then moved forward a stage at a time, gauged by measuring rods. The first plan is the better, especially in broke ground, but is more laborious; the second is available o even grass land, but the stretch of the rope must be esti-mated and allowed for. The great object sought is to hav the lines perfectly regular; and, instead of making an deviation where stumps or other obstacles occur, the rope i laid over them, and the corresponding plant is omitted Yet another method of holing is that known as "quin-cunxing," i.e. placing the plants so that alternate lines ar opposite; it was recommended by Laborie, but is open t several objections, and is quite out of favour.

Distances of the Plants.—Scarcely any two planters ar agreed as to the best distance to allow between the plants The question is governed in some measure by the richnes of the soil and by the climate. The object in view is tha with the greatest convenient number of trees in a give space, none shall incommode its neighbour. In cold o exposed situations, where the plants cannot attain any grea size, close planting is necessary; the reverse being the cas where the climate is warm and humid and the soil is produ tive, and consequently likely to produce large bushes. I the West Indies and Java, the space is often 10 to 12 ft., bu other crops are there usually planted with the coffee. I Ceylon and Southern India, distances vary from 4 ft. eac way to 8 ft., the best being, perhaps, 7 ft. between the row and 6 ft. between the plants. The number of trees containe in an acre planted 6 ft. × 7 ft. will be 1037; 6 × 6, 1210 6 × 5, 1452; 5 × 5, 1742; 5 × 4, 2178; 4 × 4, 2722. Adva tages in wide planting are that field labour is facilitate and the shrubs grow larger; a disadvantage is that mo room is left for weeds.

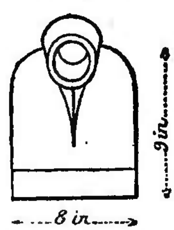
Holing or Pitting.—Around or beside each stake, a hole is ug, its size depending much upon the kind of soil. In iff, poor land, 2 ft. each way is not too large; in good ght ground, 18 in. will suffice. They had better be too əep than not deep enough. The implements commonly sed by coolies for this purpose re: the *quintannie*, or grubbing oe, Fig. 2; the *mammotie*, ig. 3; and the *alavangoe*, or pade-bar, Fig. 4. The earth rown out is left to mellow ntil just before planting. The ole is then "filled in" with e best of the mould, which as been carefully freed from ones, roots, &c., and mixed ith a little manure. The lling in must be done very ghtly, and the loose earth ould rise in a heap above the ole. The operation is best erformed while the ground is oist; it is also a good plan break down the sides of the hole somewhat, especially if ey are hardened.

FIG. 2.



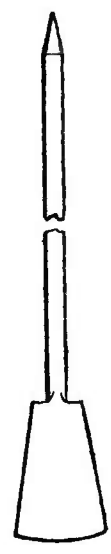
Quintannie.

FIG. 3.



Mammotie.

FIG. 4.



Alavangoe.

Roads.—Efficient roads not only greatly facilitate the orking of a plantation, but they should be so laid out as serve the additional purpose of drainage. A cart road ould pass through the centre of the estate, wherever it possible to avoid a steeper gradient than 1 in 15, emerg-ig upon the main highway. From this, branch roads ould be cut at right angles, with as easy gradients as ossible, and not more than 100 to 150 ft. apart. These branch oads should cross the lay of the ground, so as to check, to e fullest extent, the effects of waste. A boundary path ncircling the estate is useful for many reasons. The main entral road should be set out before pitting and planting.

Wire tramways commend themselves as eminently suited to minimise labour on coffee estates. An excess of road accommodation, as regards both the number and the width of the paths, is far preferable to insufficient roading, despite the extra first outlay. If the ground be rich, it may cost a good deal to keep the roads clean and free from weeds. This however, may be greatly lessened by ploughing them up and planting them with an annual crop, until the land is exhausted; not only will the roads be rounded by the ploughing, but weeds will not so readily grow.

Drains.—Nothing is more important than the thorough draining of a coffee estate, in order to carry away the excess of moisture during heavy rains, without allowing the surface soil to be washed away. Continuous open trenches are cut in parallel lines across the face of the slope, and at 10 to 15 yards apart; their gradient should never exceed 1 in 12, and 1 in 20, or even 30, will be better; their width may be 15 to 18 in.; and their depth, not less than 1 ft. at the lower side. They need constant cleaning out and repair, especially after a heavy shower. They must in all cases empty into a natural or artificial channel amply capable of carrying off the water; if furnished with breaks to catch the suspended soil, so much the better, as the latter can then be collected and returned to the estate as a dressing.

Plate I. shows a set of planter's tools, as made by Brooker Dore, & Co., 4 Corbet Court, E.C.; they comprise: 1 and 3 galvanised buckets; 2, mammotie; 4, cattie; 5, pruning knife; 6, pickaxe; 7, sledge hammer; 8, double-faced sledge hammer; 9, crowbar; 10, quintannie; 11, spade; 12, Ceylon roundeye felling axe; 13, planting bar (alavangoe).

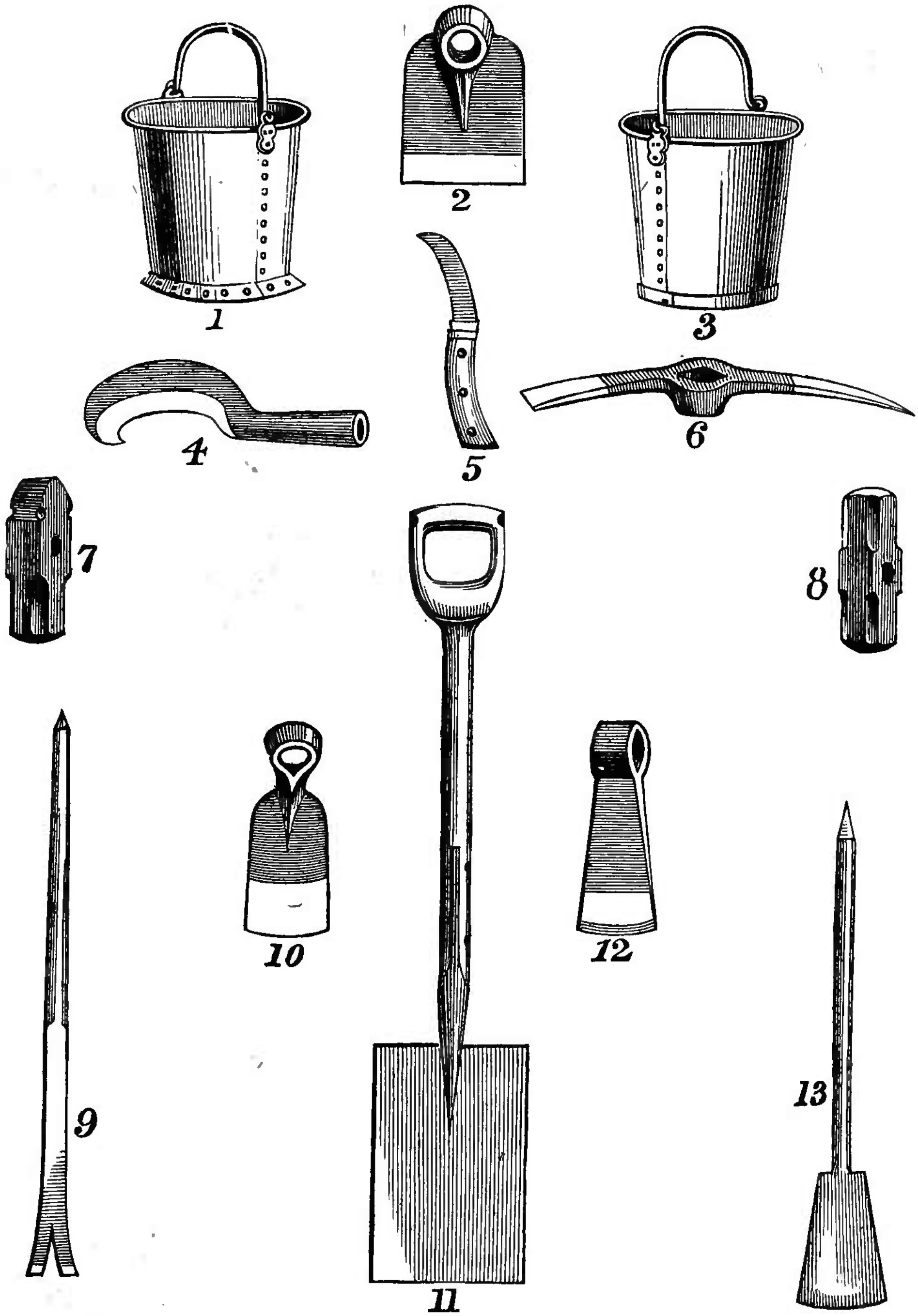


PLATE I.—PLANTERS' TOOLS.

[*To face p.* 20.

give 20,000 to 30,000 plants; the best is "parchment" coffee, picked when fully ripe, pulped by hand, unfermented, unwashed, and dried in the shade. The nurseries proper are prepared in much the same way, but not shaded. When the plants have two to four leaves (exclusive of the seed-leaves), they are carefully loosened, and transplanted, in damp, cloudy weather, from the seed-beds to the nurseries, and placed 9 to 12 in. apart. Care must be taken not to double up the tap-root, and not to leave a space for water to accumulate and rot the roots. If the tap-root is very long, it is best shortened by an oblique cut, and it soon shoots again.

When transplanting from seed-beds to nurseries is not practised, the plants are left in the seed-bed until larger; but Stainbank and others strongly recommend the former plan, as, by checking the growth, the young wood becomes hardened, and better able, when finally planted out, to resist insects and unfavourable weather. A practical suggestion for preventing young seedlings being eaten off at the surface of the ground by grubs, is to lightly wrap round a piece of paper about 3 in. broad, where the stem joins the root, on planting. The risk of having young seedlings burnt up just after planting, is guarded against by various simple measures for shading them. In about a year, the plants are ready for transfer to the permanent estate, which is meantime being prepared for their reception.

It is remarked by Hull that "in Ceylon, abundant supplies of coffee plants of all sizes are generally to be found growing wild in the forest, in the vicinity of old estates—the product of seed pillaged and subsequently sown by tribes of monkeys, wild cats, squirrels, &c. These plants having grown up in the shade, are generally lanky and straggling, and consequently require, before being planted out on the estate, to be 'stumped,' i.e. cut down to within some six inches above the roots. These stumps are then very independent, and usually come on well, throwing out shoots within three or four weeks from the time they are put into the ground. The best size of stump is the thickness of a common pencil; these throw out shoots and take root more quickly than larger plants, while those that are younger and thinner are more liable to be burnt up by the sun, should the season be more than usually dry.

"Where wild plants, however, are not to be had merely for the trouble of collecting, others can frequently be got from native gardens at a trifling rate per thousand. When plants are obtainable in sufficient numbers in either of these ways, a nursery is but little required; but in case the planter should not be so fortunate as to find his wants thus supplied, it will be advisable to begin making a nursery at once. The best time of year for this is the end of October, when a few bushels of fresh coffee seed of the new crop can be obtained from some neighbouring old estate. A bushel contains about 40,000 berries of cherry coffee, and as most berries contain two beans, the number of seeds will be not far from 80,000; but allowing 10 per cent. for peaberries and imperfect beans, we ought to get about 70,000 plants in the nursery from one bushel of parchment. Seeds should be carefully selected, as far as possible from healthy trees only, and should not be picked until fully ripe. They should be pulped by hand, so as to avoid the injury which would be incurred by a certain percentage in being passed through the pulping machine. The seeds are better not washed, but may be shaken up with wood ashes, to dissolve the saccharine pulp adhering to them, and thus prevent fermentation. They should then be *slightly* dried, when they will be ready for the nursery.

"The seed-beds should be dug up to the depth of a foot, all roots and stones being picked out. The surface must then be nicely smoothed over, when the beans may be placed in straight drills and at equal distances from each other, being then lightly covered over with fine mould. Over this a layer of rotten leaves may be spread two inches thick, the bed being then well watered at least once every three days, if the weather be dry, until germination takes place. In about six weeks the seeds will begin to force their way above ground, and to send a root downwards, and the layer of decayed leaves may then be gently and carefully removed.

"Where the nursery is made in virgin soil, manure will be unnecessary, and indeed is better dispensed with, as being calculated to introduce grubs likely to prey upon the seeds; but in old nurseries, after the first year or two, manure will be required. This should be given in the form of compost, or the produce of the stable or cattle shed, *old* and *well-rotted*, and a moderate quantity will suffice if thoroughly broken up and dug in. Watering should be done in the morning or towards sunset, and not during the heat of the day, as wetting the plants during sunshine will prove fatal. The seeds may be put in about one inch apart at first; the plants being afterwards, as they increase in size, thinned out. The beds should not be more than $3\frac{1}{2}$ or 4 ft. wide, so that a person standing on either side may be able easily to reach the centre, without stepping off the footpath. Weeds can thus be easily pulled out, and the beds watered without any mischief being done. They may be either raised above the level of the surrounding paths, or the reverse, each method having its advantages in different localities. In damp situations the beds should be raised for dryness, while in very hot localities they should be depressed in order that they may retain as much as possible of the moisture they receive. Some planters prefer nursery-beds made after the fashion of paddy-fields, that is to say, perfectly level and surrounded by raised borders or 'bunds,' to admit of their being irrigated at pleasure. The drawbacks to this method, however, are, that the rush of water when it is let in carries the seeds in a heap before it, and also that the water after subsiding is apt to leave the ground hard and stiff. Once the plants have taken root and are well above ground, irrigation is the cheapest and most expeditious method of supplying them with moisture, and is not so objectionable except where the soil is inclined to be stiff and clayey.

"If the plants are intended to remain in the nursery for a second or third season, they should be allowed space, and be at least 3 or 4 in. apart. If grown in straight rows at right angles, it will always be easy to ascertain the number of plants in each bed by simple measurement. Thus a bed $3\frac{1}{2}$ ft. wide by 28 in length, with plants at 4 in. apart, would contain about 1200, or sufficient to cover an acre planted at 6 ft. by 6 ft.

"In order to keep up the nursery from year to year, seedlings can be raised in fresh beds, and then transplanted into it, after it has been well dug up and enriched with a little rotten dung or compost. The soil of the nursery is just as well *not to be too rich*, otherwise the plants will be apt to suffer from the change if put out into one of poorer quality. Some planters are strongly of opinion that the seedlings should be brought up in the *same soil* as that in which they are afterwards to dwell, and that, consequently, plants brought from a distance are less promising than those raised on the spot." (Hull.)

Planting.—When the holes have been duly prepared, the young plants are removed from the nurseries with the same care as they were transplanted to the nurseries from the seed-beds. For taking up the plants, an ordinary prong is much superior to the spade-bar; hand-pulling must be rigidly guarded against. The fibrous roots of each plant, as taken up, are carefully pruned off to about 4 in., so that they may not be doubled up in the planting; the tap-root is also shortened to about 9 in. by a clean sloping cut, for the same reason. A ball of earth should surround the roots; and if the plants are exposed to the air for more than a few minutes, the roots should be covered with wet moss, or some other damp material.

A dull cloudy day should be chosen whenever possible; in bright sunshine, the plants would all be burnt up. The plants are carried in batches on trays to the estate. They are placed in the ready prepared holes by hand, great care being taken that no roots are doubled up, that the plants are upright, and that they are no deeper in the ground than they were before. In treading the earth down round the plant, every precaution is necessary to prevent leaving holes for the accumulation of water round the roots. The surface should be made firm and as level as possible. On a steep slope, the outer edge may be made slightly higher than the inner, to check the effect of wash; but in subsequent weeding, it will be necessary to guard against exposing the lateral roots.

There is some diversity of opinion as to the size and age most suitable for putting out nursery plants. When dull rainy weather can be depended on for some little time, nursery plants of the second year are the most satisfactory. Plants of one season only are too tender for the operation. Under ordinary conditions, and with due care, no serious loss of plants should be incurred in this way. A novel plan, which may be advantageously adopted in small plantations, is one resembling the method of planting cinchona. A number of calabashes are deprived of their small end and emptied of their contents; into these, the seedlings are placed, gradually exposed to the sun as they grow, and finally planted in the calabashes; the latter soon rot, and form manure for the plants.

A plan that has been much followed is the substitution of "stumps" for nursery plants. Plants that have been in the nursery for about three years are dug up and pruned back, leaving only about 6 to 8 in. of stem. They are hardier and safer in a general way than whole plants, more especially in uncertain weather. They will strike readily, even without rainfall for some little time after being put in, provided the ground has become sufficiently moist to prevent their being burnt up; but they cannot be used with success in districts where a long period of drought may be expected to succeed the wet season. The planting is performed in the usual way. The plants send up several shoots from the parent stem; of these, the finest is retained to form the future tree, and the rest are pulled off carefully. The shoot that is left grows rapidly; but, from the way it springs from the stem, it is liable to be accidentally broken off, either by a high wind or by the weeders. The crookedness of the stems of stumps from native grown seed renders them very inferior. The best size for stumps is the thickness of a common pencil.

Dibbling.—Where the land is very rich and friable, holing may be replaced by the less expensive plan called "dibbling." It is performed in two ways:—(1) By the aid of the spade-bar is made a sufficiently deep hole, into which the plant is dropped, and secured by treading the earth lightly round; (2) A patch of ground measuring about 1 ft. each way is thoroughly loosened, without the soil being taken out; in the disturbed earth a hole is made with the hand, the plant is inserted, and trodden round as before. The latter method is preferable. Dibbling is only practicable in exceptional cases. It is, moreover, open to objection, as a hole is often left, in which water may accumulate and rot the plant; and the roots are more liable to injury than in ordinary planting. On the other hand, very much labour is saved.

Staking.—When the plants are exposed to wind, they should be provided with supports as soon as they are 10 to 12 in. high, and present a resisting surface. For first season's plants, lining pegs may be used; but larger plants will need strong, inflexible stakes, 3 to 3½ ft. long, entering the ground on the windward side, at about 6 in. distant, and at such an angle as to meet the stem at about its middle. The plant is attached to the stake by a broad loop of some vegetable fibre, firmly tied to the stake, but loose around the stem. If the plants have already been worked by the wind, they will need earthing up 5 to 6 in. as well. The ties may be brushed with coal-tar, as a protection against theft, insects, and decay.

"Belts of jungle are sometimes left standing in likely situations, to protect the coffee from the wind, but opinions differ as to the probable advantage of this course, some planters holding that more harm is likely to result than good, the wind being thus frequently concentrated into eddies or whirlwinds, instead of taking its natural and more equable course. This, however, is a question which can only be decided by local circumstances in each case. It is not uncommon in Europe, when plantations have been made in exposed situations, to put in hedges, or rows of some hardy quick-growing shrub, to protect the plants during the first few years; and I remember a case in which a Ceylon planter constructed a wall or barrier of posts and brushwood, some 8 ft. high, along the most exposed part of his estate, with the same object. All operations of this kind, however, are costly and laborious, and seldom productive of much permanent benefit; and as the result of experience, I believe it will probably *be wiser not to plant land where they are required.* At the most they can only mitigate the evil complained of. In moderately sheltered situations, staking combined with low topping ought to be sufficient to secure the stability of the plant; where they are not, the situation has little to recommend it for coffee culture." (Hull.)

Supplying Vacancies.—Every precaution should be taken to guard against failures, as "supplies," as they are called, will seldom, if ever, do as well as young plants put into virgin soil. In new land, failures can be almost entirely guarded against by care. Their number may subsequently be limited by keeping the ground free from weeds, and by good draining, manuring, and pruning. A certain number of vacancies, however, will occur from time to time, and they must be filled up in the following manner:—The original pit, having been re-emptied, should be enlarged an inch or two all round, and especially in depth. This should be done in dry weather, the pit being left open for some time, and only filled in when the time for planting has arrived. In most cases, it will be desirable to refill the pit with the soil which has been taken out of it.

Where the vacancy is in the midst of old trees, a large pit is necessary, to protect the new plant from being interfered with by their roots, and it is well to isolate the young plant by surrounding it with a ring trench, 6 to 8 in. wide, and 1 ft. deep. It is also desirable to put a basketful or so of new soil from the forest into the pit, near the top; where this cannot be managed, a few handfuls of manure should be mixed with the surface mould. Only strong, healthy plants may be used for this purpose. Stumps are often considered more suitable than nursery plants, as being hardier; they throw out three or four "suckers," the best of which is selected when they have attained a height of 6 to 9 in., the others being carefully pulled off. Well-formed nursery plants, with three or four pairs of primaries, and about 12 to 15 in. high, put in just as they come from the beds, with a good ball round the roots, are to be preferred when steady wet weather can be calculated on for some time. In any case, supplies ought to be put in early in the wet season, so as to give them every advantage. They should always be marked by a tall stake; and should be allowed to bear a maiden crop before being topped.

Shelter.—The worst enemy of the coffee shrub is wind. Its effects become apparent in pinched and stunted growth, or in lack of foliage. In situations where the soil is soft and yielding, it does equal mischief by working the stems in the ground, so that in a short time a funnel is formed round the neck of the plant, and this being continually chafed, the bark is worn off, the roots are loosened, and the plant dies "wind-wrung." Should it be rescued before the bark is entirely worn off, the plant may live; but it will be extremely liable to attacks from "bug," "worm," or any other blight prevalent in the locality. Belts of jungle are sometimes left standing, as a protection; but opinions differ as to the advantage of this plan, some planters holding that more harm is likely to result from the wind being concentrated into eddies, instead of taking its natural and more equable course. This question can only be decided by the local circumstances of each case. Such belts, being sure to form nurseries for weeds and vermin, are not intended to be permanent, and should gradually give way to fruit or other useful trees. Sometimes artificial shelter is erected, but it is too costly to find general favour. Indeed, in moderately sheltered situations, staking, combined with low topping, ought to be sufficient to secure the stability of the plant.

Shade.—This is a consideration of great importance, and the opinion now generally adopted is, that the wholesale felling of the forest in some places has been altogether a mistake, and that plantations which are now extinct might still be flourishing, had the forest shade been at least partially retained. The history of coffee cultivation in the East proves that, in hot climates, and where prolonged seasons of drought may recur, coffee will not flourish permanently, except under shade. In a state of nature, the plant almost universally affects shade; this is the more remarkable, that the seeds are deposited by wild animals and birds as freely on open grass lands as in forests. A suspicion that the borer, leaf-disease, and other immediate causes of decay, are only induced by the weakened state of the shrubs, consequent upon their exposure to lengthened periods of drought, is supported by the fact that where shade trees are found standing upon an abandoned estate, they are surrounded by a surviving remnant of coffee bushes.

The question as to where shade is necessary is one of climate; it is not universally beneficial. The advantages to be derived from it, in very hot climates, are:—Diminished exhaustion, and consequently increased longevity of the plant; reduced cost of cultivation; a conservation of the nutritious properties of the soil, and an actual increase of them, as the cover given to the ground causes the surface vegetable matter to decay more rapidly; and, provided the shade-furnishing tree be a subsoil feeder, the shedding of its leaves will yield a positive gain of surface matter, which the roots of the coffee would otherwise never have reached. In addition to this, there is to be considered the direct value of the timber grown. The only drawback to shade would seem to be a diminished yield of coffee; but this is atoned for by the increased longevity of the plant. The most suitable trees for affording shade will be alluded to in Chapter VII., as the same kind of tree is not to be found in all the countries where coffee is grown.

Catch-Crops.—Much has been said both for and against the growing of other crops among the coffee shrubs. In the West Indies, the culture of plantains, yams, cocoa, &c., was carried to such an extreme that the coffee became, in fact, of secondary importance, or was even killed out. In Ceylon, too, catch-crops were long in vogue; but they seem now to have gone out of fashion, as they exhausted the soil, and produced too much shade. There is nothing to object to in the simultaneous cultivation of several crops so long as each has due space, and sufficient manure, and the plants are not antagonistic to each other, as the failure of one crop may be compensated for by the success of another.

Rice and tobacco have been found to yield good returns as catch-crops, but they possess a disadvantage in not affording any shade to the young coffee plants. Cocoa, yams, and plantains are, perhaps, even less advisable; and similar attempts with cotton have proved altogether failures. Maize, on the other hand, is highly spoken of by Stainbank, from experiences in Natal. It should be planted thinly in three rows, 18 in. apart, between the coffee rows, and two plants in the coffee rows between the coffee plants. The seed should be sown immediately after the coffee is planted. It grows very quickly, and should early be thinned out to 18 in. apart in the rows; it will soon be high enough to completely shelter and partially shade the coffee, which will grow all the faster in consequence. The latter will also be benefited by the extra working of the ground. In the autumn, a dressing of manure is applied, and the ground is ploughed, or deeply hoed, preferably the former. The crop may be repeated in the following spring, reducing it, however, to two rows and one plant, and repeating the manuring and ploughing or hoeing; this time the choice between plough and hoe will be governed by the size of the coffee shrubs; the same manure will suit both coffee and maize.

Weeding.—By "weeding" is meant the eradication of every plant which is not being intentionally cultivated. The operation is performed in different ways, according to the nature of the soil. On light soils, and sloping situations, hand weeding is much the best. The labourer is provided with a pointed stick, to help in getting up obstinate roots, and carries at his waist a small bag, into which the weeds are at once thrust. They are turned out of the bags into pits dug at convenient intervals, or are heaped up in the roads, and are finally buried or burned, the latter being the surer way to destroy them. By weeding early, and repeating as often as necessary, the ground may be kept clean by hand. When hand weeding will not suffice, recourse must be had to "scraping" the ground, which is attended with a serious drawback, viz.:—that the first inch or more of the best surface mould is removed at the same time, thus robbing the plants of food, and exposing the earth to the full effects of wash. On stiff clay soils, on level plantations, and in damp, cool climates, on the other hand, hoeing is not only necessary for the perfect eradication of the weeds, but is of itself exceedingly beneficial to the soil, and, except during the dry season, should be regularly done whether weeds are present or not. When scraping or hoeing, it is imperative that the operation should be conducted from the outside towards the tree, so that the roots may be kept well covered, and the wash may easily escape into the gutters.

"By beginning to weed early," says Hull, "much subsequent loss and expense will be avoided, and the work should be systematically and carefully pursued once a month, *or oftener if necessary*. Unfortunately, however, this is not always practicable, owing to scarcity of labour, and hence it is estates are often seen so deplorably overrun. Within the first month or two after a clean burn, on forest land, the number of weeds should be so small as almost to admit of their being *counted;* one springing up here and there, but each isolated and independent. If, then, these are taken up *before they have run to seed*, and if the whole estate is subsequently gone over in the same way, once a month *unfailingly*, it can easily be kept permanently clean at a very trifling expense; *but*, once allow the isolated weed-plant to

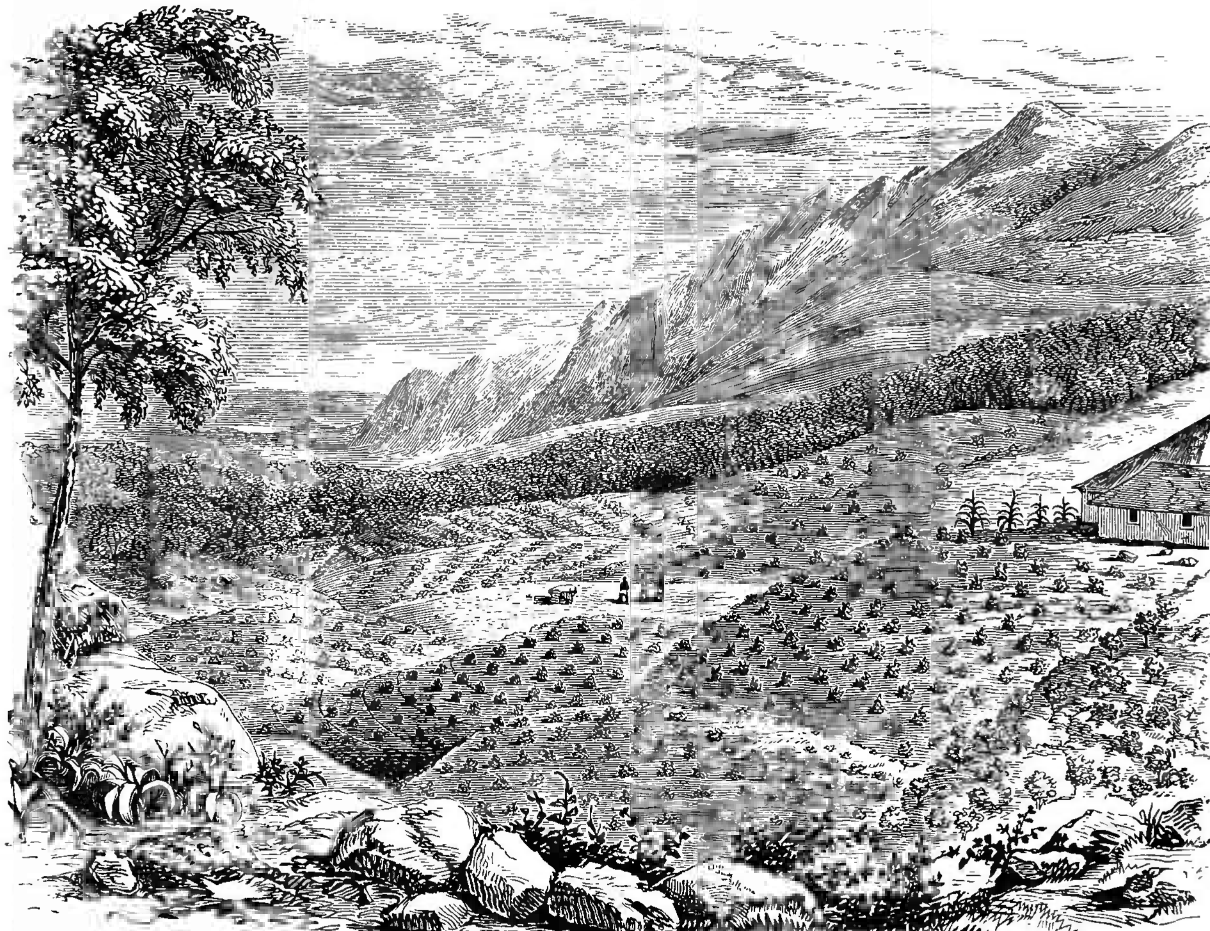


PLATE III.—COFFEE PLANTATION IN JAMAICA.

[To face p. 32.

run to seed, and for every *one*, soon a hundred will appear; and if these hundred go also to seed, then we may expect for every hundred, ten thousand more; and so on until the surface is covered so closely that not an inch of soil is to be seen. In bamboo districts, where the prevailing weed-pest takes the form of grass, matters are even worse, this being propagated *from the roots* as much as from seed; and within an incredibly short space of time, unless great care is taken, the planter will find, to his dismay, his estate turned into a luxuriant hayfield, the coffee steadily waning away under the influence of the irrepressible invader. And here it may be remarked, that seldom will finer hay crops be met with than are sometimes to be seen covering estates in the districts alluded to. The thing to be regretted is their being so entirely in the *wrong place*.

"A not uncommon, and in many respects a most advantageous, practice is to give out weeding contracts to *canganies*, or native overseers, at so much per acre per month. In these cases the contractor has to provide and pay his own labourers, and is usually bound to weed over the land let out to him once a month. On clean forest land, where this system has been in vogue from the first, the cost is even as low as from one to two shillings an acre; but on old estates, which have been allowed at one time or other to get weedy, and are consequently more or less stocked with seed, it will be as much, sometimes, as 4*s*. an acre monthly. The great advantages of contract-weeding are, that a special gang being permanently devoted to the work, there is less risk of its being at any time interrupted; also that the onus of providing this part of the labour gang is taken off the shoulders of the superintendent; thirdly, that the latter is saved the labour and anxiety of supervision; and, finally, that the cost is less than would be the case under a system of day-work." (Hull.)

Pruning.—The kind of pruning first required by coffee bushes is that known as "topping." The age and height at which this operation is performed, depend in a great measure upon local circumstances; the question is also a much-debated one. The object of "topping," or removing the top of the bush, is to restrain its upward growth within convenient limits, and, as a natural consequence, to strengthen and concentrate its lateral growth. According to Sabonadière, topping is commenced, in Ceylon, at the age of 12–18 months, the maximum ordinary height being 4 ft., sometimes reduced to 2 ft. He prefers to postpone the operation till the shrubs have borne the maiden crop, even though extra staking is required to withstand the wind. His plan is to remove the two primaries at the required height, by a sloping outward cut close to the stem, and then to remove the top by an oblique cut, so that the stumps resemble a cross, and a firm natural knot remains to guard against the stem splitting down.

Hull (Ceylon) contends that the plants should be topped as soon as they have reached the required height, when the soft wood is easily severed by a pinch between the finger and thumb. In Natal, the shrubs are topped either at their full height—4½–5 ft.—or at 3 ft., allowing a sucker to grow up on the weather side to complete the height. The latter plan is preferred. There is much advantage gained in limiting the height to 5 ft.; not only is the crop gathered more easily and without damage to the tree, but it is actually heavier, and the shrubs are more readily made to cover the ground.

The first result of topping is to induce the growth of a number of shoots, the removal of which is termed "handling" or "searching." The first to appear are vertical suckers or "gormandisers," from under the primary boughs; these are immediately rubbed off without injuring the bark. From the primaries, spring secondary branches, in pairs, and at very short intervals. All such appearing within 6 in. of the main stem are removed at once, so that a passage of at least a foot is left in the centre of the tree, for the admission of air and sun. The object of pruning is to divert the energies of the tree from forming wood, and to concentrate them upon forming fruit. The fruit of the coffee tree is borne by young wood; and, as the secondaries are reproduced when removed, they are cut off as soon as they have borne, and a constant succession of young wood is thus secured. In order that this may be regular, and to avoid weakening the shrub, the secondaries that grow outside of the foot space are left on alternate sides of the primary, their opposites being removed each year in turn; thus one is growing while the other is bearing.

The one point in view must be the equal development of the tree, and the yearly growth of as much as it will bear, but no more. Branches must not be allowed to grow into or cross each other; if two or more secondaries spring from one spot, the strongest only must be retained; where a gap occurs, tertiaries may be trained to fill it, in the same way. When practicable, the bushes should be handled twice before the crop; and the pruning should be commenced immediately after the crop, and finished before the blossom comes out. Should that be impossible, it must be suspended during the 3 or 4 days of blossom-time, and then be carried to completion. When it is evident that the crop on a tree will exhaust it if allowed to mature, a portion of it must be sacrificed by pruning. The loss thus occasioned is more apparent than real. In very prolific seasons, much fruit is wasted for lack of labour, and the trees are unnecessarily overtaxed, and bear poorly for some time afterwards. Everything should be done to ensure regular and even crops. The cuttings should be trenched in as manure. No branch should be allowed to bear more than two or three crops before removal. Regular and systematic pruning is one of the first essentials to successful coffee culture; where plantations have been neglected on this score, they must be very gradually reduced to proper condition, by sawing out the cross branches, and opening up the centre of the trees, in the first year; and thinning out half the remaining wood, in the second year.

Manuring.—It is commonly said that coffee is an unusually exhaustive crop; but the exhaustion of the soil consequent upon coffee culture is a result of the peculiar conditions under which it is prosecuted, rather than of the nature of the plant itself. Better than any amount of artificial manuring is the retention of the naturally rich surface soil, by the effective prevention of wash. As a secondary adjunct, however, judicious manuring will not only be highly beneficial, but necessary, in almost all cases after the first year or two. It is impossible to lay down any hard-and-fast rules for manuring; the most that can be done is to indicate the elements or ingredients necessary to fertilise coffee soils, the various sources from which they may be obtained, and the best methods of applying them. As is well known to those who have studied the matter, every growth, whatever its character, requires, in suitable proportions, nitrogen, phosphoric acid, potash, and lime. Coffee soils, in addition to these, appear to contain about 15 per cent. of combined iron, and alumina: the iron, if as red oxide, may amount to 20 or even 30 per cent., being a good absorbent of fertilising constituents; but the alumina should not exceed 10 per cent. These are the necessary ingredients; the sources from which they are obtainable may be considered under three heads: (1) Manures obtainable close at hand, whether animal or vegetable in their nature, such as dung, coffee pulp, prunings, &c.; (2) manures and compounds purely chemical in their origin; and (3) manures or guanos which are organic in their nature, but are imported, such as Peruvian, Ohlendorff's, and Jensen's Guanos.

1. The best average local manure for supplying nitrogen and potash is well-rotted dung; but its frequent application should be accompanied by a little lime, unless the soil is already very rich in that constituent; without the presence of lime, the shrubs will not receive the full benefit of the nitrogenous principles, but its use in a tropical climate must be governed by caution. Thoroughly fermented coffee pulp is only half as valuable as dung, and costs more to apply. It should be kept covered as it is produced, and is best mixed with fermenting dung, failing which, it should be

well limed. Alone it is of small benefit, but forms a good vehicle for concentrated fertilisers. Both these manures have one drawback, viz. lack of concentration, and consequent extra expense in haulage and manipulation.

2. Manures of purely chemical origin are useful as stimulants, and when applied with organic fertilisers; but they are generally considered to exhaust the soil, and are not advisable for coffee. Lime and potash salts, which are absolutely necessary, are exempted from this category.

3. The third heading above named includes the fertilisers to which the coffee-grower must give his attention. An organic manure, in a highly concentrated form, containing the four ingredients previously referred to, is at once the most effective and economical food. It is necessary above all things to apply a manure which is a *sustenant*, as well as a stimulant, one which will *feed* the plant until the time of harvest. This desideratum is only obtained in an organic substance, and, when that organic matter is concentrated, a great saving is effected. Ohlendorff's and Jensen's Guanos, manufactured respectively by the Anglo-Continental Guano Company, 15 Leadenhall Street, and by Messrs. J. Jensen and Co., of 109 Fenchurch Street, London, answer these requirements, and planters cannot do better than communicate with these firms. Generally speaking, the great object of manuring is to supply all the constituents required in an available form. In tropical climates, all manures are best applied frequently and in small quantities. Regular manuring after each crop and before rain (except in the case of soluble chemicals, such as sulphate of ammonia and nitrate of soda) would doubtless be most generally economical and advantageous. Dung may be applied at any time. Potash seldom requires to be directly applied, but is advantageous after attacks of leaf-disease. Magnesia seems to be a necessary constituent (from 0·5 to 2·0 per cent.) of all good coffee soils; when wanting, dolomite may be applied.

The manner of applying manures is not the same in all cases. No manure should be put more than 1 ft. below the surface of the ground, nor less than 18 in. from the stem of the coffee bush. On flat land, where there is no danger of wash, the manure may be spread over the surface, and hoed in to a depth of 9–12 in., or a square hole may be cut between each four shrubs, and the manure buried in it. On slopes, it is usual to dig a hole above each bush. For bulky manures, it may be 2 ft. long, $1\frac{1}{2}$ ft. wide, and 1 ft. deep; for concentrated manures, its dimensions will be reduced. The holes should be filled up with any prunings or other vegetable matter at hand, and covered down firmly with the loose top soil; the new earth from the hole should be spread around the stem of the neighbouring tree to protect its roots.

Ordinary manuring is sometimes supplemented by other methods of improving the soil. One of these is to loosen it, by driving a long bar or a manure-fork deeply into the ground, and then prizing up the earth, without turning it over. A second operation is that known as "mulching," or "ground-thatching," which consists in covering the ground under the bushes with a layer, 6–9 in. thick, of hard long grass. The effect of this, in cold, wet soils, is to keep the ground warm, and to throw off excessive moisture; in hot, dry situations, it is equally useful to retain moisture. In any case, weeds are kept down, and wash is quite prevented. When rotten, the grass may be hoed or dug in as manure. This thatching has been found a perfect cure for black bug.

A third operation is called "trenching," or "waterholing." The trenches are made across the slope, and may be either open or closed. In the former case, holes, 3–4 ft. long, 12–15 in. broad, and 15–18 in. deep, are cut between each four trees; the soil taken from them is spread over the roots of the trees, while the holes are left open to act as catch-drains, and as receptacles for wash, weeds, prunings, and other vegetable matters, being emptied twice a year, and their contents spread around the roots of the shrubs. Closed trenches are ditches cut across the entire length of the coffee rows, 2 ft. wide and deep, and filled with any vegetable rubbish at hand; they are then covered with earth, and well trodden down, while the remaining soil is spread under the trees. The benefit of trenching is greatest in stiff soils. The refuse matter in the trenches should be limed, to kill grubs and other vermin for which it will form a nursery.

Harvesting.—The clusters of buds which duly make their appearance are, at first, little, dark-green spikes; as they grow, they become straw-coloured, then, under the influence of a few showers, almost white, and finally burst into snowy blossoms. After a day or two, the flowers turn brown and fade away, the more gradually the better. While the bloom is out, rainfall is unwelcome; but after it has "set," a shower is beneficial. The pistils of the flowers soon assume the form of berries, gradually growing, and changing their colour from dark-green to light-yellow, which finally deepens to red. As soon as a sprinkling of red berries is seen, picking should begin; it will continue as long as any berries ripen, say 1 to 3 months. The berries, or rather cherries, must not be picked until fully ripe, as indicated by a deep purplish-crimson colour.

As the crop rarely or never ripens all at once, two or three pickings are required, the second being the principal one, while the others are rather gleanings. Each mature cherry should be picked separately off its stalk, and never stripped off; the cherries as picked are dropped into a small bag—say 18 in. square—suspended from the neck; these bags are emptied into 1½- or 2-bushel sacks placed at intervals on the paths. If allowed to get overripe, in wet weather, the cherries are liable to burst and drop the beans, or to fall off bodily; on clean ground, much may be recovered. In hot weather, the cherries are more likely to dry up and hold on to the trees. In order to convey the cherries to the curing-houses, a great saving is effected, in long distances, by running them with water down galvanised iron spouting, made in 8-ft. lengths, laid with even gradients and curves, and duly secured. The cherries are despatched from cisterns, to which the due proportion of water is admitted; provision is made for collecting and utilising the latter at the works.

CHAPTER IV.

DISEASES AND ENEMIES.

Besides peculiar conditions of climate, aspect, drainage, shade, shelter, &c., already alluded to, particular attention must be paid to the prevention or cure of certain maladies to which the coffee shrub is specially liable. The number of these insectiform and fungoid pests is considerable; but the only ones of sufficient importance to merit description are leaf-blight, fly, borer, bug, and canker.

Leaf-blight.—The leaf-blight of Ceylon and Southern India was first noticed in the former country about 1869, and in India two years later; by 1875, it had devastated whole districts, and since then it has been found in Sumatra and Java. Its existence at a distance from the Indian Ocean has not yet been proved, though there is some suspicion that an allied disease is indigenous to Western Africa. It is a fungus, known as *Hemileia vastatrix*, and allied to the moulds. It is present in some form or other all the year round, and first attacks the under side of the leaves, causing spots or blotches, at first yellow, but subsequently turning black. These blotches are covered with a pale orange-coloured dust or powder, which easily rubs off; they gradually increase in size, until at last they have spread over the leaves, which then drop off, leaving the trees unable to produce crop, or to bring to maturity that which may have already been produced.

In districts affected by the south-west monsoon, during December to February, the fungus generally exists as an external parasite, in the form of long filamentous threads, covering every part of the bark and leaves, but so minute as to be invisible to the naked eye. The disease was made the subject of an official inquiry, by Daniel Morris, of the Peradineya Botanic Gardens, from whose report it appears that a successful mode of treatment has been found. Of the many materials experimented with, one only is invariably effective, viz. a mixture of best-quality flowers of sulphur with caustic lime, in the proportions of 1 part (by weight or measure) of the former with three parts of the latter—1 : 2 gives much better results at increased cost—and thoroughly incorporating them before use.

When small areas only are to be treated, sulphur blowers may be used for applying the powder; but it can be as effectively spread by hand, taking care that it is thrown upwards into the tree, and that the stem and branches become well coated. Sufficient will generally fall to the ground to disinfect the vegetable matter lying there; but under large and leafy bushes, a few extra handfuls may be sprinkled. This will especially apply when "mulching," or open trenching, is carried on. When once the *mycelium*, or vegetative part of the fungus, has penetrated the tissues of the leaves, no remedy can be used which will not also destroy the leaf. The only opportunity for combating the disease is while it is in the invisible filamentous state, on the exterior of the bark and leaves. At this time (December to February), each tree should be treated with about 5 oz. of the mixture, not omitting to disinfect the ground and whatever encumbers it.

It has been observed that the treatment produces marked beneficial effects upon the trees in other ways; their appearance becomes more vigorous and healthy, the foliage improves in texture and colour, the wood matures and bears earlier, the blossom sets better, and the crop is heavier. The measure is preventive only. The disease being infectious, and the spores of the fungus easily distributed by wind, every precaution should be taken to eradicate it from abandoned coffee patches, and stray wild trees. Such had better be burnt, and the ground occupied by other produce. The cost per acre of the treatment is estimated as follows:—Flowers of sulphur, 1 cwt., R. 10; coral lime, 3 cwt., R. 5·25; hand spreading, R. 1·25; total, R. 16·50. In hardly any case would it exceed R. 18–20 an acre, without transport.

Following is a summary of a most important paper on the life-history of *Hemileia vastatrix*, by H. Marshall Ward, late on special duty as Cryptogamist to the Government of Ceylon.

The economic aspect of "leaf-disease," as affecting the coffee-plant and the production of a large staple, he does not comment upon; for the proper appreciation of the facts and their bearings, however, he states shortly some peculiarities of climate, &c., under which coffee is cultivated in a tropical island such as Ceylon.

"If we confine our attention to the coffee growing, for example, on the hilly slopes of the great south-western coffee-districts, the following *general* statements are true. The trees are arranged in rows on the hill-sides, the stems some 5 to 6 feet apart and under 5 feet high: the branches and main stem of each tree are so pruned and trained that they form a thick shrubby head of leafy shoots, touching, or nearly so, the corresponding branches and twigs of each nearest tree. Apart from changes produced by special causes, the normal course of phenomena on a mass of trees such as has been sketched during the year would probably be, shortly put, somewhat as follows:—

"During the dry hot season from January to March few young leaves are formed, but the foliage already on the branches is actively at work, under a blazing sun, supplying materials for the flowers, which succeed one another in clusters during this time, and for the future demands of the trees; occasional showers or rainy days supply necessary moisture to the roots, but little or no dew forms during the dry nights towards the end of the period. The wind (which during the early part of the year may be plentiful, but is commonly slight later) is dry, and comes chiefly steadily from the north-east.

"Some time near the beginning of what we may term the second three months (April to June), the rainy weather sets in, and the hitherto dry atmosphere becomes more or less saturated with moisture. An obvious consequence of these changes is the renewal of growth on the part of the trees, and new leaves and shoots are rapidly formed in the early portion of this period, while the fertilised flowers produce young fruit in the successive clusters. During the showery weather, or at periods more or less alternating, the wind is frequently gusty and heavy. On the whole, however, while the dry and often drooping coffee of February and March has to depend on occasional rains to bring out its numerous flower-buds, the April and May rains fill out the young fruits and force new leaves from the buds, and a general state of turgescence is enjoyed by the tissues of the plant. The warm cloudy days and nights prevent dangerous evaporation or radiation, though boisterous winds may injure the tender shoots mechanically.

"About the end of the last or beginning of the next of our arbitrary periods, i.e. July to September, the south-west monsoon sets in, accompanied by continuous and heavy rains and winds; July and August are frequently characterised by fine hot weather, with alternate showery and cloudy intervals, the south-west wind becoming more gentle and continuous; while September commonly ushers in another warm damp period, when moulds and mildew luxuriate in the steamy atmosphere.

"In the fine weather, which usually characterises great part of the next three months, the 'picking of crop' is carried on; the trees become weary, so to speak, as their last fruit ripens, and little more growth is noticeable after November; the leaves formed in September have attained their full size and normal dark colour and leathery texture, and a state of comparative rest is characteristic of December and January.

"Having premised these facts, the importance of which will be more evident as we proceed, I may sketch in a similarly general manner the phases of the malady known as 'Coffee-leaf disease' as they commonly occur in the districts named. From the middle of January to the end of March the orange-red 'rust' spots, so characteristic of this disease, are either altogether absent or rare; during April and May the spots occur here and there, chiefly on the older leaves and very rarely on the young ones. In June and July the great and disastrous annual 'attack of disease' usually becomes manifested by the myriads of yellow spots breaking forth from the leaves in all stages, each producing its masses of orange-red 'rust'; and from this time forwards, until the dry weather is again fairly set in, the disease is constantly present, fluctuating in intensity according to circumstances. It generally happens, indeed, that another severe 'attack of the disease' occurs about December or January; and in rare cases, as in wet ravines, the disease-spots do not completely disappear all the year round.

"It became an important part of my duty to ascertain clearly what conditions influenced the rise and fall, so to speak, in the virulence of the disease; it was therefore necessary to obtain an accurate knowledge of all the circumstances affecting the life of the fungus causing the latter.

"Having ascertained that the spore ('uredospore') of *Hemileia*, germinating on the damp under surface of the coffee-leaf, emits a short, delicate tube which sends a prolongation through a stoma, and that the further development of this results in the production of the intercellular mycelium, a point of departure for further investigation was established.

"The presumption was fair, considering the analogies discovered between *Hemileia* and other parasitic fungi, that this ingrowth of the germinal tube is the true 'infective' act; and I proceeded to ascertain if leaves on which spores were thus sown developed disease-spots, while others did not. Experiments made during the latter part of 1880 and the early months of 1881 established conclusively that this was the case. Having selected a number of seedlings which had been carefully grown under cover, from washed seeds, in baked earth, and which had presented no signs of disease, spores were sown on certain leaves of sixteen of the plants.

"The sowing in each case was performed as follows:—A large drop of water was caused to adhere to the under surface of the leaf, and in this suspended drop a number of the orange-coloured spores of *Hemileia* were carefully placed with a needle. A small glass chamber (formed by a glass ring, covered by an ordinary 'cover,' and a piece of bibulous paper with a hole punched through the centre) was then clipped over the drop, and kept moist by means of blotting-paper on which a siphon was allowed to play slowly. All the plants were kept in a well-lighted, thoroughly ventilated room, of which the average temperature was 78° Fahr. At various intervals, spores were carefully removed from one of the damp chambers and examined; the details of germination have been fully described elsewhere.*

"All the plants were watched day after day, and the leaves examined to see if any 'disease-spots' appeared. At length 'disease-spots,' or yellow patches, were seen to have arisen one after another, until fifteen of the infected plants had developed these normal symptoms of the malady. After carefully examining the whole experiment, and allowing a considerable time to elapse after the appearance of the first spot, I was driven to the following conclusion:—

"The 'disease-spot' was only developed on those leaves and plants whereon sowings of the fungus-spores were made; moreover, the yellow spot made its appearance only in the immediate area where the spores were sown, and nowhere else on the plant, even when the latter was subsequently kept for several weeks. During the same period I further made numerous isolated experiments, none of which contradicted the above conclusions. I need not dwell upon the agreement between these results and those obtained from the anatomy of the fungus, nor is it necessary to point out the analogy between the phenomena of *Hemileia* infec-

* Quart. Journ. Micros. Sci., January 1882.

tions and those obtained for Uredinous fungi.* The possible reply, that I had induced special conditions within the glass chambers, not realised on the various check-plants, led me to alter the details of the experiments by using damp bell-glasses; and I found that, provided every care was taken to ensure the absence of spores, even very damp plants did not become infected.

"Here, then, in the results of experiments looked at in the light of the anatomical facts, was proof that the act of infection consisted in the emission of something from the spore, which made its way into the leaf and caused the disease. The microscopical examination of spores and leaves proved that this 'something' is a germinal tube—a direct outgrowth from the spore.

"I next proceeded to inquire if any constancy is evinced in the periods necessary for (1) complete germination, (2) complete infection and the formation of the internal mycelium, (3) the formation of the yellow spot and 'rust,' and (4) in the duration of the activity of the spot.

"With respect to the germination of the spore, the following facts have been established by numerous experiments and observations. Germination can only occur if the spore be in contact with water for a sufficiently long period. If the spore has been completely desiccated for some time, as is the case with spores which have been formed at the commencement of the dry season, several days may be required for the successful formation of the germinal tubes; but with quite fresh ripe spores, produced in the moist atmosphere of the south-west monsoon, the changes are effected much more rapidly. In from twelve to twenty-four hours after the removal of the ripe spore from its mycelium, the tubes sometimes commence to form, and, as a rule, the whole cycle of germination (i.e. the formation of a complete germinal tube, the end of which has commenced to block up the orifice of a stoma) has been gone through.

"From the facts that spores may remain dormant on the

* *Vide* De Bary, Monatsber. d. Berl. Akad. 1865, and lit. quoted.

leaves during dry weather, and that they may retain their capacity for germination for several weeks if gathered dry and kept in cool, dry, sealed glass-tubes, the proof that moisture is necessary for their germination becomes strengthened; and this is, of course, in accordance with what we know of other similar germinating bodies.*

"That oxygen is also necessary may be demonstrated: germination is delayed or prevented if the spores be immersed in small air-tight chambers. Too low a temperature, as on flat open spaces, chilled by radiation to near the freezing-point, as well as artificially high temperature, kill the spores. Their rapid and vigorous germination at or near the temperature of 75° Fahr. is sufficiently established by numerous successful experiments.

"I demonstrated on several occasions the fact that the uredospore germinates well in the open on young vigorous coffee-leaves in the warm, damp atmosphere of the south-west monsoon, and also showed that spores germinate under such conditions on the soil, in the meshes of exposed canvas-cloth, and on glass, &c.; whence it may safely be inferred that, given the conditions for germination, any spore may throw out germinal tubes. If this occurs on the under surface of the coffee-leaf, the chances are infinitely in favour of the leaf becoming 'infected' through its stomata.

"Complete infection may be taken to mean the successful establishment of the mycelium (derived from the germinal tube passing through the stoma) in the intercellular passage of the leaf. By cutting sections of the coffee-leaf at various periods after the spores were sown as above, it was shown that on or about the third day after the formation of the germinal tubes, the diverticula sent through the stomata were becoming established within the leaf as branching mycelial structures; while further comparisons demon-

* NOTE *added August 8th.*—Spores of *Hemileia*, received by post from the Royal Garden, Kew, in July 1882, were successfully germinated in Strassburg on July 18–20th; these specimens came from the island of Réunion.

strated that during the second week after the sowing a well-branched and vigorous mycelium occupies that part of the leaf coloured by the area on which the spores were sown. So constant are these phenomena that one could depend upon having preparations in a given stage for each three or four days after infection.

"From further observations it became clear that when the intercellular mycelium has attained a certain development, its branches have blocked up many of the lacunæ, and having sent *haustoria* into the cells bounding them, the tissues of the affected area become paler in hue, the contents of the cells are disorganised, and a yellowish discoloration becomes visible on the exterior of the leaf. This discoloration (the incipient 'disease-spot') is readily detected after a little experience, though during the first or second day it may be but slightly perceptible.

"This stage, the first evidence of the presence of disease to the unaided eye, may be looked upon as a distinct one in the cycle of development of the fungus; and I will give one or two examples to show how constant and well-defined is the period at which a vigorous mycelium may be known to be present, as evinced by the yellowish incipient 'disease-spot' seen from without.

"*α*. Spores were sown in the manner described on the living coffee-leaf on July 24th; the pale spot appeared on August 7th, i.e. 14 days after.

"*β*. Spores were sown on January 30th; the spot appeared on February 13th, also 14 days after.

"*γ*. Spores were sown as above on October 20th; spot first visible November 3rd, also 14 days after.

"Hence we see that a certain constancy appears observable in the rate at which the mycelium proceeds in its work of destruction. These examples, chosen simply to illustrate this fact, might be multiplied. However, it is not true that the 'disease-spot' always appears on the 14th day; as will be shown, it may happen that one or two days more or less are required, according to circumstances to be examined; an average of nearly 14 days is very common, however, as shown by the following Table (I.), which summarises shortly a number of experiments, selected from a large series, made to determine (1) the time occupied in the germination of a spore, (2) how soon afterwards the 'disease-spot' appears on the leaf, and (3) how long the mycelium may continue to produce spores. In each case a vigorous young plant was selected which had been grown for some months in a sheltered situation, and was clean and healthy. On a recently formed leaf a sowing of spores was made, kept moist for 24 to 28 hours, and then (the damp cell having been removed) placed in a carefully cleaned Wardian case, well lighted, sheltered, and kept at an average temperature of about 78° Fahr. In all cases the spores were found to germinate in 24 hours, and the tubes had commenced to block up the stomata within 48 hours. For all examples, also, the following holds good: the 'disease-spots' appeared on the leaf on which the sowing was made, and within the area of sowing, *and nowhere else on the plant.* Moreover, no more 'disease' appeared on the same plant, even after keeping it for several (six to eight) months, unless a fresh sowing was made and kept moist for 24 to 48 hours as before.

"These facts prove (1) that the 'disease-spots' and 'rust' result from the tubes and mycelium traced by the microscope from the spore; (2) that the fungus corresponds in area with the disease-spot; (3) that even if spores be present on the leaf, no 'disease' results unless the conditions (moisture, &c.) for germination be also present. Finally, taken in conjunction with the results of microscopic analysis, they prove that the disease-spot is due to the action of an organism derived from without, which passes through definite changes and has a limited term of life.

"It is therefore true that a certain approach to constancy is exhibited by the successive phases above described; and it is abundantly proved that the yellow 'disease-spot' is the outward sign of internal injuries caused by the mycelium, and co-extensive with it.

"TABLE I.

Variety of Coffee.	Date on which spores were sown.	Date on which the 'disease-spot' appeared.	Date on which spores were first seen.	Approximate date of greatest vigour.	Approximate date on which spot turned black in centre.	Approximate date on which spores ceased to form.	Time occupied in forming 'disease-spot.'	Time during which spores were continuously produced.
							Days.	Weeks.
A. Jamaica	Jan. 27	Feb. 4	Feb. 6	Feb. 12	..	..	8	..
B. Do.	„ 30	„ 13	„ 15	Mar. 1	April 25	May 1	14	10
C. Nakunaad	„ 11	Jan. 25	Jan. 28	Feb. 6	Mar. 14	April 1	14	8
D. Do.	„ 23	Feb. 4	Feb. 6	„ 13	„ 10	Mar. 31	12	7
E. Do.	„ 22	„ 3	„ 6	„ 14	„ 12	April 1	12	7
F. Java	„ 18	„ 6	„ 9	„ 20	April 2	May 1	19	11
G. Do.	„ 22	„ 4	„ 6	Mar. 1	Mar. 30	April 20	13	10
H. Indian	„ 11	Jan. 26	Jan. 30	..	..	..	15	..
I. Ceylon	July 24	Aug. 7	Aug. 10	Aug. 20	..	..	14	..
K. Java	Aug. 1	„ 17	„ 20	..	..	..	16	..
L. Ceylon	Jan. 21	Feb. 3	Feb. 5	..	..	..	13	..
M. Do.	„ 20	„ 3	„ 6	..	Mar. 20	..	14	..

On examining the above it will be noticed that the average of the 8th column (164/12) gives nearly 14 days (13·7) as the period between the date of sowing and that of the first appearance of the 'disease-spot.'

"As soon as the yellow 'disease-spot' has become obvious, the reproduction of the fungus takes place, as described elsewhere;* and the first appearance of orange-coloured 'rust' or spores occurs on the outside. The outcome of all the observations shows that this takes place, on the average, about the third day after the first external signs of the yellow spot are evident.

"Now it is plain that, as the above facts became established, one could predict, more or less accurately, when and where a disease-spot would appear on a given leaf on which spores had been sown and kept moist.

"To illustrate this important point more fully, a few more experiments, as carried out, may be quoted.

"Spores were sown, as described above, on a leaf of *Coffea arabica* on Oct. 15. From the known data, the disease-spot due to the action of the produced mycelium should be visible on or about Oct. 29–30, assuming rapid germination: the spot actually became visible on Oct. 29, in the area of the sowing, and nowhere else on the plant. Several other experiments gave similar results.

"On Dec. 12 I treated six seedlings in the same manner, sowing spores on the young leaves of five and on the cotyledon of the sixth specimen. All the seedlings were grown in the same pot and soil, and may be considered equal in all essential respects. A very faint spot appeared on each of the leaves of four specimens on Dec. 21st; a similarly indistinct spot was developed next day on the leaf of the fifth; but the spot on the cotyledon did not become visible till the 23rd.

"Here, therefore, appeared a less successful attempt to predict the rate of development of the 'disease-spot'; whereas I had expected at least 14 days to be occupied in the whole process, there were, in fact, only 9–10 and 11 days respectively so occupied. One more example :—

"On Oct. 25 a sowing was made on a large, dark, tough leaf of *Coffea arabica* treated as usual. According to calcu-

* Quart. Journ. Micros. Sci., January 1882.

lation, I searched for the 'disease-spot' on Nov. 8 and 9; but no spot appeared, and no trace could be discovered till the morning of Nov. 11, when the yellow spot appeared as usual. Here about 16 days had been occupied in the formation of the given mycelium and spot.

"In Table II. are summarised the results of further experiments of the same nature; these should be compared with those already published in the Third Report to the Ceylon Government (Sessional Paper xvii. 1881).

"Although in the above-cited examples, which have been purposely selected to illustrate all the chief points, it is evident that an absolutely accurate prediction did not always occur, some stress should be laid on the fact that the time allowed for the production of the 'disease-spot' (viz. 14 days) proved correct in a majority of experiments.

"It is now time to inquire if any explanation of the differences is forthcoming. During the progress of the investigation it became clear, as already stated, that spores which had been matured some time and become quite dry took longer to germinate than fresh spores which had just ripened: experiment also showed that spores which were produced during the moist weather could be made to germinate in a few hours, and might produce a normal and complete germinal tube within 12 hours from the moment of sowing. I had indeed found the uredospores germinating while still on the damp parent rust-patch; and the teleutospores commonly do so.

"Apart from accidents during the formation of the germinal tube,* therefore, it is clear that in a given experiment the act of infection by any one tube may be delayed or hastened according to the previous state of the spore as regards moisture, &c. The outcome of my observations in this connection is, that while the act of infection or entry of the germinal tube through the stoma may commence in 12 hours after the sowing of the uredospore, it may require 3 days or

* Such as non-contact with a stoma, the attacks of insects, fungi, &c.

"TABLE II.—*Infection Experiments.*

Description of Coffee employed.	Date on which spores were sown.	Date on which 'disease-spot' appeared.	Time occupied in producing the spot.	Date on which new spores appeared.	Remarks.
Nakunaad	Nov. 3	Nov. 20	17 days	Nov. 25	Very hard, dark, adult leaf.
Ceylon (*C. arabica*) ..	„ 11	„ 25	14 „	Dec. 4	Medium, ordinary green leaf.
Ditto	„ 11	„ 25	14 „	„ 1	Ditto.
Ditto	„ 11	„ 25	14 „	„ 8	Ditto.
Ditto	„ 16	„ 26	10 „	„ 1	Ordinary young leaf.
Ditto	„ 16	„ 28	12 „	„ 2	Ditto.
Ditto	„ 16	„ 28	12 „	„ 9	Ditto.
Ditto	„ 16	..	Failed	..	Ditto.
Ditto	„ 16	..	Ditto	..	Ditto.
C. liberica	Dec. 12	Dec. 25	13 days	Jan. 1	Very young leaf.
Ditto	Nov. 28	„ 16	18 „	Dec. 20–23	Large ordinary adult leaf.
Ditto	„ 28	..	Failed	..	

more. Nevertheless 40 to 48 hours is a very common period for the completion of this process.

"Having taken this into account, however, and made experiments under such circumstances that the germinal tubes are found to be completely formed and entering the stomata during the second day, I find that several other factors complicate the question as to the period occupied in forming the spots. Not only does the vigour of the mycelium depend upon the amount of food and moisture present in the leaf, but also on the ease with which the proper materials can be obtained and assimilated. It is therefore clear that the age and condition of the coffee-leaf may influence the rate of development of the parasitic mycelium within it. (N.B.—This has nothing to do with the *infection* itself; the difference is important.) We have seen that the period at which the yellow 'disease-spot' makes its appearance depends upon the progress made by the mycelium in its work of destruction of the tissues: this may be affected by the thickness of the walls of the cells which are to be invaded, and also by their number in a given area of the leaf. The connection between all these facts and the general healthiness and activity of the tree are obvious, whence must be inferred that anything affecting the one may indirectly affect the other.

"I will now describe a further series of experiments showing the kind of evidence which exists in fact for the above views. In October 1881 I commenced two series of experiments as follows:—

"A. A number of plants of *Coffea arabica* were selected, which had been obtained from Samarang in a Wardian case, and had been two months in a cool, carefully ventilated room. These plants were one year old, still retained their early leaves, were healthy, dark green, producing new shoots and leaves. They had been removed without disturbing the rootlets, in each case a large cube of the original soil having been retained. There was no reason to suppose these plants other than fair subjects for experiment.

" A sowing of spores was made on the under side of a chosen leaf on nine different days from October 5 to 25, in the manner already described, with fresh, ripe, moist spores; and a slowly dropping siphon played on the damp chamber for four days. On the fifth day the damp chamber was removed in each case, and, with a perfectly clean sponge filled with pure water, the adhering spores, &c., were then washed off—the detection of the young 'disease-spot' at its earliest appearance being thus rendered easier. The leaves were closely examined daily, and the following Table (III.) gives the summary of observations.

"B. Nine young seedlings of *C. arabica* were selected which had been raised in pots in a closed Wardian case, and in soil dug from a depth with great care. Each seedling possessed its cotyledons, and one pair of thin, apple-green, succulent, and healthy leaves of a fortnight's growth; the second pair of leaves were just appearing. The sowings, &c., were made exactly as before; and all circumstances were the same, except that the Wardian case in which these experiments were conducted stood in another room. I have no reason, however, to believe that the very small differences in the amount of light, air, &c., which may have existed could materially influence the results. The temperature of both rooms was nearly the same, viz. 75°–78° Fahr. on the average. The results are appended in Table IV.

" It appears impossible to avoid the conclusion that, generally speaking, the thinner and more tender the leaf, the more rapidly does the 'disease-spot' appear. If it be objected that the older plants, having travelled from Samarang some months before, were not fairly compared with the Ceylon seedlings, it may be justly remarked that the young and tender leaves on these plants also developed the spots more rapidly.

" If, in the above instances, we take the average number of days occupied in producing the spots on the old leaves and compare with the time occupied in the case of the young ones, however, the difference is very striking: the numbers

"TABLE III.—EXPERIMENTAL SERIES A.

Description of Leaf employed in the experiment.	Date on which spores were sown.	Date on which 'disease-spot' first appeared.	Date on which new spores first appeared.	Time occupied in producing the 'spot.'	Discoloration extended through the whole thickness of leaf.	'Disease-spot' in full vigour (approximate).	'Spot' old and becoming exhausted (approximate only.)	Remarks.
1. Leaf dark, thick, tough, and more than 5 months old.	Oct. 5	Oct. 21	Oct. 23	16 days	Oct. 30	Nov. 7	Dec. 5	Very large and productive spots, the spores hanging in dense masses. On Dec. 13 concluded observation. $\frac{4}{5}$ of leaf healthy and green on that date, and petiole sound.
2. Similar in all respects to the last.	Oct. 7	Oct. 23	Oct. 25	16 "	Oct. 30	Nov. 7	Dec. 6	On Dec. 17 the spot covered about $\frac{1}{6}$ whole area of leaf, and had turned black; rest of leaf sound. A few spores still forming.
3. Thinner and more succulent leaf, about 6–8 weeks old.	Oct. 10	Oct. 23	Oct. 26	13 "	Nov. 2	Nov. 10	Before Dec.	On Dec. 5 the leaf had become brown and shrivelled, and saprophytic fungi had attacked the spot. Leaf fell on Dec. 7.
4. Very young and succulent, a fortnight old.	Oct. 13	Oct. 24	Oct. 27	11 "	Nov. 22	Dec. 5	..	On Dec. 17 spores were still produced in large quantities.
5. Dark, thick, about 5 or 6 months old.	Oct. 15	Oct. 29	Oct. 31	14 "	..	Nov. 15	..	On Dec. 5 dense masses of spores were still being formed; $\frac{1}{4}$ of whole leaf destroyed. On Dec. 17 two new spots had arisen (from germination of new spores?).
6. Young, succulent leaf.	Oct. 17	Oct. 31	Nov. 7	14 "	Dec. 7	Dec. 16	..	Leaf fell on Dec. 19 or 20.
7. Dark, thick, and vigorous.	Oct. 20	Nov. 3	Nov. 7	14 "	Dec. 5			
8. Young leaf ..	Oct. 23	Nov. 4	Nov. 9	12 "	Dec. 5	Dec. 17		
9. Old, dark, leathery leaf.	Oct. 25	Nov. 11	Nov. 16	17 "	Dec. 5	Dec. 13	..	On Dec. 13 this leaf was taken for histological purposes. The black spot was surrounded by dense masses of spores. All other parts of leaf and petiole green and healthy.

"TABLE IV.—EXPERIMENTAL SERIES B.

Description of Leaf employed in the experiment.	Date on which spores were sown.	Date on which 'disease-spot' first appeared.	Date on which new spores first appeared.	Time occupied in producing the 'spot.'	Discoloration extended through the whole thickness of leaf.	'Disease-spot' in full vigour (approximate).	'Spot' old and becoming exhausted (approximate only).	Remarks.
1. Very young and succulent.	Oct. 5	Oct. 18	Oct. 21	13 days	Nov. 1	Nov. 18	Dec. 1	On Dec. 17 spores were being feebly produced at the margins of the black patch.
2. Ditto ..	Oct. 7	..	..	..	..	..	..	No disease-spot had appeared up to Nov. 20; therefore discontinued experiment.
3. Ditto ..	Oct. 10	Oct. 21	Oct. 23	11 "	Nov. 6	Nov. 18	Dec. —	On Dec. 5. the whole leaf was rotten and dropped on touching.
4. Ditto ..	Oct. 13	Oct. 24	Oct. 28	11 "	Nov. 20	Nov. 30	Dec. 5	Spores only produced in small quantity at any time. The soil was poor, and many small worms were found afterwards at the roots. The leaf rotted and fell off on Dec. 10, and whole plant was rotten on Dec. 17.
5. Ditto ..	Oct. 15	Oct. 24	Oct. 29	9 "	..	Nov. 21	Dec. 8	The whole leaf was rotten and fell on touching. Soil too damp?
6. Ditto ..	Oct. 17	Oct. 30	Nov. 2	13 "	..	..	..	Leaf bitten off by cockroaches on the evening of Nov. 5.
7. Ditto ..	Oct. 20	Oct. 31	Nov. 4	11 "	Nov. 21	Dec. 5	Dec. 17	But still many spores produced.
8. Ditto ..	Oct. 23	Nov. 2	Nov. 5	10 "	Nov. 18	Dec. —	Dec. —	On Dec. 17 the leaf was rotten over half its area, and dropped on shaking the pot.
9. Ditto ..	Oct. 25	Nov. 4	Nov. 8	10 "	Dec. 6	Dec. 16	..	The spores produced were not numerous but slowly formed during January.

are $\frac{90}{6} = 15$ days, against $\frac{129}{12} = 10\frac{2}{3}$ days, for the old and young leaves respectively.

"I do not imagine that the differences in the rate of development of the spots in the above cases were due simply to differences in the rate of infection. It has already been stated that freshly ripened spores produced in the moist season germinate rapidly; and it will be noted that slowly dropping siphons were used in all cases, a method which almost ensures immediate and successful germination, as had been largely experienced with other sowings.

"Nor do I think that slight differences in the soil, affecting the supply of food and water to the plant, unduly influenced the two sets of experiments. Nevertheless, while insisting on the fact that *the* great difference between the leaves in which the mycelium produced the spots in 10 days or so and those in which it required 15 days on the average, was that in the former the cell-walls were thin and soft and less numerous, yet it must be allowed so far that slight differences in the circumstances (light, air, and possibly temperature and moisture) existed, while unknown differences may have been presented in the quality and quantity of food and water absorbed by the roots, in the vigour of the plants generally, and (though experiments do not support this idea) in the rapidity of actual infection—all of which might more or less, though very slightly in the individual cases, affect the physiological activity of the mycelium, and therefore the accuracy of the conclusions.

"Passing to the consideration of the question, how long may a 'disease-spot' continue to produce spores? I may refer for details to the tables and to results already published. These were obtained by (1) marking certain leaves in the open, and noting when the development of spores ceased; and (2) making experimental sowings as above detailed, and watching the progress of the spots. By these means it was shown that the spores may be continuously produced for from 7 to 11 weeks; and there can be no doubt that the extreme limits are not here stated.

"One interesting and important observation may be recorded. On a 'disease-spot,' produced on the leaf of a protected plant in a Wardian case, the successively developed spores hung in clusters in the perfectly still, moist air. From certain known data as to the number and length of these clusters, and the average size of the single spore, I was able to estimate the quantity of spores present; these were probably more than 150,000. Now, since 127 disease-spots have been counted on one pair of leaves, some idea of the enormous quantity of spores produced may be readily obtained.

"The slightest shake causes these spores to fall; and it may be proved directly that others are formed very rapidly by the same spore-heads. By gently brushing off the spores with a camel-hair pencil no injury is done, and in a few hours others are found to have been formed in the moist atmosphere. The development of new spores may also be shown to proceed on leaves which have fallen to the ground, and in which a supply of food and moisture is still afforded to the spore-producing mycelium.

"The time during which the production of disease-patches and spores on a leaf may continue must necessarily depend upon a number of circumstances. Where one disease-spot only occurs on a coffee-plant, it may go on forming spores for many weeks. In given cases I have observed this process for from ten to sixteen weeks and longer; but if several spots form on the same leaf, their period of activity is shortened by the premature fall of the leaf. It may well be, also (though I have no *direct* proof of this) that in the latter case each spot produces fewer spores in a given time; since, where there is a struggle for food-supplies among several independent mycelia, it is unlikely that all are as abundantly supplied as one would be.

"The following Table (V.) summarises the results of observations made to determine (1) how long a time is occupied by the coffee-plant in forming a complete pair of leaves, (2) at what period they become attacked by the fungus, and (3) how long they survive the ravages of the

"TABLE V.

Date on which the bud was first noticed.	Date on which unfolding of leaves had begun.	Date on which leaves may be considered adult.	Last date on which leaves appeared quite clean.	Date on which the 'disease-spots' were first noticed.	Date on which the spores were first noticed.	Date on which the leaf was badly 'diseased.'	Date on which the spots were brown.	Date on which the leaf fell.	Total life of unfolded leaf (approximate).	Time during which the 'disease' was visible (approximate).
									Weeks.	Weeks.
A. Aug. 27	Aug. 30	Sept. 30	Oct. 16	Oct. 20	Oct. 29	Nov. 18	Dec. 1	Dec. 22	11	8
B. „ 29	„ 30	„ 30	„ 29	Nov. 1	Nov. 8	Dec. 5	„ 5	„ 20	11	7
C. Sept. 14	Sept. 17	„ 30	Sept. 30	..	„ 7	Nov. 23	..	„ 5	9	5
D. „ 30	Oct. 20	Nov. 15	Nov. 15	Nov. 16	„ 18	„ 30	Dec. 22	„ 30	6	6
E. Aug. 20	Aug. 26	Oct. 16	Oct. 29	„ 1	„ 8	Dec. 5	„ 22	Jan. 1	10	8
F. Sept. 6	Oct. 16	Nov. 15	Nov. 18	„ 23	Dec. 5	„ 22	„ 22	„ 1	6	5
G.* Oct. 29	Feb. 1	Feb. 27	Mar. 14	Mar. 29	0	0	0	June 29	16	0
H. „ 30	„ 1	„ 27	April 25	May 8	May 25	June 29	July 15	Aug. 3	21	10
I.* Jan. 30	„ 10	Mar. 14	May 8	0	0	0	0	July 6	16	0
K.* „ 30	„ 5	„ 10	June 26	July 6	0	0	0	Aug. 10	21	0

N.B.—In the examples marked (*) the leaf never became badly diseased, but at most one or two 'spots' appeared and produced no spores at all; and it is doubtful if the mycelium of the fungus was ever present to any large extent. In all the other cases about 10 to 15 "disease-spots" appeared on each leaf, and produced spores as described.

pest. In all the specimens selected there were several of the disease-spots on each leaf; but, of course, no absolute standard of the damage done is given. The following example will illustrate the mode of reading the columns. Taking the specimen F, the minute terminal bud evident so early as September 6th, 1880, remained quiescent during forty days (till October 16th), and then commenced to swell and unfold its pair of leaves. In about a month's time (November 15th) the leaves were completely formed and in full activity, and apparently clean and healthy. November 18th was the last date on which no trace of disease was visible to the naked eye; but it is evident, from what is known of the periods in the life-history of *Hemileia,* that the germinal tubes had already entered the stomata, and formed mycelia; for on November 23rd the yellow spots were apparent, and had developed spores before December 5th. The formation of spores continued, and the leaf was badly diseased with 'rust-patches' before December 22nd, when the spots were already old and turned brown. On January 1st, 1881, the leaf had fallen; and an examination of the last two columns shows that, out of 2½ months' term of life, the leaf was obviously pestered with the fungus half the time. Moreover, we must recollect that nearly a month (October 16th to November 15th) was occupied in bringing this leaf into full activity, and probably a fortnight must be added to the last column, during which time the mycelium was forming. How little of the total life and powers of such a leaf benefited the tree will be evident on comparing these results.

"The method adopted in arriving at these conclusions was to mark a given vigorous twig, and note the progress of the bud, fungus, &c., at intervals of a few days. No other conclusions than those for which the tables are designed are intended to be drawn: e.g. in the example given, the date December 5th (in the 6th column) does not mean that *the first spore formed on that day*, but that, taking notes of the progress of events on December 5th, I found *spores were* *already formed by the spots in some quantity*, whereas they were not present when notes were taken some days earlier.

"To take another example (K), we find a very different series of events when no mycelium or only an odd spot appears: here the bud of January 30th began to unfold in February, and reached its full development as a pair of leaves about March 10th. Up to June 26th no signs of disease had appeared; and we notice that the traces of spots noted on July 6th never came to anything, as signified by '0 in the column. The leaf fell on August 10th, after a total life of twenty-one weeks or so. In such a case we may safely assume that its work was chiefly devoted to the benefit of the tree.

"I shall have occasion shortly to point out the importance of the fact that one or two 'disease-spots' do not suffice to destroy the leaves: a luxuriant tree may support a certain amount of fungus, as well as a large quantity of fruit. Meanwhile attention may be directed to some experiments showing that the greater the quantity of mycelium (and therefore of 'disease-spots') the sooner the leaf falls (Table VI.).

"To take an example (F): on December 20th the leaf was adult and in full working order. It retained its green, bright colour until April 2nd, when a few faint yellowish cloudy patches were observable, the signs of approaching dissolution.

"On April 25th the leaf had become yellow, like an autumnal leaf in Europe, and fell soon after, about May 3rd, having done its work for the tree, but having escaped the ravages of the mycelium of *Hemileia*.

"An instructive series of observations were made to obtain an answer to the question, how long will the leaf remain on the tree when not attacked by *Hemileia*, and when only one or two small and barren disease-spots appear?

"It was shown that leaves on which no disease-spots appeared commonly remained on the tree for eighteen to twenty weeks and longer; whereas leaves on which

"TABLE VI.

Date on which leaf may be considered fully formed.	Date about which leaf began to turn yellow.	Date on which leaf was quite yellow.	Date on or about which the leaf fell.	*Hemileia*-spots absent or present.	Length of time the leaf remained (approximate).
					Weeks.
A. June 26	September 30	October 10	October 16	None	16
B. November 22 ..	February 15	February 24	March .. 1	One minute spot on February 22	16
C. December 20 ..	April .. 2	April .. 25	May .. 3	None	20
D. July 18	November 8	November 15	November 18	None	17
E. July 16	„ 15	„ 20	„ 21	Four small dull spots in November	18
F. January 2	April .. 25	May .. 1	May .. 8	None	18

N.B.—These examples should be compared with examples G, I, and K in Table V. It is to be noted that none of the small spots taken into account here were either very vigorous or present for a long time before the leaf fell. It is also worth remark that 20–21 weeks is the longest period I have yet found a coffee-leaf to persist on the trees in the open.

numerous spots were developed fell in six to eleven weeks, or even sooner, after the unfolding of the buds. It may be imagined how differently two trees must be affected, if the leaves of one escape the ravages of *Hemileia*, and are permitted to work for the good of the tree during eighteen to twenty weeks; while those of the other have to work (so to speak) for the benefit of the fungus as well, and yet persist but six or eight weeks in all. Every degree of difference in these relations occurs in masses of diseased coffee.

"Having thus examined more or less in detail what occurs in laboratory experiments, and having drawn certain conclusions as to the behaviour of *Hemileia* when the chief circumstances are under control, we may pass to the description of its behaviour in a state of nature, in the open, and see how far this is explained by the known facts.

"In proof that a 'disease-spot' is formed exactly as before on coffee exposed naturally, I may cite the following experiment, which will also serve to illustrate other points of importance:—

"On December 23rd, 1881, a Wardian case was received from Jamaica, in which were eight living coffee-plants in bamboos containing Jamaican soil; in this rich dark mould flourished a dense mass of healthy roots, and each plant possessed a fair supply of vigorous leaves.

"Two of these plants were transferred to the open ground, being plunged into the soil without any disturbance of their roots or soil; these may be called A and B respectively.

"Two (C and D) were placed undisturbed in a cool shaded room, from which draughts of wind were carefully excluded.

"Two others (E and F) were placed untouched in another room, more exposed to light and air, and, like the rest, were watered regularly.

"A seventh specimen (G) was placed also untouched in a closed but light and well-ventilated Wardian case.

"The eighth plant (H) was placed in the same room as E

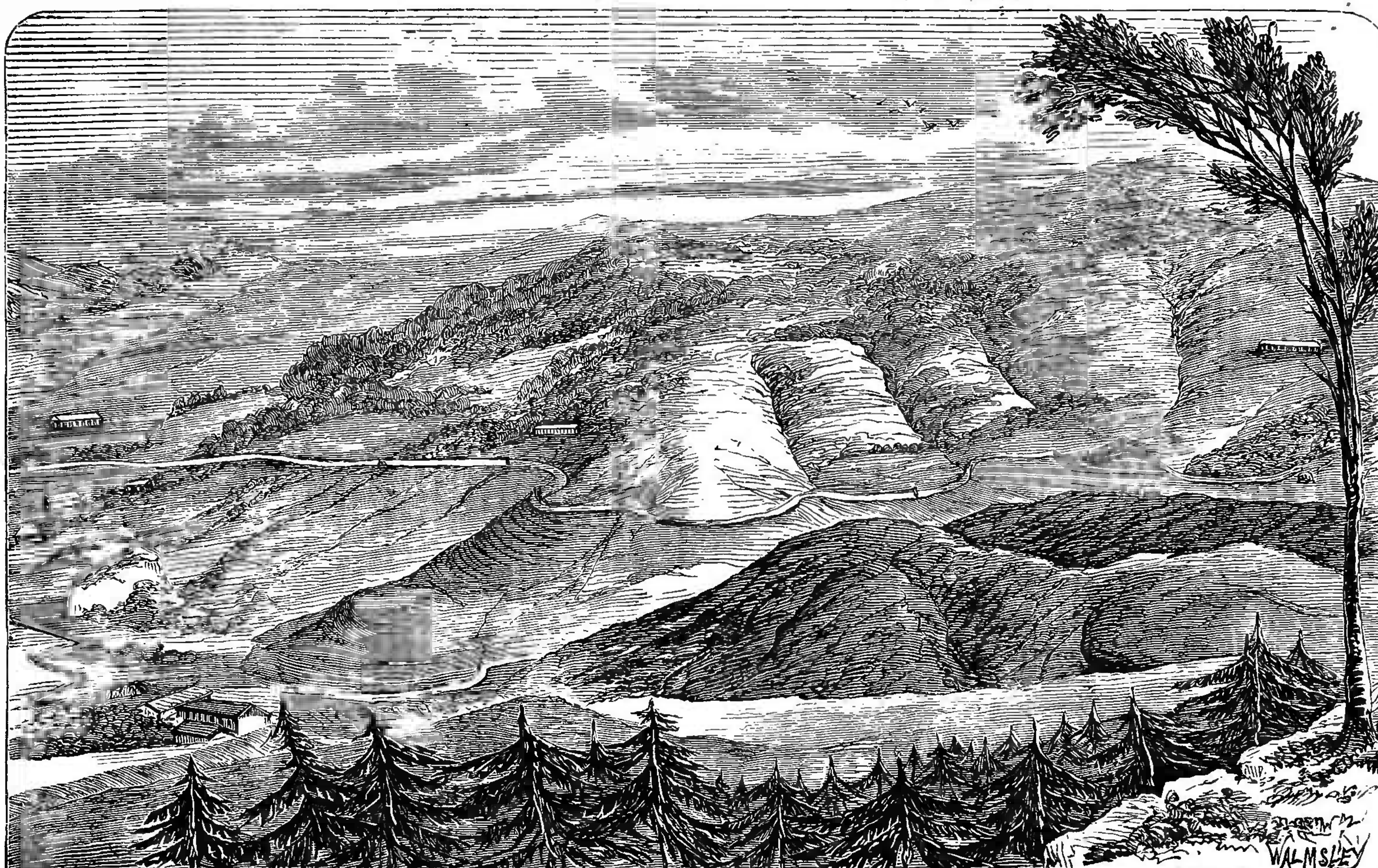


PLATE IV.—COFFEE DISTRICT, NEAR PUSELAWA, CEYLON.

[*To face p.* 64.

and F, and under similar conditions. On the exposed plants A and B spores were scattered from a neighbouring 'diseased' tree, the leaves being already wetted by a drizzling rain; one leaf was then marked on each plant, and spores carefully placed on each in drops of water on the under surface.

"On one leaf of plant C a sowing was made, under the siphon, &c., as usual; D remained untouched.

"E and F remained untouched, as also did G. One leaf of H was infected under a siphon as usual. All this took place on December 23rd.

"On January 3rd, 1882, several leaves from both the exposed plants (A and B) had been torn off by wind, &c. On several of the younger leaves were distinct, though small disease-spots; these were particularly noticed on the marked areas. During the following week the spots increased in number and vigour, and there could be no reasonable doubt that the plants had been infected as described earlier, and that eleven days (December 23 to January 3) had been occupied in the process.

"On January 4th a 'disease-spot' appeared on the leaf of the plant C, where spores had been sown twelve days previously; no trace existed on D, however, either then or later.

"The plants E, F, and G remained without a trace of disease up to January 12th, and no reason existed for supposing that any mycelium or 'disease' was imminent.

"The plant H, at the spot where spores had been sown thirteen days before, developed a 'disease-spot' on January 6th on which spores appeared on January 10th.

"Now this experiment, the latest which I performed in Ceylon, appears in some respects the most instructive and conclusive which has yet been offered.

"It seems clearly to prove, 1st, that the nature of the soil, coffee-plant, and past circumstances, &c., have nothing to do with the possibility of infection; 2nd, that previous experiments had conclusively established the normal course of the

F

'disease'; and 3rd, that, provided the plants are kept sheltered from the fungus-spores, there is no fear of their incurring the inroads of the pest.

"For additional evidence on these points the reader is referred to my previous Reports.

"With regard to the exposed plants A and B, it may be asked, how was the moisture necessary for germination supplied, since no siphon was used? The answer is given by my diary of the weather. The week before was cloudy and showery, and the spores employed were already prepared for rapid germination. Then:—

"December 23rd. Drizzling rain; cloudy afternoon; rainy night.

"December 24th. Cloudy, with sunny breaks. Cool. No rain.

"December 25th. Sunny and hot, with cloudy intervals.

"The germination must have occurred in these intervals.

"At various times experiments had been made to determine how the spores, which were observed germinating naturally on the coffee, arrived at their proper positions on the leaf. Careful observations on diseased coffee, made during gentle showers and steady breezes, convinced me of the following facts. Bearing in mind what an enormous quantity of orange 'rust,' each grain of which is a spore capable of reproducing a 'disease-spot' in less than three weeks, may be produced by one spot, and remembering also how easily these spores are detached, it seemed probable that the disease-spots produced later on a leaf might arise from spores shaken or washed from the earlier spots.

"If a perfectly clean glass slip, 3 in. by 1 in., be clipped on to a branch of coffee in the position of a leaf, in moist weather, two facts appear:—(1) spores, not only of *Hemileia*, but also of Sphæriæ, Lichens, &c., may be observed on the slip in the course of several hours; (2) these and other small bodies tend to accumulate at the lower edges or tip of the glass, and even to travel to the lower surface and become suspended in the moisture pendent therefrom.

"That the spores, &c., are washed, shaken, and blown into such positions aided by the action of gravitation cannot be doubted; and this view explains why the earlier disease-spots on coffee-leaves, which have not been violently shaken, frequently appear at the edges and tips, subsequent spots appearing in the other regions of the leaf. These causes, combined with violent shakings during gusty and rainy weather, must contribute largely to distribute spores from a diseased spot to a healthy part of a leaf, from one leaf to another, and even from tree to tree. But other observations prove that the wind conveys the spores of *Hemileia* through longer distances than the above. By exposing slips of glass, smeared with a thin layer of glycerine, in various positions in the neighbourhood of diseased coffee, it was shown that spores of *Hemileia* became entrapped in the glycerine; in one remarkable experiment the glass slips were exposed for twelve hours in a vertical position (the side smeared with glycerine facing the coffee) during a very high wind. The glass slip was 5 ft. from the ground, and 18 ft. in a direct line from the nearest coffee-trees; on these trees the spores forming 'disease-spots' were abundant and active, and spores were being plentifully shaken from them. At the end of the twelve hours I found no less than 117 spores of *Hemileia* embedded in the glycerine. Many other experiments confirmed the conclusion that the wind conveys the spores over considerable distances; innumerable spores, in all stages of freshness and decay, were observed in the meshes of some canvas exposed among the coffee for several months.

"How far the agency of man and insects, &c., is responsible for distributing the spores has not been directly determined; but it is fair to assume that this also comes into play.

"Hence it is certain that the spores of *Hemileia*, passive though they are, become plentifully distributed among the coffee on estates. If, as in the highest degree probable,* the

* For evidence of this *cf.* Third Report, &c.

fungus became conveyed to the cultivated coffee from the surrounding forests, it is easy to understand how its spread would be at first slow (since many spores are known to fail in obtaining a suitable starting-point); but we may also as easily comprehend that a large stock of spores having become formed in a favourable damp and warm season, the rapid spread over a wide area of coffee-trees would be but a matter of time. That this has occurred during the last fifteen years in Ceylon is only too evident.

"TABLE VII.

Month.	State of the Disease.	Wind.	Distance of glass slip from Coffee.	Distance of glass slip from ground.	Method of exposure of the slip.	Length of exposure.	No. of *H. vastatrix* spores found.
June 3	A few spots of 'rust' here and there.	High.	12 feet	On the grass.	Flat.	8 hours	7
July 8	Bad.	Very high.	25 "	4 feet	Vertical.	12 "	21
July 9	"	"	20 "	4 "	"	2 "	8
"	"	"	12 "	5 "	"	2 "	13

"The spores of *Hemileia*, then, can become spread over the coffee; the necessary conditions for their germination are known to recur naturally at frequent intervals; and experiments have conclusively shown that within three weeks from the successful sowing of any spore on a coffee-leaf the mycelium reproduces spores again, to go through the same cycle.

"Moreover, evidence has been brought to show that any kind of coffee may become infected, though of two given leaves the younger and thinner one usually shows the 'disease spots' more rapidly. How far do these and similar facts explain what occurs on masses of coffee?

"I have shown in detail elsewhere* that in the districts chosen for illustration, young coffee-leaves are formed most rapidly during the 'growing weather' of April to August, and that, practically, the quickest development of new leaves occurs during May and June. On the contrary, very few leaves are produced during the hot dry season of February and March. Alternations of rapid and slow growth occur during the rest of the year, depending on the variations of climate experienced; but it commonly happens that a rapid renewal of growth occurs towards the end of the year, in October and November.

"To determine as far as possible the rate of growth and other changes in leaf-buds and leaves at Péràdeniya, certain trees were selected in August 1880, and watched during the following twelve months, notes being made at short intervals as to the conditions of the buds and leaves on twigs around which coloured ribbons had been loosely tied.

"The shortest time in which a pair of leaves was developed in my experiments was about 4 weeks, when the bud first exposed on April 10th became an adult pair of leaves by May 8th; and the longest period occupied by the same process was (excluding a very abnormal example, where 17½ weeks were occupied in the process) 13 weeks, when a bud which first appeared free on October 29th did not begin to open until the following January, and its leaves were not fully formed before February 27th.

"During the very dry weather experienced in Péràdeniya from December to March, there is, on the whole, much less activity displayed in the formation of leaf-buds and leaves than during the period from April to August; and this is in accordance with the general experience of planters on the Kandy side of Nuwara Eliya. Of course there are differences in the rate of development of leaves, dependent on circumstances other than the weather, since the time at which pruning, manuring, &c., are done affects these and

* Appendix to Third Report.

"TABLE VIII. *Branch A.* (Tree not pruned.)

Date on which bud became visible.	Date about which bud began to open.	Date when the leaves separated.	Date on which the leaves were full sized, &c.	Time occupied in opening, &c. (approximate).	Whole period of development (approximate).
August 2	August 26	September 6	October 16	7 weeks	10½ weeks
September 6	October 16	October 29	November 15	4 ,,	12 ,,
October 29	January 10	February 1	February 27	7 ,,	13 ,,
..	February 1	,, 20	March 29	8 ,,	..
March 7	March 29	April 5	April 25	4 ,,	7 ,,
April 25	May 20	May 25	June 15	3½ ,,	7 ,,
May 25	June 15	June 26	July 14	4 ,,	7 ,,
June 26	July 6	July 18	August 1	3½ ,,	5 ,,

On this branch, therefore, eight pairs of leaves were completely formed during the 12 months (August 1, 1880, to August 1, 1881), the period of slowest growth being September to February; that of quickest growth, April to August. The pair of leaves which developed most rapidly was formed in June to July; that which developed most slowly, in January to February.

"TABLE IX. *Branch B.* (Not Pruned.)

Date on which bud became visible.	Date about which bud began to open.	Date when leaves had separated.	Date on which leaves had attained full size, &c.	Time occupied in opening (approximate).	Whole period of development (approximate).
August 5	October 10	October 16	November 8	4 weeks	12 weeks
November 1	January 20	—	February 25	4½ ,,	17½ ,,
..	February 21	March 7	April 25	9 ,,	..
March 7	March —	,, 30	,, 30	..	7½ ,,
,, 30	April 14	April 20	May 2	2½ ,,	4½ ,,
April 20	,, 25	May 1	,, 30	4½ ,,	5 ,,
,, 30	July 6	July 20	August 8	5 ,,	6 ,,

"TABLE X. *Branch C.* (Pruned Tree.)

Date on which bud became visible.	Date about which bud began to open.	Date when leaves had separated.	Date on which leaves had attained full size.	Time occupied in opening (approximate).	Whole period of development (approximate).
January 22	January 30	February 10	February 27	4 weeks	5 weeks
,, 31	February 10	,, 24	March 14	4½ ,,	6 ,,
February 24	April 2	April 15	May 1	4 ,,	5 ,,
April 10	..	..	,, 8	..	4 ,,
May 1	May 8	May 20	June 20	6 ,,	7 ,,
,, 25	June 15	June 20	July 15	4 ,,	7 ,,

other phenomena; moreover, since the buds are slower in development where wind or a general low temperature prevails than where the air is quiet and warm, it will be evident that elevation affects this as other processes of growth. The trees on which my observations were made suffer much from leaf-disease, and bear little crop, circumstances which must also be taken into account.

"Let us now suppose, for the sake of argument, that a quantity of spores of *Hemileia* are scattered about the above-named districts in January, after the dry season has fairly set in; many of these spores may be imagined on the rocks, ground, tree-stumps, &c., around, while others are on the leaves of the coffee. The air is so dry that, except on the banks of sheltered streams and in damp shady places, those spores cannot germinate; the wind is not high, and even in cases where sudden gusts raise spores from dead and 'diseased' leaves on the ground, there are comparatively few leaves on the trees, and the chances of many spores attaching themselves to their dry surfaces are not great.

"With the April rains and gusty winds there come in conditions which distinctly alter the circumstances of these spores: a few of these spores on the leaves germinate, infect the leaves, and in three weeks reproduce their kind in the normal manner. By the time that the May leaves are becoming formed, a somewhat larger stock of *Hemileia*-spores exists on the trees than before; and these newly formed spores are better placed for distribution—every shower of rain and puff of wind must scatter some of these spores.

"During May and June the weather is not unfavourable to the germination of the above-named spores; by the time that this second generation has gone through its cycle, the older spots are still producing vigorous spores in the moist atmosphere, while the wind may successfully place others from the original sources of infection.

"It must be remembered that the trees are by June becoming densely clothed with young, succulent foliage, and that the spores from the more recently developed spots are more likely to be deposited on the leaves, since they are more numerous. The life-cycle of these later spores may be more rapid by several days in the tender young leaves, in the moist, warm atmosphere.

"If the above be correct, it should follow that July, or thereabouts, would show a wide-spread and sudden outbreak of the yellow disease-spots; and we know that such is the fact.

"In August the leaves, destroyed by the abundant mycelium, fall in showers, the trees becoming in many cases almost stripped.

"One set of observations may be recorded as typical of all the others.* A coloured ribbon having been loosely tied on a twig of the growing coffee, the development of the buds and leaves was carefully watched, and notes made of the changes which occurred from time to time as the latter passed from their earliest stages to adult age, and finally died off.

"In the case which I will here cite, the terminal bud commenced to open about March 21st, and in a few days had developed a pair of shining, dark green, tightly opposed young leaves about $\frac{1}{4}$ in. long.

"During the first three weeks in March, a continuance of dry, hot days caused all quick growth to cease; but the opening of the bud commenced at once after the showers which set in towards the end of March, and continued for the most part throughout April.

"On April 2nd, in fact, after a week of showery growing weather, the swollen bud had burst, and presented two leaves each $\frac{3}{4}$ in. long; and by April 25th these were fully formed, handsome bright-green structures, about $4\frac{1}{2}$ in. long by $2\frac{1}{4}$ in. broad in the middle. On or about this date the leaves ceased to enlarge, and may be considered adult and in full working order.

"During the last week in April and the first week in May

* For further evidence *cf.* Third Report.

much rain fell in heavy showers; but from May 8th to May 25th a hot period intervened, the mornings being frequently close and steamy, however. At this time a few spots of 'leaf-disease' were observable here and there on surrounding coffee-trees.

"Now, from April 25th, the period at which we may consider the leaves adult, to June 1st no trace of *Hemileia* was discovered on either of the leaves; but on June 1st a distinct though small 'pin-spot' was seen on one of the leaves, which I shall call the left-hand leaf; and on June 3rd a few spores were seen proceeding from this. On the latter date also I found a minute yellow 'pin-spot' on the right-hand leaf of the pair.

"The question is, what connection had the weather, the presence of spores, and other circumstances with this definite appearance of two 'leaf disease-spots' on leaves which had been to all appearance perfectly healthy from April 25th to June 1st, i.e. during some five weeks? It may first be stated that the weather from May 25th commenced to indicate the wet usually associated with the incoming of the south-west monsoon; and wind and rain prevailed more or less up to the end of June, June 20th to 26th, however, being fine.

"The disease was first noticed on June 1st: if the 'pin-spot' arose from the germination of a spore as I have described, this spore probably commenced its action within three weeks or so previously. On comparing the notes made about the requisite period, two points are clear:—1st, there were spores being shaken and blown about at that time; 2nd, it rained heavily up to May 8th, and a series of hot, close, steamy mornings occurred thereabouts; and it also rained during the week preceding the discovery of the spot It is evident, in fact, that an odd spore of *Hemileia* germinated (probably in the dew) on each leaf on or about the 16th–18th of May, and sent its tube into the leaf to form the mycelium of which the presence was discovered on June 1st–3rd.

"On June 15th the spot on the left-hand leaf was large and producing abundance of orange spores, which were being widely distributed by the high winds (from June 3rd to 15th), as well on surrounding trees and leaves as on other portions of the same leaf-surface.

"On June 29th many more disease-spots were apparent for the first time: these rapidly came to produce spores, and on July 1st numbered 35 new patches, each pouring forth hundreds of spores to be distributed as usual. The spores which produced these probably germinated about June 15th, in the showers so prevalent during the month. By this time, also, the disease was bad all over the tree. I think it highly probable that the 35 new spots arose from spores detached from the one spot of June 3rd.

"By July 6th the leaf was badly diseased—the one older spot (of July 3rd) beginning to turn brown in centre, but still active in spores; the others, which might be termed the second generation, shining through above with an orange hue.

"On July 15th there appeared about 12 new spots, evidently from spores which germinated during the wet week preceding July 1st. Each series of spots on the left-hand leaf could now be distinguished as follows:—One large and old spot, with a black patch in the centre, and few spores—that of June 3rd. A number (35) of very active spots which are just commencing to become brown in the centre—those of June 29th. A smaller number (12) of new active spots, and only just tinged yellow above—those of July 15th.

"On July 23rd the leaf was evidently becoming destroyed by the numerous (48) virulent spots draining it, and curious green rings around the spots of June 29th alone represented the normal colour of the leaf; by July 26th these had faded, and the leaf was quite yellow and exhausted, and it fell during the night of that date.

"As to the right-hand leaf, its history is very similar. On June 15th there were two *Hemileia*-spots on it, a new one having appeared in addition to that of June 3rd; on the 29th June appeared 57 new ones, which spread rapidly, and covered the greater part of the leaf by the 6th July; on July 15th were 13 still newer spots: the three generations were quite evident on July 27th, when the leaf was yellow. Before the last day of July this leaf also had fallen.

"It is clear from the foregoing that what the planters term an 'attack' of leaf-disease, i.e. a sudden outburst of the 'rust,' results from the coming to maturity at or about the same time of a series of mycelia which have been formed from the successful sowing of a certain number of spores; and since all were exposed to similar conditions, we must look for the origin of the rust to the conditions previously present. It is clear, however, that we cannot say exactly when a given disease-spot commenced to form; we can only argue from the known data. I do not think that any mycelium takes less than one week, or more than three weeks to form, as a rule, however; and hence the above argument may be widely applied.

"Here appears direct proof of the cumulative power of the fungus. We cannot well doubt that the earliest spots on the leaves arose from odd spores blown by the wind from fallen leaves or other coffee-trees, and that these sowed their spores in turn to produce spots in June, while further spores from the last-formed spots produced the July outbreak, and so on.

"The above-recorded history of a pair of coffee-leaves may be summarised thus:—

"About one month was occupied in forming the new leaves, a period during which they cannot be looked upon as very useful to the tree. During the next five weeks or so the leaves may be considered as normally active, i.e. they would during this period elaborate much material not used in constructing their own tissues, which would be passed down into the tree for the benefit of other portions.

"After this, however, the disease-spots appeared; and the increasing mycelium would consume more and more of the elaborated materials until the leaf became exhausted and fell. This latter period must be one of struggle between the leaf-cells and the fungus-cells, and, especially towards the end of the time, the tree cannot derive much benefit from the devastated leaf-tissues. As here shown for a pair of leaves so with a whole tree—in proportion as the amount of fungus-mycelium increases the lease of life enjoyed by the leaves decreases, other things being, generally speaking, equal. This also I have proved by actual experiment and observation, by marking certain young trees and watching the results as they became badly affected with the disease.

"Young trees were chosen because on such the development of the leaves takes place very nearly equally at all the branch-tips; hence one can be certain of comparing structures of equal value. Some healthy plants of *Coffea arabica* were two years old in June, when they were planted in the open in a sheltered hollow, at equal distances apart; at this time they had no disease, were not developing new leaves, and had lost but few. During August and September a typical plant was watched more particularly; and the following facts are true, especially for it, generally for the rest, since all the plants were equal and developed very similarly:—

"On September 8 there were ten pairs of primary branches; a bud from the axil of each topmost leaf represented the eleventh primary. The foliage was dark green, fine, and healthy. Neighbouring coffee (to leeward) had lately suffered from virulent leaf-disease, and was still badly affected; but very few spots were apparent here.

"The total number of leaves presented on this plant at the date given was 243; the number of cicatrices whence leaves had fallen amounted to 85. The terminal buds of the 11 branches represented 22 leaves *in posse*, and that of the main stem of course = 2 leaves more, 24 in all. It is therefore clear that such a two-year-old plant would possess about 350 leaves, if all were present. From data obtained by counting the leaves on a one-year-old plant, I find about 66 a common number, and on two-year-old plants about 250 to 260.

"On September 23 I carefully examined the young tree once more. 15 leaves present on September 8 had now fallen, most of them diseased, and all among the oldest; and the terminal buds of the latter date had each produced its pair of leaves, which were still small however. We may therefore consider that the manufacturing capacity of the tree was little altered, if at all, by the replacement of 15 old leaves by 22 young ones; for although the latter could do little at present for the tree, the former could not be looked at as of much use either.

"On October 15 the tree, like its neighbours, was becoming badly 'diseased,' the yellow spots appearing on the leaves at all points. The actual number of leaves present = 274; and of these 70 were young, and had been formed in the interval September 23 to October 15, while 46 leaves had fallen under the devastating action of *Hemileia*. Nevertheless, we may here well imagine that the 70 new leaves largely compensated the loss of 46 older ones; only, in comparing this remark with the statement before made, we must keep two facts before us—1st, the destroyed leaves in this case were more *directly* destroyed by the fungus; and 2nd, many spots, that is, masses of mycelium, were now present on the foliage yet on the tree.

"On November 9 there were 254 leaves present; of these 46 were newly formed since October 15. In the interval 66 leaves had fallen, badly diseased.

"On December 25 the disease had gained the mastery to a terrible extent; only 50 new leaves had been formed, whilst 107 had fallen victims. The actual number of leaves on the whole tree = 197. Thus after little more than three months, during which period the tree had formed no less than 188 new leaves and lost 234, the total number of leaves present was fewer than at the commencement, although the *possible* leaf-bearing area was, of course, much increased during the interval. Moreover, these fewer leaves were to a great extent badly diseased. The experiment does not contradict what has been said as regards the seasons, since the trees were only planted out (and exposed to the wind-blown spores) in *June*.

"Other facts come out if the above records be carefully studied. It will be noted that the largest production of new leaves occurred in the interval September 23 to October 15: this corresponds to a period of rapid vegetative growth which then took place during moist, cloudy, and warm weather. After this, the rapidity of growth ceased as the air became drier towards the end of the year.

"The greatest development of 'leaf-disease,' however, did not take place until the interval November 9 to December 25, i.e. about a month or six weeks later. This is in accordance with what is already known of the behaviour of the fungus, as, indeed, are all the details of this experiment.

"It is now possible to understand the explanation of some difficulties which have been raised in objection to the generalisations presented in this and preceding publications on this subject.

"One of the commonest popular difficulties freely expressed in connection with the history of this and similar diseases of plants may be stated somewhat as follows:—It being proved that the fungus in the leaves causes the disease-spots to appear and the leaves to fall, how can such huge effects arise from such apparently small causes? The complete reply to this question would be a lengthy summary of our knowledge of the physiology of the leaf and its connection with the life of the tree. It must be remembered that the mycelium of *Hemileia* not only robs the leaf of valuable materials, on the manufacture of which a large expenditure of energy was required, but it diverts the flow of nutritive substances. Moreover, in occupying space in the tissues of the plant, it prevents these tissues from fulfilling functions of service to the coffee-tree. To replace the damage done, the leaves would require either to do more work in a given time, or to have a longer lease of life to work in; whereas they have less opportunity of doing either. When the fungus is present in quantity there is less available substance sent down to the tree for the support of crop; and the life of the leaf is shortened. Hence the amount of fruit matured by the tree must be diminished unless one of two things happens —unless (1) more leaves are quickly formed and enabled to work for the benefit of the tree; or (2) more food substances can be sent into the leaves and elaborated in the time allowed, so to speak, by the voracious pest. I have directly proved that the coffee-tree cannot produce crop if the leaves be stripped from its branches—a fact in accordance with what we otherwise know of similar cases.

"By cultivation and proper manuring, it is conceivable that one of the above-named effects could be produced; and, as a matter of experience, coffee-trees in richer soil, or better treated than others, may support more crop. This has given rise to another popular error with regard to 'leaf-disease,' that manuring, &c., diminish or cure it.

"I have elsewhere* discussed this at some length, and shown that the reason that manured or favourably situated coffee supports more crop is due to no direct action on the fungus at all (it is clear that circumstances which favour the host must rather benefit the parasite than otherwise), but that such trees support more crop because they can spare more food for that crop after paying the tax demanded by the fungus. Nay, it is certain that many trees support more crop and more fungus-mycelium at the same time than do others with which they are compared.

"Closely connected with the above fallacy is another—that certain trees are 'predisposed' to the disease or to infection. A refutation of this view has been matter of experiment: I have purposely waived all arguments from analogy, and tried to infect every description of plant—young and old, West-Indian and East-Indian, *Coffea arabica* and *C. liberica;* and there is no ground for supposing one more easily infected than another. This has nothing to do with the rapidity with which the mycelium produces the yellow spot. We have seen that a tender young leaf may succumb more rapidly (as a whole) than an older and more leathery one; and it

* Third Report, 1881.

PLATE V.—COFFEE PLANTATION, NEAR NEURA-ELLIA, CEYLON.

[To face p. 80.

must be evident that moisture, temperature, and other simple events may affect this.

"We here face another difficulty, viz. Why do some trees suffer more than their neighbours? Let us shortly examine how complicated are the causes which aid in determining the amount of fungus-mycelium, &c., on a coffee-tree. We may do this by assuming that two trees, side by side, are equally diseased. This involves one or the other of two comprehensive assumptions:—

"Either (*a*) that the two trees were at the outset equal in all respects, that their root-masses, areas of leaf-surface, &c., were alike in extent and exposure, and that the relations of these to the soil, moisture, air, and light, &c., were equal in all respects—that equal quantities of food-materials were present in each, and that the expenditure and income connected with these remained equal in each case. It must be further assumed that each tree received at the outset the same *quotum* of disease-producing spores, which developed with equal energy and effect, and were equally related, actively and passively, in both examples.

"Or (*b*), if the above formidable details and their consequences be not assumed, it must be admitted that the various complex relations between coffee and its surroundings on the one hand, and *Hemileia* and its environment on the other, though differing in details in all possible degrees, amounted to the same final result in the two cases selected —that, although both trees were dissimilarly related in mass, vigour, &c., and in their quantitative and other relations to earth, air, light, and the fungus, &c., yet they became 'diseased' in the end to the same extent.

"Either of the above assumptions would be rash in the extreme; and no argument in favour of the view that some trees are predisposed to the attacks of *Hemileia* can be logically based upon them.

"As a summary of the foregoing, it may be fairly considered proved that 'leaf-disease' here, as in so many other cases now known, is not antecedent to the fungus (*Hemileia*) but is consequent upon the injurious action of the mycelium; the 'rust' and 'disease-spots' are not mere signs of ill-health, due to obscure causes, but are preparatory stages in the spread of the disease-producing parasite. This being so, no ground exists for considering the fungus as a 'product of vitiated plant-life,' or 'of the sap'; and just as little reason is there for the view that a sickly plant is prone to infection. Nay, experiments prove conclusively that a vigorous and healthy West-Indian tree is as easily infected as one from Ceylon; and it has also been shown that such a vigorous plant may produce more vigorous mycelium and spore-groups, i. e. it may disseminate more of the disease-producing fungus in a given period.

"Those who have the necessary knowledge of the physiology of such a plant as coffee, and can appreciate the changes produced by a disturbing agent such as the parasite, will not fail to see a *vera causa* for 'coffee-leaf disease' in the action of the fungus at many points for a long period.

"It may be asked, 'How came the rapid spread of this fungus?' The answer appears simply, having provided immense quantities of suitable food, carefully protected and preserved, man unconsciously offered just such conditions for the increase of this fungus as favour the multiplication of any organism whatever. Whether any natural check to the further progress of this pest will arise is at present problematical, much as it may be desired from an economical point of view.

"It may be remarked that, although careful trials have been repeatedly made, I have utterly failed to infect either the coffee-leaf or any other plant with the small '*sporidia*' produced by the germination of the *teleutospore* of *Hemileia*; no evidence exists for doubting that the reproduction of the fungus on coffee-estates takes place wholly by means of the innumerable *uredospores*, as described.

"Several *Æcidia* (notably those on *Emilia*, *Tabernæmontana*, and *Pavetta*) have been experimented with, to observe whether their spores can be made to infect coffee. In no case has any positive result been obtained; and the obverse is also true—the *teleutospores* of *Hemileia* did not infect the plants named. I hope that further trials will be made, however, with *Pavetta indica* and *P. angustifolia*: two *Æcidia* (*Æ. flavidum* and *Æ. Pavettæ*) have been described* on these hosts; and it is remarkable that the genus *Pavetta* stands somewhat closely allied to *Coffea*. As to the original source of this fungus, there can be no reasonable doubt of its antiquity.† Whether *Hemileia vastatrix* is more than a form of *H. Canthii*, moreover, must be considered at present undecided." (*Journ. Linn. Soc.*)

A disease known as "leaf-rot," rather prevalent in Mysore, is distinguished from the above, and is referred to a fungus named *Pellicularia Koleroga*, by Dr. M. C. Cooke. It appears about July, when the leaves of affected shrubs become covered with slimy, gelatinous matter, turn black, and drop off; clusters of berries also rot and fall. There is every probability that the sulphur and lime treatment would be effective in this case also. The shed leaves and fruit should be collected and burned.

Fly.—This disease has been known for many years in Dominica and Brazil; it has also spread to Venezuela, the Antilles, Porto Rico, Martinique, Trinidad, and all down the Atlantic coast of South America. It is caused by the larvæ of a moth, scarcely $\frac{1}{6}$ in. long, named *Cemiostoma coffeellum*. The colour of the insect is dull-white or pale-grey, with a bar of black across the posterior end when quiet; its motions are very active, and it readily takes alarm. The female is either provided with an ovipositor of sufficient strength to pierce the cuticle of the leaf, beneath which the egg is deposited, or it deposits the egg in some irregularity on the surface of the leaf, leaving the future caterpillar to find its own way into the tissue. In either case, a caterpillar develops from the egg, and feeds on the cell tissue of the leaf, in all directions, between the two cuticles. The insect

* Messrs. Berkeley and Broome, in Journ. Linn. Soc., Bot. vol. xiv.
† As first suggested, I believe, by Mr. Thiselton Dyer.

prefers young and delicate leaves, and is most active about the commencement of the wet season, when, doubtless, the majority of the eggs are deposited. It is dormant during the wet season—say from March to May.

Of the varieties of coffee met with in Dominica, the Mocha is most subject to the attacks of this moth, its leaves being the most delicate. Stronger leaved varieties, when fairly healthy, are scarcely attacked; but when existing under unfavourable conditions, such as to induce flaccidity of texture, they are sometimes much affected. The disease manifests itself by the appearance of large discoloured blotches on the leaves, causing their decay and fall. It has been stated that, by picking the leaves at such a time as to take the greatest number of the larvæ when about two weeks old, it would be easy to destroy the pest, as the size of the blotches would then easily distinguish the diseased foliage. The insect is very susceptible to the effects of wood smoke, and may easily be driven off or destroyed by the smoke of ordinary wood or grass fires. At present it does not exist in the West Indies to such an extent as to injuriously affect the fruitfulness of the trees, and is markedly less numerous where insectivorous birds abound.

Borer.—This pest, formerly known as the "worm" and "coffee-fly," is most troublesome in Southern India, especially in Coorg and the Wynaad, where, in 1865–6, it destroyed whole estates. Beetles with similar boring habits infest the coffee bushes on the West Coast of Africa, and in Zanzibar, and are occasionally troublesome in Jamaica. The Indian borer has been identified as the *Xylotrechus quadrupes.* In its complete stage, the insect appears as a winged beetle; it is ½ to ¾ in. in length; rather finer in shape than a wasp; with a hard, shiny coat; in colour, red and black, or, in other cases, yellow and black, in alternate transverse lines. It bores a passage into the stem of the coffee-tree, usually at some few inches above the ground. This passage, at first horizontal, soon takes an upward spiral direction, and proceeds until a safe retreat is found, in which the larva may be deposited. The tree soon droops, and dies down to the point at which the entry has been effected, and where it can be easily broken off by a sharp pull at the upper part. The only course is to break off the tree in this manner, and then to burn the stem, with the larva secreted in its centre. Young shoots will proceed from the stump (if the perforation has not begun too near the roots), and one of these may be trained to succeed the original stem. There is a growing impression that the borer can be kept out of estates in hot dry situations only by providing shade, and perhaps irrigation. Its ravages have always been worst on weedy plantations and new clearings.

Bug.—The coffee tree is attacked by various species of *Coccidæ* in most countries, where they are known by different names. Ceylon has been, perhaps, the worst sufferer in this respect; but careful cultivation has greatly reduced the evil. There are two distinct species of bug found in Ceylon, and called respectively "black," or "scaly," and "white," or "mealy." The former, *Lecanium coffeæ*, is a minute insect which attaches itself to the tenderest shoots of the plant; the females have the appearance of small scollop shells, of a brown colour, and adhere to the leaf or twig in the same manner as the scollop shell to a rock. Each of these contains several hundred eggs undergoing incubation; and in a short time, the whole of the green wood of the tree will become covered with the young insects, and coated with a black soot-like powder which renders the tree easily discernible at a distance.

The bug will soon spread over whole estates, entirely checking the growth of the trees; the fresh young shoots are always first attacked, and such wood as is allowed to mature produces hardly any crop. The berries, moreover are, in their earliest stage, destroyed by these insects, which cut them off at the stalk. The measures recommended for checking this scourge are to dust the brushes with a mixture of pounded saltpetre and quicklime, in equal parts; or to brush or sponge the affected parts with a mixture of soft soap, tar, tobacco, and spirits of turpentine, in about equal quantities. A coolie, with a bucket and a piece of rag, can perform the office effectually. This species affects elevated (above 3000 ft.), cold, damp, close localities, where it is found in all stages of development all the year round, the propagation being continuous. It generally makes its first appearance under the shelter of a large rock, near a belt of forest, or at the bottom of a nullah.

White bug is a distinct species of insect, known as *Pseudococcus Adonidum.* It is small, flat, oval, about $\frac{1}{16}$ in. long, covered with a white down or fur, and having parallel ridges running across its back from side to side, like the wood-louse, though on a much smaller scale. It is found in various stages of development all the year round, and takes up its quarters on the roots of the trees to about 1 ft. beneath the surface, at the axils of the leaves, and among the stalks of the crop clusters, which it cuts off wholesale, either during the blossom stage, or just after the young berries have been formed; in the latter case, its operations may easily be recognised, by the large quantities of young green berries with which the ground beneath the trees will be strewn. It is also easily discovered by a white, flour-like excretion which it deposits around the axil nooks where it has made its abode. The prescriptions above recommended for black bug will be here found equally efficacious. In either case, probably, a decoction of common tobacco might be sufficient, while much more easily prepared. The white bug has a decided preference for hot, dry situations, and generally disappears in the wet season; too often, however, only to return as soon as the blossom has set.

Canker.—A disease which has created great havoc in Natal, and which causes an annual loss of about 1 per cent. of the trees in Jamaica, is "canker" or "bark disease." The first symptom is the withering of a tertiary or secondary branch, when it will be found that the bark under the primary branches is decayed and blue mouldy; the blue mould gradually extends downwards over the whole stem; a tree once attacked never recovers, but dies in a few months. All soils and situations seem liable to the disease, the trees beginning to suffer when about six years old. Though the mould is the proximate cause of death, the ultimate cause is evidently due to some unfavourable external condition. The opinions of experienced persons as to what this may be are various; it is attributed to neglect of cultivation, to unsuitability of climate, and to want of depth of subsoil. All may be partially right; but the last seems most probable, and is the reason given for it in Jamaica.

Rot, Grubs, Rats, Squirrels, &c.—"Rot," or the blackening and withering of the young leaves and shoots, is due to wet and cold, and may be cured by good drainage and mulching. Grubs of a large yellow kind destroy the tap-roots of the plants; cattle manure is a fertile source of them, and should be well limed. Rats, squirrels, grasshoppers, ants and spiders collectively do considerable mischief, and should be exterminated whenever possible. In Java, a fungus attacks the stems, giving them a white appearance, and producing death in all the parts above. In Venezuela, occurs a minute fungus named *Depazea maculosa,* which causes the so-called "iron-stain," circular or elliptical blotches of an ochreish-yellow colour. The same appears to be in Jamaica also.

Black rot.—The following paper was read by M. C. Cooke before the Linnean Society on the Coffee Disease of South America.

"In the coffee-plantations of Mysore occurs a form of disease known as the Koleroga, or black rot, also of fungoid origin, and apparently unknown in Ceylon. It was this disease which I examined and reported upon to the Government of India in 1876 under the name of *Pellicularia Koleroga.** The fungus is entirely superficial, spreading over the leaves in a compact filamentous film, somewhat like the mycelium of an *Erysiphe* in external appearance, but quite different in its internal structure when seen under the microscope. The felted threads bear their own proper spores, reminding one

* 'Grevillea,' iv. p. 116.

somewhat of the genus *Zygodesmus;* but the film is so superficial that when it is moistened it can be removed in flakes from the surface of the leaves without resistance. With the majority, probably all, of the species of *Erysiphe* and its allies the mycelium cannot be thus removed, on account of the processes which enter the substance of the leaves through the stomata. Until recently it was not known that this disease had made its appearance on the coffee-plant outside of Southern India.

"The existence of destructive parasites on coffee in South America was intimated as long ago as 1876, the same year in which the Mysore fungus was investigated. The first communication was from Venezuela,* which stated that the coffee-disease there known was called '*Candelillo*' or '*Mancha de hierro*' (iron stain); and specimens of the leaves were sent for examination with the following note, drawn up by Señor Saenz, Professor of Botany in the University of Bogotá. The disease, he says, 'consists of circular or elliptical blotches of an ochreish-yellow colour, in which are to be observed hard knots in the centre, round which are formed concentric bands. The salient knots are to be easily distinguished on each side of the leaf; but on the one side only are to be found small fungi of a yellow colour (orange), formed of a very delicate pedicle crowned by a small sheaf of fibres, in which are an abundance of oval corpuscles of a darker colour, approaching to green, and of ·003 millim. in diameter.'

"The specimens which accompanied this note were submitted to the Rev. M. J. Berkeley, who reported that the spots were occupied by a minute fungus which he called *Depazea maculosa*, Berk., having fusiform spores ·0008 in. long (or ·02 millim.) with about seven nuclei.

"It may be remarked here that the old genus *Depazea* of Fries was characterised chiefly by the presence of small perithecia seated on discoloured spots, the structure of the perithecia and their contents not being taken into account.

* Kew Gardens Report for 1876, p. 21.

Hence some of the species of *Depazea* had perithecia which contained only stylospores, others asci with sporidia. When microscopic fungi had to be revised, as a consequence of improvement in the microscope, the genus *Depazea* was divided into two parts: those containing stylospores in the perithecia were denominated *Septoria*, and those in which the perithecia contained asci were relegated to *Sphærella*, and the old name of *Depazea* became practically obsolete. The species above noted as *Depazea maculosa* would therefore now be denominated *Septoria maculosa*. Experience has demonstrated that in some cases the *Septoria* is only an imperfect condition of an ascigerous *Sphærella*, which makes its appearance on the same or upon contiguous spots on the same leaves. The relevancy of these observations will be apparent hereafter.

"Subsequently, further specimens were sent to Kew Gardens * from Dr. Ernst of Caracas, which demonstrated that the names of '*Candelillo*' and '*Mancha de hierro*' were not applicable to the same disease, and also that destruction was caused, and some of the leaf-spots produced, by an insect named *Cemiostoma coffeellum*. At this time (1877) it became manifest that three parasites had attacked the coffee-plant in South America, namely, the *Cemiostoma*, the '*Candelillo*,' and the '*Mancha de hierro*.'

"In a memoir published by Dr. Ernst in Spanish he described the Candelillo somewhat fully, and applied to the fungus which produced it the name of *Erysiphe scandens*. The felted mycelium which overspread the leaves seemed to him to be the mycelium of an *Erysiphe*; and he believed that he discovered also some cysts similar to the pycnidia of *Erysiphe*. It was never assumed that the conceptacles of an *Erysiphe* had been found; but the name was applied to the imperfect mycelium on account of its supposed resemblance to that of some *Erysiphe*.

"During the past year I received some coffee-leaves from

* Kew Gardens Report for 1877, p. 28.

Dr. Ernst bearing the '*Candelillo*,' or supposed *Erysiphe*; and these leaves I examined carefully without finding pycnidia, but with somewhat of surprise that it was the identical 'black rot' or '*Koleroga*' of Mysore, and that the fungus was none other than that which I had described as *Pellicularia Koleroga*. This fact was clearly demonstrated by finding the globose echinulate spores, that the '*Candelillo*' of Venezuela is the '*Koleroga*' of Mysore, and the *Erysiphe scandens*, Ernst, a synonym of *Pellicularia Koleroga*, Cooke.

"The '*Mancha de hierro*' differs most distinctly from the '*Candelillo*' in forming discoloured orbicular spots on the leaves; and it is therefore to *that* which reference is made in the note by Professor Saenz, and also in a further communication from the Commissioner of Agriculture at Bogatá to Dr. Ernst, published in July 1880.* The Commissioner writes:—'At first there appear on the leaves small spots of a light greenish colour, which in two or three days turn brownish, and then appears on each of them a fungus divided in three or more greenish-yellow branches. This fungus is said to be phosphorescent at night; and in places where it is very common a phosphoric smell is noted. After some days the diseased leaves fall off, the fruits, which also are attacked by the parasite, follow very soon, and the trees are left quite bare. They form, however, new leaves after some months; but these are again attacked by the fungus. The disease is reported to be more frequent in damp places than in dry ones, its ravages being greatest in plantations where the trees are planted rather close. The fungus has also attacked the shade-trees, especially the Guamos (*Inga* sp.).'

"Other communications which I have received, accompanied by specimens, demonstrate that the same disease is spreading widely through the coffee-districts of Costa Rica and other parts of Central America, New Granada, and Venezuela, and causing considerable alarm.

"The leaves and unripe berries are marked by distinct

* 'Nature,' July 29th, 1880.

pale spots, nearly orbicular, with a regular well-defined outline, and in the leaves quite perfect on both surfaces, from about a quarter to nearly half an inch in diameter, from two or three to five or six or more spots on the same leaf. These spots are often quite smooth, uniform in colour, and without any external evidence of the presence of a fungus. In these instances they seem as if they might as well have originated with an insect as with a fungus. Others of these pale spots are occupied by a few minute dark-brown perithecia, so minute as not to exceed the puncture of a pin. These perithecia, seated on pale orbicular spots, constitute the *Depazea maculosa* of Berkeley; but as I have found in all of them which I have examined perfect asci and sporidia, they were named and described as *Sphærella coffeicola*.* At that time I had not seen the specimens which Berkeley determined as *Depazea maculosa*; but as he found no asci, and characterised it as a *Septoria*, the *Sphærella* may be treated as a distinct fungus, although, in my own opinion, it is only the perfect or ascigerous condition of the same parasite.

"The question would rises at once as to the general character of *Septoria* and also of *Sphærella*, and whether they are likely to be productive of such a disease as that of the South-American coffee. There are no very distinct records of species destructive in this manner and to this extent; but there is, on the other hand, no reason why either *Septoria* or *Sphærella* may not be destructive. This may be affirmed more strongly of *Sphærella*; since within the past two years *Sphærella Taxi* has undoubtedly proved very destructive to yew-trees in Cornwall; and as for *Septoria*, some species have, to a limited extent, appeared as a destructive pest. Under any circumstances, if this really proves to be the cause and not a consequence of the coffee-disease in South America, it has the merit of being more truly devastating than any of its predecessors. It must be remembered that the perithecia are never numerous on the spots, and that

* 'Grevillea,' ix. p. 10 (1880).

at least half the discoloured spots are wholly without them. The spots are present, but there are no external evidences of fungi; and in some of these naked spots which were examined internally I failed to trace any mycelium.

"There is, however, still another feature in connection with these discoloured spots, that upon some of them, sometimes on the upper and sometimes on the under surface, another and very different kind of fungus flourishes. A pocket-lens will be sufficient to detect on some of the spots small, erect, slender, yellow threads with a globose head, five or six of them upon one discoloured spot. Sometimes they will be found on the same spots as the perithecia of the *Sphærella*, and sometimes on spots in which no perithecia can be detected. This *Stilbum*, which has been named *Stilbum flavidum*,* has, like all other species, a compound stem formed of a bundle of slender filaments, parallel to each other, fused into a common stem, terminated by a globose head, composed of the free ends of the component filaments, subdivided and terminated by minute subglobose spores, scarce ·0015 millim. in diameter. This corresponds very closely with the description of the parasite as described by Professor Saenz, who indicated 'the circular or elliptical blotches of an ochreish-yellow colour' and the 'hard knots in the centre, which are the perithecia of the *Sphærella*, and the 'small fungi of a yellow colour, formed of a very delicate pedicle crowned by a small sheaf of fibres, in which are an abundance of oval corpuscles.' The only difference appears to be that his measurement of the corpuscles is about double that of mine, his being ·003 millim., and my own ·0015 millim. for the spores of the *Stilbum*, a discrepancy not so very extraordinary when the minute size of the bodies is taken into account.

"The Commissioner of Agriculture at Bogotá also undoubtedly saw the same fungus, although his description is less exact and accurate. Whether there is any foundation for the belief that this little fungus is phosphorescent or

* 'Grevillea,' ix. p. 11 (1880).

emits an odour of phosphorus, cannot be affirmed, as he evidently mentions it with some reservation.

"I have now demonstrated that the coloured spots may be without any visible fungus upon them, and exhibit no trace of mycelium in the tissues, or they may nourish a *Septoria*, as seen by the Rev. M. J. Berkeley, or a *Sphærella*, as found by myself; or, finally, a species of *Stilbum*, as seen by myself and by Professor Saenz. Further, the *Stilbum* may occur on the same spot as the perithecia of the *Sphærella*, or both perithecia and *Stilbum* (the one without the other) may be found occupying different spots. All these points are worthy of consideration in searching for the source of the disease.

"I cannot forbear noticing incidentally that *Sphærella isariphora*, Desm., a small species of *Sphærella* common on the leaves of some species of *Stellaria*, owes its name to the fact that it is sometimes found associated with a minute species of *Isaria*, a mould closely allied to *Stilbum*, although the *Sphærella* is often found without the *Isaria*.

"On unripe coffee-berries from Costa Rica, as well as from Venezuela, the same orbicular spots occur, usually one spot only on each berry; and on some of these spots I have seen the *Stilbum*, but hitherto have not observed the *Sphærella*.

"These observations are communicated to the Society as a summary of all that at present has been determined respecting the coffee-disease of South America. I venture to think that the disease seems to be a complicated one; and for the present I am not prepared to affirm that either the *Septoria*, or *Sphærella*, or the *Stilbum*, or all together, is the cause of the disease. At the same time I cannot but think it possible that none of the three forms of fungus is autonomous, and that all may be related to each other as forms or conditions of the same fungus, of which the *Sphærella* is the highest and most perfect manifestation.

"Since the foregoing was written, I have been permitted by the Rev. M. J. Berkeley to examine some diseased coffee-leaves * from the island of Jamaica. The same discoloured spots are present, although smaller in size, and little dark specks or points (visible under a lens) on these at once suggested a *Septoria* or *Sphærella*; but microscopical examination showed that the dark points were not perithecia, but tufts of short-jointed olive threads, with hyaline bacillary spores growing at the apex. This apparently new species of *Cercospora* has been called *Cercospora coffeicola*, Berk. and Cooke. Nearly all the species of this genus occur on living or fading leaves, and many of them grow on discoloured spots. The septate threads generally grow in tufts; and the habit is somewhat that of a small *Cladosporium*, to which the genus is closely allied. It is noteworthy that we have here, in another locality, an entirely different species, genus, and order of fungi growing upon almost identical pallid spots on coffee-leaves. It renders still more difficult an answer to the question, 'What is the cause of this form of coffee-disease?'"

* [The leaves in question were sent by Mr. Morris, Government Botanist at Jamaica, accompanied by a sketch of the *Cercospora*; but neither Mr. Morris nor Mr. Berkeley could find spores; and Dr. Cooke found them only after long and patient examination. Mr. Berkeley thinks that the *Cercospora* is possibly the same with *Cladosporium stenospora*, B. & Curtis.—M. J. B.]

CHAPTER V.

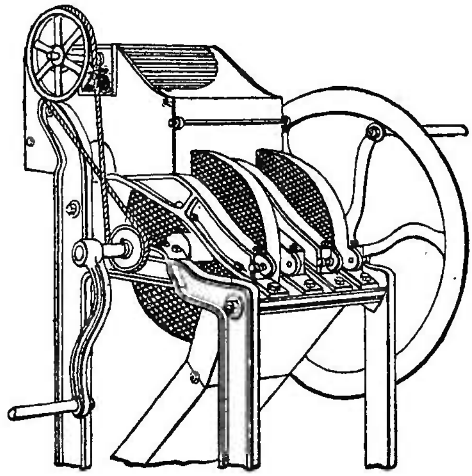
PREPARATION OF THE BERRY.

The preparation of the coffee necessitates the erection of extensive buildings and machinery: for these no specific plan can be given, because much depends upon the size and situation of the estate, and much upon the kind and degree of preparation contemplated. The site chosen for the works should be as near the centre of the plantation as is compatible with securing a patch of open airy ground, to which a good stream of water can be brought. The first requisite building is the "pulping house," comprising three floors—the cherry loft, the pulping platform, and the cisterns. Whenever possible, it should be built against a shallow cliff or embankment, so that the cherry-coffee may be delivered into the loft without being borne upstairs. The cherry loft is usually immediately over the pulping platform.

Pulping.—The operation known as "pulping" consists in liberating the coffee beans from the pulp in which they are enveloped. With ripe cherries, this is most easily and effectively accomplished immediately after picking, and efforts are usually made to complete the pulping of a day's picking during the same evening; if over ripe and shrivelled, but still comparatively moist inside, the cherries should first be soaked in water for a few hours. A number of machines have been invented for this purpose, the object in all cases being to pulp rapidly, thoroughly, and without injury to the bean; if the inner skin of the bean be broken, the latter is wasted. The most simple form of pulping machine is the "disc pulper," in which the separation of the bean and the pulp is effected by means of rotating discs, covered with a thin sheet of copper, whose surface has been "knobbed," or raised into rows of oval knobs, by the application of a blind punch.

Pulpers of this class, being portable and cheap, are often used in the opening of distant estates, and commonly in India and Java. The "single" form is very light; driven by three coolies, it will pulp 20–25 bush. cherry an hour. The "double" form, shown in Fig. 6, has two discs, and is furnished with a feeding roller inside the hopper. It requires four to six coolies to pulp 40 bush. an hour; but

Fig. 6.



Double Pulper.

driven by power, it will do 70–80 bush. The discs are placed between "cushions" of smooth iron, set at such a distance that the cherries cannot pass without being bruised; the cushions rest on a movable bed of iron, set so that no bean can pass downwards. When the disc revolves, the cherries are driven forward, and squeezed; the corrugations then catch the skins, and drag them between the disc and bed. These small pulpers have an advantage over the larger ones, in that each can be set to suit the size of a portion of the crop—which always varies; and with a number of machines, there is less likelihood of complete stoppage in

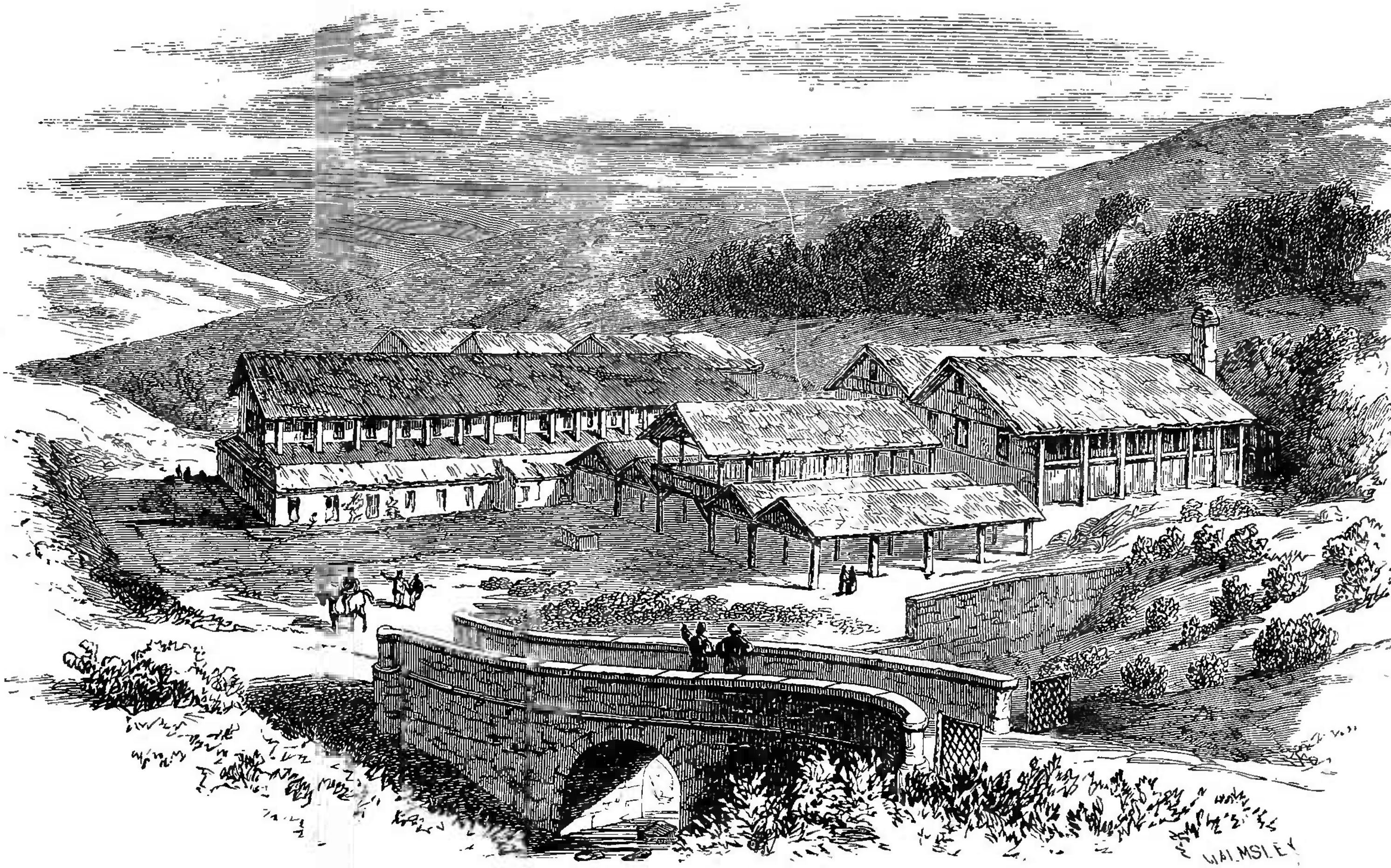


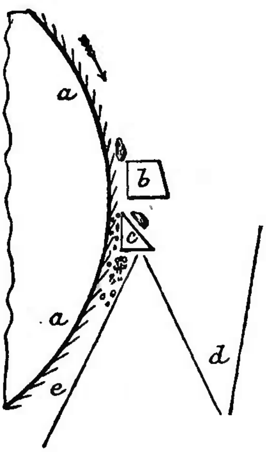
PLATE VI.—COFFEE ESTATE BUILDINGS IN CEYLON.

[To face p. 96.

case of an accident. One disc pulper to every 30–40 acres—say three to 100 acres: two to be set alike, and one for smaller cherries—should be ample.

The "cylinder pulper" is an older invention than the preceding, and has been subjected to numerous modifications. The principle is illustrated in Fig. 7; *a* is a cylinder of various diameter, revolving in the direction of the arrow. The cherries and water are guided between the cylinder and a piece of iron, called a "chop," *b*, set at such a distance that the smallest cherry is bruised while the largest bean is not damaged. The teeth of the cylinder catch in the pulp and drag it within the second chop *c*, which is made sharp at the top and is set so that while admitting the pulp it rejects the beans, which fall into the trough *d*; the pulp passes into the trough *e*. The cylinder is furnished with a toothed surface, by means of a sheet of copper pierced with a number of partial perforations, so as to resemble a magnified grater. Sometimes the punching is effected in such a manner as to produce three-cornered points, the apex of the triangle being at the top; in other cases a "half-moon" punch is used, and this is said to reduce the percentage of pricked beans. In any case, it is essential that the teeth shall be equally raised. Care must be taken to retain a bold working edge on the lower chop, as when it becomes worn and rounded, small and dry beans are liable to be caught and broken.

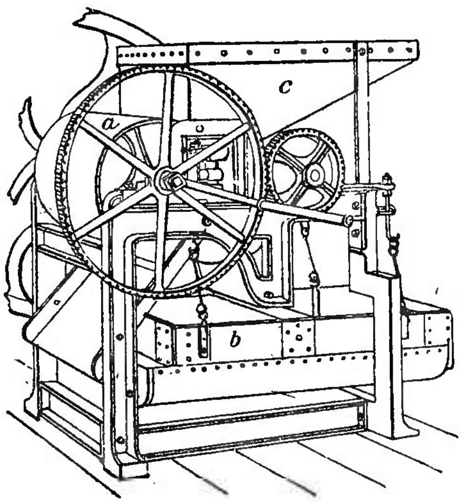
Fig. 7.



Cylinder.

A very handy form of cylinder pulper is seen in Fig. 8. The pulping parts consist of an iron cylinder *a*, 24 in. by 15 in., covered with punched copper, and a pair of iron chops set to the breast of the cylinder. Below the cylinder is a sieve *b*, provided with circular motion, for separating the clean pulped beans or parchment from the pulp and imperfectly pulped cherry. The parchment is carried by a spout to the cistern; the unpulped cherry is returned to the hopper *c*, and again passed through. Worked by six coolies,

Fig. 8.



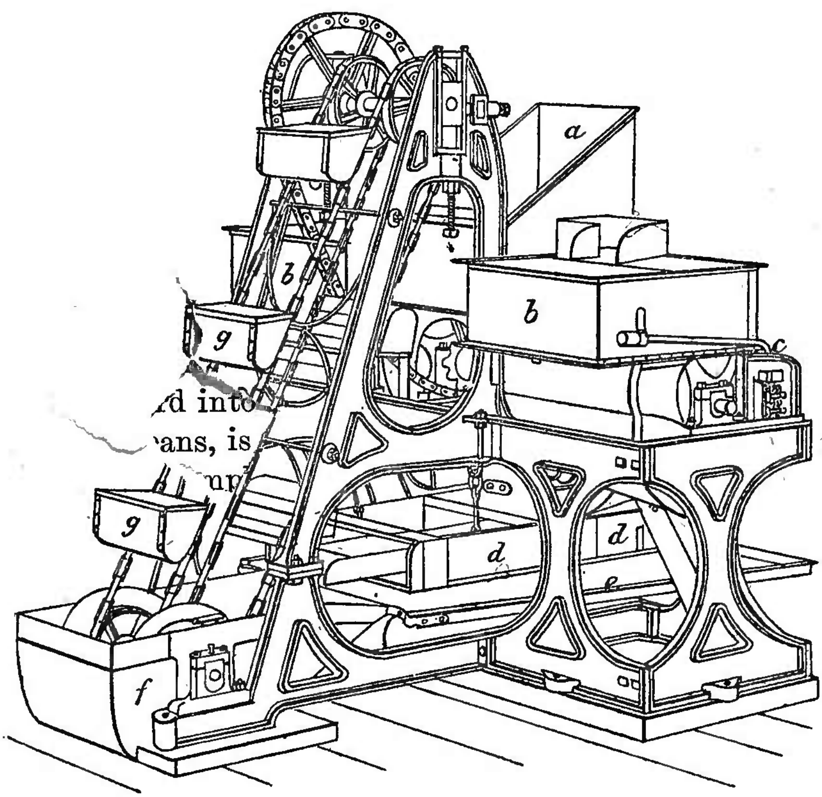
Cylinder Pulper.

it will pulp 30–40 bush. cherry an hour; by power, 50–60 bush.

Fig. 9 represents a "gearless" pulper. It has two pulping cylinders, two pairs of chops, hopper and feed-boxes of galvanised iron, a large sieve with circular motion, and a set of elevator buckets. It easily pulps 100 bush. cherry an hour, and can be made to do 150–160 bush.; for effective speed, it requires a 16 ft. water-wheel, or a 3 h.-p. engine. The cherry is dropped into the central hopper *a*, whence it passes laterally into the two side hoppers *b*; from these, it drops on to the sides of the cylinders, and the pulping is effected at the chops under *c*. The pulp is floated away. The beans, together with some pulp and unpulped cherry, fall into a sieve *d*, through which the beans pass nearly clean, and are carried by spouts *e* to the cisterns. The pulp and unpulped cherry are delivered into a well *f*, whence they are returned, by the elevator *g*, to *a*, to be again passed through with fresh cherry.

The use of chops is now often superseded by a breast.

Fig. 9.

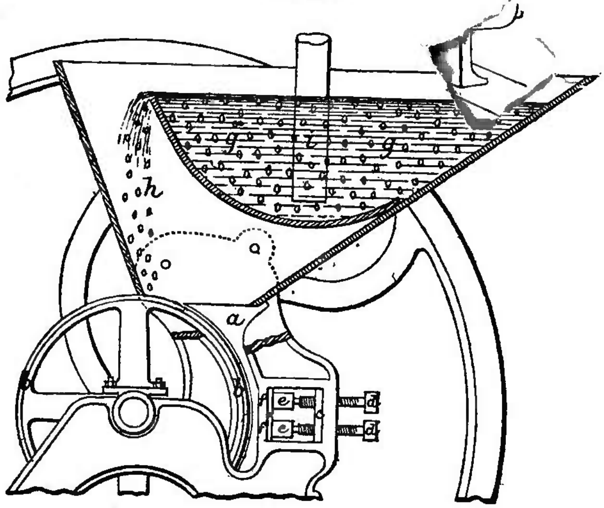


Gearless Pulper.

This arrangement is shown in Fig. 10. The breast *a* is pushed by hand against the barrel *b*, and adjusted by the nut *c* and the screws *d*, which bear on the ends *e* of the breast by means of wooden wedges *f*; it is thus kept tightly in its place, as close as possible to the barrel without being in actual contact. The part *g* of the hopper *h* forms a water-box, to prevent stones from entering the machine. The cherry descends from the loft, through a trap-door, into the perpendicular spout *i*, reaching nearly to the bottom of the water-box. A continual influx of water carries the cherries gradually over the lip of the box into the hopper; the supply thus depends upon the rate at which the water is fed. When purchasing pulpers, care should be taken to obtain clear directions for setting them up, such as are issued by the makers, J. Gordon and Co., 9, New Broad Street, London, E.C.

There are three points which need attention in all pulpers —(1) regular feeding; (2) exact adjustment of the pulping parts; (3) suitable sieves. The first condition is best ensured by the arrangement shown in Fig. 10; the second will depend in a great measure upon keeping the parts quite clean, and watching their wear; the third consists in

FIG. 10.



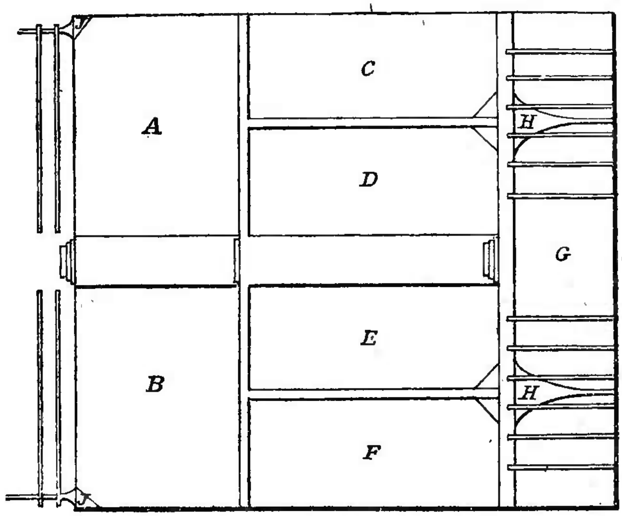
Breast Pulper.

providing a circular mesh of such a size as to stop the smallest cherry, while admitting the largest parchment bean. It is common to have sieves with two meshes, the smaller part being at the back, where the coffee comes down with force, the larger at the front, where it merely passes forward. This latter part should permit the largest beans to pass. In some seasons, there will be but little saccharine matter between the pulp and the parchment, so that they will adhere so strongly as to render pulping a difficulty. Instead of reducing the grade of the pulper, it is much better to leave it at the full size for ripe cherry, and to pass the coffee through several times, the pulp gradually becoming separated without damage to the bean.

The pulpers above described comprise those most commonly in use; a few others demand passing notice. The "bevel-gear" pulper is made with three pulping cylinders, or with two cylinders and a crusher. The office of the latter is to squeeze the cherries with sufficient force to effect the separation of the beans and the pulp of the larger cherries, while rendering the smaller ones more easily acted on by the pulper; it consists of a cylinder covered with overlapping steel plates, and does not get rid of the pulp, but sends everything forward into a sieve, whence all, except the proportion of pulped beans, is passed to the pulpers. It works well, but is somewhat complicated. The "double pulper and crusher" has two pulping cylinders and a fluted crushing roller, which latter is sometimes replaced by a third pulping cylinder. The "spur-gear" is cheaper than the gearless, or the bevel-gear, and will pulp 90–120 bush. an hour. "Butler's" consisted of two cylinders covered with grooved metal, revolving inversely; it worked well with uniform coffee.

Fermenting.—The "parchment" coffee, as it comes from the pulpers, is next submitted to a fermentation process, to remove the saccharine matter, without which the beans would not dry. This operation is performed in a series of tanks whose capacity will vary with the size of the estate, and which may be arranged as shown in Fig. 11. The pulpers are placed on a platform G, above the tanks, and in such a position that the pulped coffee can be run by water into the tanks, which must also be so situated that the coffee will always advance by the aid of running water, and may finally be conveniently conveyed to the drying ground, while the water and refuse run off. The amount of cistern accommodation necessary for an estate may be based on the allowance of 1 cub. ft. for each bushel of cherry picked in one day. The tanks are seldom less than three in number—two receiving cisterns, each large enough for the greatest possible daily pick, and a third for washing the parchment, nearly as large, superficially, as the other two combined.

Fig. 11.



Fermenting Tanks.

In the figure, A B are the washing tanks, 12 ft. 6 in. by 17 ft. 2 in. by 2 ft. deep, separated by a causeway $3\frac{1}{2}$ ft. wide; C D E F, the fermenting tanks, each 8 ft. by 18 ft. 9 in. by $2\frac{1}{2}$ ft. deep. These tanks are usually of brickwork, lined with cement or asphalt; but wood is much better, because less cold. They all have a slight incline, to assist the drainage. The receiving tanks are provided at the lowest corner with a good-sized outlet fitted with a plug, and with a movable sieve of perforated zinc or woven wire, fine enough to keep back the coffee when draining off the water, but not so fine as to choke with the saccharine scum. The receiving cisterns are used alternately. All the coffee pulped in one day is allowed to remain in the receiving cistern until a slight fermentation has set in; this occurs in twelve to eighteen hours in mild weather, but in cold weather it may take thirty to forty hours, or even more.

There are two ways of conducting the fermentation—the dry, and the wet. The former consists in allowing the pulped berries to lie without water, the bottom of the tank being perforated, so as to drain off the liquid; by the latter, the tank remains full of water. The dry system is the better, as long as care is taken to turn the mass, so that the fermentation shall be equal throughout; the presence of water equalises the fermentation, but retards it, and slightly injures the quality of the coffee. When the fermentation is not sufficiently prolonged, the beans will assume a yellowish colour—called "blanketty"—and will be difficult to dry, and liable to absorb moisture. When properly fermented, the separation of the saccharine matters is easily effected in the washing tanks, to which the beans and a good supply of water are admitted. The washing cistern is provided with a sluice door J at the lowest corner. This door commonly measures 6 in. wide by 3 in. deep. The coffee is constantly agitated by a wooden scraper or rake, by which the light coffee and refuse matters float, and may be skimmed off. The dirty water flows off through a tail-cistern, provided with a grating to catch the skins and any stray parchment. The sound berries are placed in draining boxes to remove the excess of moisture, and are then transferred to the drying ground, with the least possible delay.

Should the climate be uncertain, it will be necessary to provide for the emergency of a succession of wet days, when drying cannot be proceeded with. Parchment coffee may be kept undried for a fortnight, without injury, by placing it in a cistern exposed to a continuous flow of cold water.

Drying.—The berries to be dried are spread out on a flat surface exposed to the heat of the sun. The material forming the drying ground, "patio," or "barbecue," varies greatly. Very commonly, the ground is levelled, and covered with a kind of concrete. Sometimes asphalte is laid down; but, besides being expensive, it is not sure to withstand the heat, and such surfaces are liable to crack and give way, if not very carefully drained. A very good plan is to lay down coir matting, on ground which has simply been made smooth and hard; the advantages of this plan are its cheapness, the ease with which extra ground can be requisitioned in case of need, and the use of the matting as a temporary covering in the event of a shower. Modifications of this method are to stretch coir or gunny cloth across wooden frames, or across trays with or without wheels. Shed accommodation must always be provided ready for the reception of the coffee at any moment. The beans must be constantly turned over, either by light rakes or by coolies' feet. The drying must be rendered equable, and must not proceed so rapidly as to crack the parchment before the bean is quite dry; for this reason, the coffee should not be exposed too long to a strong sun for the first day or so. During the drying, it is gathered in each day while the sun is still hot, and will then continue to dry under cover. Every care must be taken to prevent heating, which may happen by prolonged drying in mild weather; rather than permit this, the coffee should be returned to a tank, and kept washed with running water.

If artificial drying can be effected, so much the better. An easy means of applying artificial heat is by passing an iron pipe, open at both ends, through a fire outside the store and below the level of the floor, continuing it into the store just beneath the floor. The heated air, passing upwards through the coffee, will carry off much of the damp. Revolving drying machines are also in the market. One of the best of these is Guardiola's, made by J. Gordon & Co., of New Broad Street, and shown in Plate VII. The coffee is fed equally into the four compartments of the cylinder; the cylinder and blower are set in motion, and the furnace is then lit. The coffee is kept in continual motion during drying, the temperature being carefully regulated. Very little attention is necessary, and the machine may well replace the ordinary "patio" or "barbecue," being equally adapted for drying other plantation products.

Three days' thorough sunning usually suffices to render the coffee quite dry and brittle, in which condition it is known as "parchment." As a rule, it is sent to port in this state, its further curing being left to the shippers; for not only is considerable expenditure on buildings and machinery necessary for the purpose, but the experience gained in manipulating various parcels of coffee will enable those who make the subject a special study to bring the sample up to the best standard of appearance and keeping properties. Coffee is said to retain its colour better, if allowed to remain for several weeks in the parchment; and its quality is said to continue to improve for months, and even years, the process being known as "curing." As, however, protracted curing causes some difficulty in removing the silver skin, coffee is seldom kept in the parchment longer than is compulsory.

Stores.—Though there is no necessity for curing the coffee, and it may be hulled at once, if desired, the exigencies of climate render a properly constructed store one of the greatest desiderata. The characteristic of the store must be dryness combined with security, hence galvanised iron forms the best material. It is generally of two storeys; the lower floor is sometimes boarded or asphalted, but the upper is always so made as to admit of free circulation of air through the coffee placed on it. This object may be attained by laying wire gauze, or coir matting, over reepers about 1 in. apart. Abundant ventilation must be provided. It will be necessary to watch for any signs of heating; and immediately on their appearance, the coffee must be turned over thoroughly.

An improved form of store is that built on the Clerichew principle. The floor of the upper storey, constructed as in the former case, rests on joists running lengthwise of the building. A ceiling is provided for the lower storey, by tacking to the joists, cloth which has been well soaked in boiled rice-water and whitewash, to render it air-tight; continuous air passages are thus made beneath the floor. About

10 ft. of one end of the lower apartment is partitioned off, and its sides are made as nearly as possible air-tight. It has no ceiling other than the floor above, so that the passages all open into it. In an opening in the wall of this chamber, a pair of large revolving fans are placed. Their rapid revolution draws a continuous current of air from the inside, and therefore through the coffee itself. In this way, dried parchment can be kept in perfect condition, without any turning over. By using heated air on the same principle, coffee may be housed while still only partially dry, and yet not suffer fermentation.

Hulling, or Peeling.—This operation consists in the removal of the "parchment" and the "silver-skin." The beans must be again exposed to the sun, for a period which it is difficult to define. Some say that they should be dried till they resist the pressure of the thumb-nail; but there is really no infallible test, as no two samples are exactly alike. It needs much experience to prevent loss of weight by over-drying, or of colour by under-drying. They peel best while still warm. A variety of hullers have been tried; but preference is commonly given to the old-fashioned edge-runner mill, composed of a circular trough with two large wheels revolving in it, and suspended about 2 in. from the bottom. The trough is one-half to two-thirds filled with beans, which remain until the grinding action of the revolving wheels has separated their skins, when they are let out by a lateral aperture. A trough 15 ft. in diameter should turn out 12 cwt. market coffee an hour; 4½ bush. good parchment coffee should give 1 cwt. clean coffee. The appearance of the coffee immediately after hulling is very light-coloured; but it soon assumes a horn-green tint, which it will retain unless exposed to damp, when it becomes dingy or mottled grey, and is classed as "country damaged."

An apparatus for peeling and polishing parchment coffee, combined with one for hulling dry cherry coffee, is shown in Fig. 12. The two parts may be disengaged and worked separately. Smout's patent machine for hulling coffee which has been dried in the cherry, is shown in Fig. 13. The

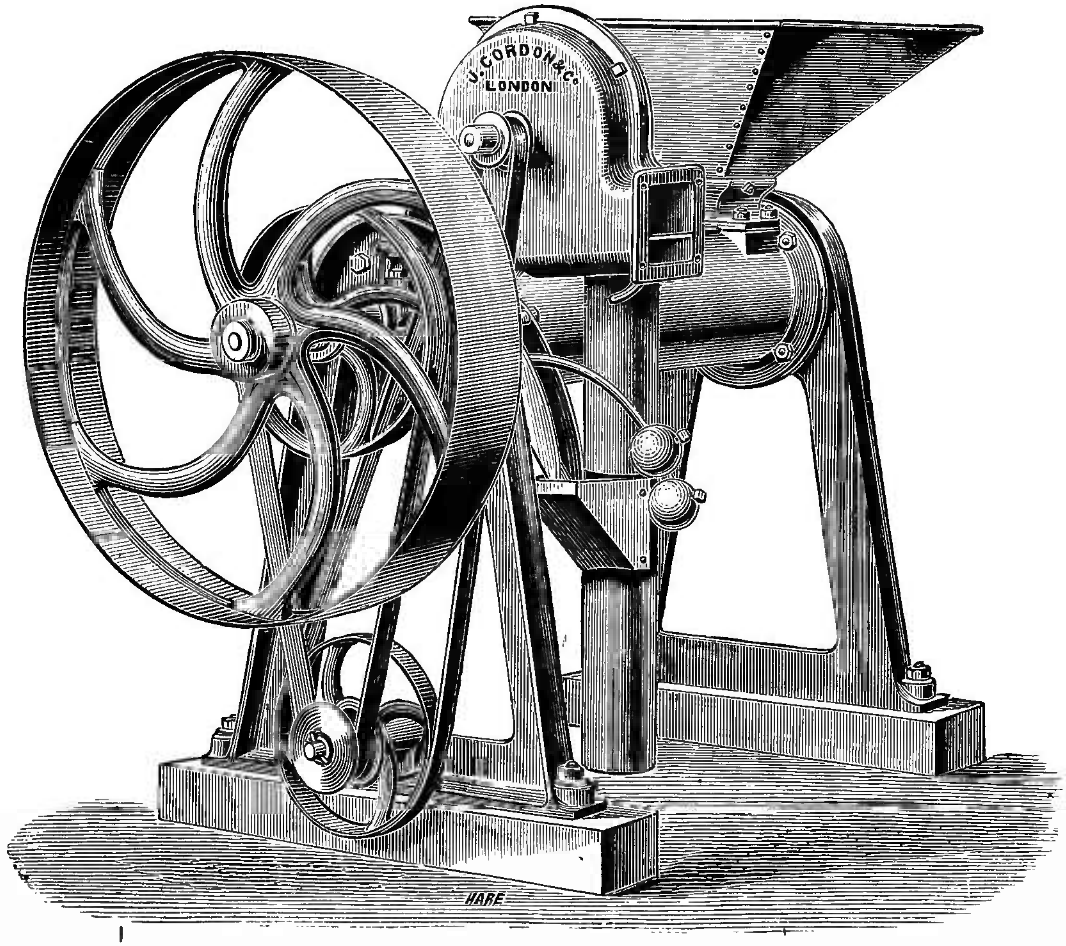
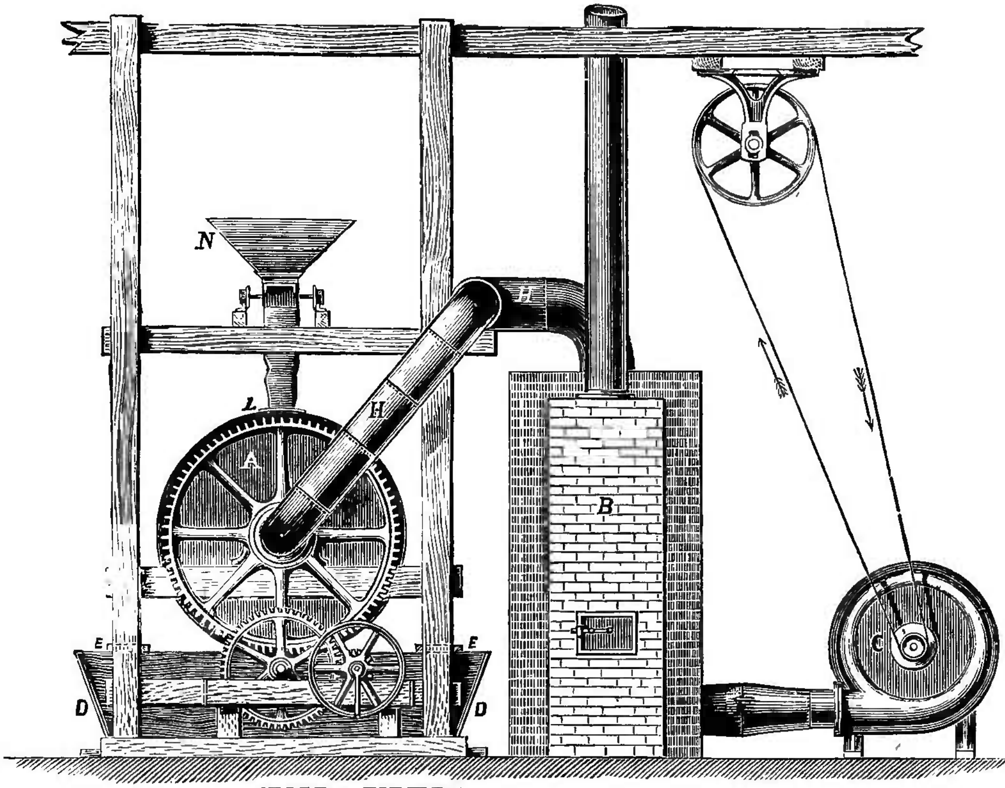


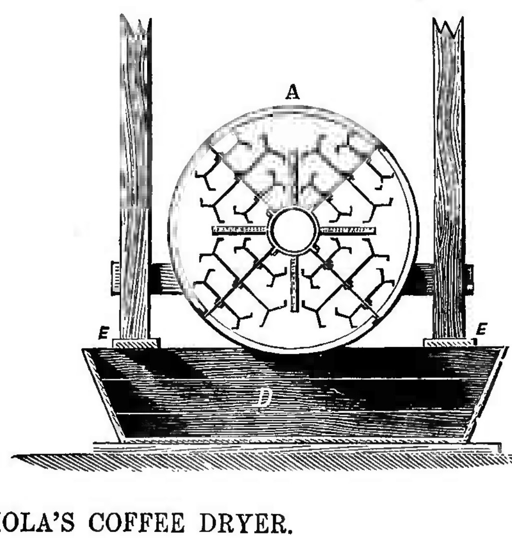
PLATE VIII.—SMOUT'S COMBINED PEELER AND POLISHER.

This machine works without noise, creates no dust, and never breaks the coffee. Its working is remarkably simple. With the fan attached, as shown, the coffee is delivered quite clean and ready for the separator.

[To face p. 107.



END VIEW



A, drying cylinder.
B, heater.
C, blower.
D, receiving box.
E, foot-board.
H, air-pipes.
L, doors.
N, feed-hopper.

PLATE VII.—GUARDIOLA'S COFFEE DRYER.

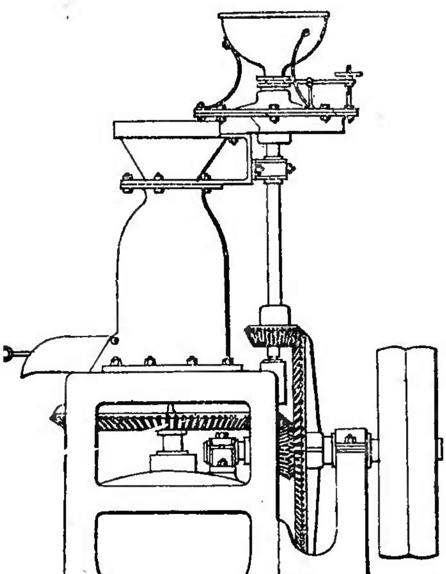
[*To face p.* 104.

shells should afterwards be removed by means of a fan. Smout's combined peeler and polisher is shown in Plate VIII.

Winnowing.—The peeled coffee, as it comes from the huller, in company with the detached skins, is submitted to the influence of a fan, whose force must be so adjusted that it will effectually remove the skins without carrying off any coffee.

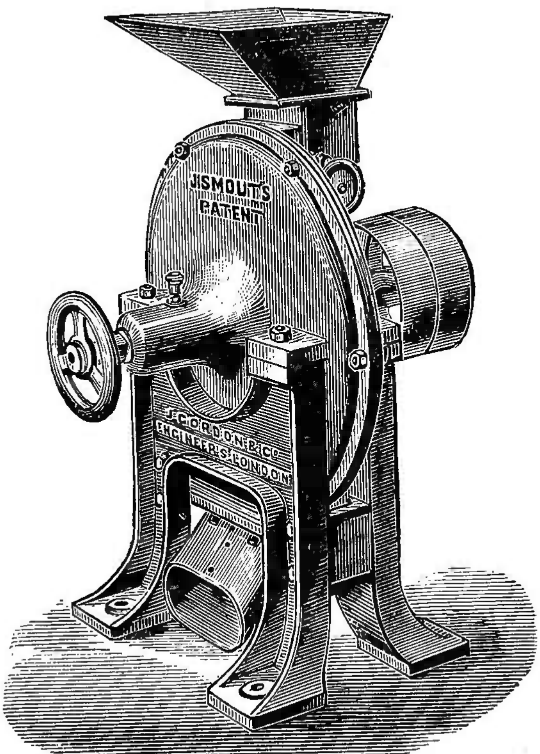
Sizing. —When the coffee has been cleaned from the skins,

Fig. 12.



Peeling and Polishing Machine.

Fig 13.



Smout's Huller.

it is necessary to separate it into various sizes for market, chiefly with the object of rendering the subsequent roasting process more equable in its effect. Formerly, the sizing was performed by hand garbling or picking; but it is now the custom to employ a "separator," as shown in Fig. 14. It consists of a horizontal, revolving, cylindrical sieve *c*, formed of perforated sheet iron, or steel wires, and divided into sections of different meshes. The coffee is fed in at the hopper *a*, which is furnished with a regulator and an internal worm, for the purpose of distributing it equally, while a revolving brush *b* prevents the meshes being choked. Sand and dust pass through the first section, and fall into the space *d*, small and broken beans are delivered at *e*, sound coffee escapes into *f*, the best and largest beans are caught at *g*, and the pea-berry rolls freely out at the end *h*. A greatly improved separator, also made by Gordon, is shown in Fig. 15.

FIG. 14.

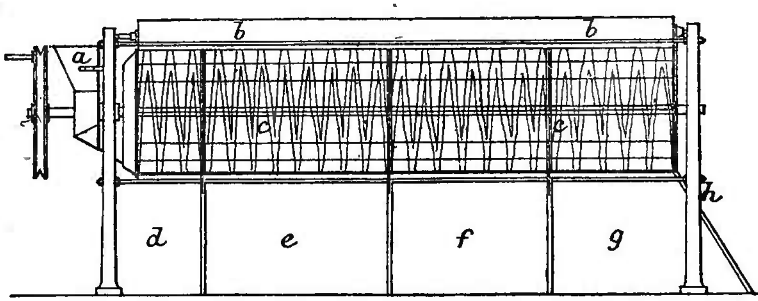
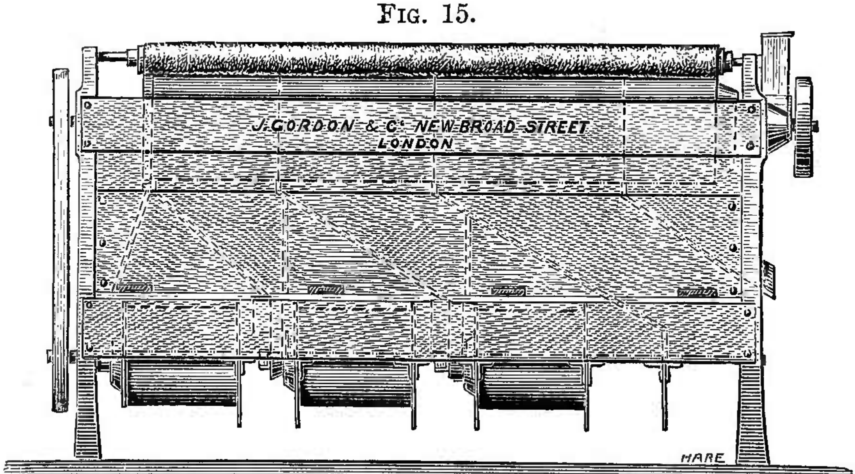


FIG. 15.



Gordon's Separators.

Other Methods of Preparation.—There are times when it is impossible to pulp the coffee; the pulpers may get out of repair, or the weather may be so untoward that the cherry does not ripen sufficiently, or becomes too dry for pulping.

In these cases, the cherry must first be fermented; the best way to do this is to place it in one of the tanks, or, if the quantity is too small to nearly fill a tank, in an old box or cask, and cover it with sacks or grass, or both. Here it is left until it acquires a good warmth. When the cherry, on squeezing, is no longer slippery, it may be taken out and spread in the sun to dry. For two or three nights, it need not be housed, nor will rain hurt it. When dry, it may be stored for curing, like parchment coffee, but must not be mixed with it.

To ferment the cherry by leaving it in a heap on the ground is a bad plan, for two reasons: first, because when fermented it becomes very wet, and collects dirt, which, in the after treatment, will affect the colour of the coffee; second, because in a heap, the fermentation cannot be equal throughout the sample. Pulping is performed whenever possible, as the increased trouble entailed by the other process is not compensated for by the alleged improvement of the flavour, and no better price is got in the market.

The native coffee of the East Indies is dried in the cherry; the dried pulp is then removed by pounding in common paddy-pounders, and the refuse is winnowed away in native baskets. Besides being tedious, ineffective, and expensive, the process gives a large proportion of damaged beans, and does not secure a regularity of colour.

"Wherever coffee has been found indigenous, it has been observed that the natives pick it and dry it in the cherry, or outer skin, and it is well known that this improves the quality, and the flavour is better retained, even for years." (Christy.)

In many places merchants can command supplies of coffee in the form of "dry cherry," or in the "parchment." The system of husking coffee in London has considerable advantages. Growers, by shipping their produce in parchment, are enabled to forward the same for disposal without delay; and coffee sent forward in parchment and worked in London has had a higher value in European markets than that which has been worked abroad.

Messrs. Major & Field, the proprietors of Red Lion and

Three Cranes Wharf, Upper Thames Street, were the first to recognise the importance of the scheme, and have, after some years of labour, and considerable expense, established a complete husking mill, using the latest and most approved machines for the various processes, and, from their experience of the many different growths of coffee, they are enabled to adapt the machinery to the requirements of the coffee that has to be dealt with.

There are two most important points to be observed in the preparation of coffee; one is the drying after pulping, it being most essential that the coffee should be properly dried, otherwise it loses the brilliant bloom natural to the berry, and no artificial drying is so efficient as sun heat in the countries of production. The second point is, that after being properly dried, any pod coffee that may be mixed with the parchment should be sorted out, as generally such pod consists of the most unripe berries, which have escaped the action of the pulper, and such berries being of inferior quality would, if passed through the mills with the clean parchment, materially detract from the good appearance of the bulk.

Packing and Shipment.—As soon as the coffee has been sized and garbled, it is ready for the market. It is best packed in air-tight casks, made from wood which is not likely to taint the coffee in any way. Bags are sometimes used double, but are inferior to casks. In shipping coffee, great care is required to prevent its coming into contact with other merchandise which may communicate to it a flavour or odour. Vessels carrying coffee should have perforated ventilating tubes from the bottom of the hold, passing through the cargo, and allowing the escape of the steam and gases generated during transit. Without this, the beans will be discoloured, and classed as "country damaged," an accident which cannot be covered by insurance. In well-ventilated ships, coffee loses about ½ per cent. in weight, but gains in quality; under bad ventilation, there will be a gain of ½ per cent. in weight, but a loss of colour, and consequent depreciation in value.

CHAPTER VI.

MARKETS AND STATISTICS.

Market Varieties and Values.—The following list is intended to show the comparative prices (in shillings per cwt.) of the principal brands of coffee brought into the home market:—*Jamaica*—good mid. to fine, 99–110, 103–126; low mid., 84–98, 92–102; fine ord. 60½–83, 71½–90; good ord., 58–60, 68–71; ord. and triage, 50–56, 63–7. *Ceylon* (Native)—bold, 66–72, 75–80; good and fine ord. 63–4, 70–4; small and ord., 50–61, 62–9; (Plantation)—fine, 102½–112, 109–17; fine mid., 100–2, 106–8½; good mid. 96½–9½, 103–5½; mid. 93–6, 100–2½; fine ord. to low mid., 82–92½, 84–99½; mixed and triage, 62–81, 68–83. *Other East India*—fine and sup., 106½–15, 110–28; good to fine, 101½–5, 107–9½; mid. to good mid., 92–101, 100–6½; fine ord. to low mid., 77–91½, 84–99; ord., 70–6½, 72–82; Native, 68–72. *Mocha*—fine yellow, 102–10; mid. to good, 93–100, 96–100; ungarbled, 80–2. *Java*—yellow, 77–94, 90–100; pale and mixed, 63–76½, 75–89. *Manilla*—54–65, 62–76. *Singapore*—50–64, 58–75. *African*—50–3, 52–7. *Rio* and *Santos*—washed, 77–97, 83–101; fine ord. and sup., 56–70, 64–80; good ord., 54–5, 61–3; ord., 45–53, 48–60. *La Guayra*—62–90, 76–97. *Costa Rica*—fine, 91–100, 92–100; mid., 84–90, 86–91; ord. to fine ord., 68–83½, 66–85. *Guatemala*—68–83, 70–85; mid. to fine, 84–97, 86–98. *New Granada*—70–98, 80–107. *Porto Rico*—75–100, 86–102. Also, occasionally, *San Domingo*—60–75. *Mexican*—65–84. *Savanilla*—plantation, 80–105; native, 62–78.

The commercial value of coffee depends upon the form, size, colour, smell, flavour, age, and uniformity of the beans;

and on the presence or absence of stones, stems, and other foreign matters. The source is only partially valuable as an index of quality. Form is not a sure guide as to source, as it varies in the same sample; there are, however, three typical forms:—Mocha, small rounded (pea-berry); pointed Bourbon, medium sized, elongated, and pointed; and Martinique, large and flattened, Brazil, Martinique and Java coffees are of fairly regular size; but those of San Domingo and Mocha are very irregular. As a rule, medium sized beans have the best flavour. Colour depends entirely upon local peculiarities of growth and preparation; generally speaking, the coffees of the Old World are inclined to yellow, those of the New, to green. Weight decreases by keeping. Odour is a distinctive test, but requires long experience:—green Mocha resembles tea; Martinique and Jamaica, pure and pleasant; Porto Rico, less agreeable; Brazil, strong, varying in Rio and Santos; Java and Sumatra, sharp; Manilla, very pronounced. Flavour is another good test:—Mocha is best; Martinique, very agreeable; Guadaloupe and Porto Rico, less so; Padang, inferior to Java; Sumatra, slightly bitter. As to impurities:—San Domingo is usually very dirty; Ceylon, East India, Rio, Santos, Martinique, and Java, generally well prepared and clean. The nutritive or stimulating value of the sample depends upon the percentage of caffeine, which can only be ascertained by analysis.

Caffeine.—"Having recently had occasion to determine the amount of caffeine in several samples of coffee, for the purpose of comparison, it became necessary in the first place to make some experiments in order to ascertain what method could be relied upon for furnishing uniform and constant results. By extracting the beans with boiling water, completely precipitating the clear liquid with subacetate of lead, then removing any excess of lead from the filtrate and evaporating to a small bulk, the caffeine may be obtained in a crystalline condition; but it is still very impure, and the recrystallisation, after pressing between bibulous paper, so readily gives rise to loss that this method cannot be relied upon to give accurate results. It is, moreover, extremely tedious and troublesome. Dr. James Bell * recommends as a better method the extraction of coffee beans mixed with magnesia by boiling with strong alcohol, evaporating off the spirit and treating the residue with water to dissolve the caffeine. In this way a considerable portion of the colouring material is separated by the magnesia, and a further quantity is got rid of by evaporating the aqueous solution to dryness with a further quantity of magnesia, and then dissolving the caffeine in hot benzol. We have not, however, found this method to give more satisfactory results than the previous one, and one circumstance that greatly interferes with its application to coffee is the considerable amount of fat present in the bean. After several attempts to modify these methods of treatment for the determination of caffeine in coffee beans we had recourse to the use of lime as a means of separating the tannic acid while dissolving out the caffeine by boiling with alcohol. For this purpose it is advisable to mix the finely powdered coffee with moist lime and then to extract the mixture in a continuous percolator of the kind described by Waitt in the 'Pharmaceutical Journal' (vol. xiv., p. 376). The alcohol is then evaporated off and the dry residue is mixed with some water and a few drops of dilute sulphuric acid, the addition of which has the effect of separating the fat and clarifying the solution by converting a small quantity of soluble lime salt into calcium sulphate. After filtering the cooled liquid it is quite free from fat, and may then be evaporated to obtain the caffeine in a crystalline state. A better plan, however, is to extract the caffeine from the solution by shaking it with chloroform, in which it is freely enough soluble to be readily taken up, and on evaporating off the chloroform caffeine will be obtained in a condition fit for weighing. The principal points to be observed in carrying out this operation are the acidification of the water solution from the spirit extract and the shaking with chloroform, but with proper care very uniform results

* Analysis and Adulteration of Foods,' Part I., p. 16.

can thus be obtained. We have hitherto been in the habit of operating upon 50 grams of coffee beans in each experiment, but after confidence in the method has been obtained and experience in operating a much smaller quantity might be taken.

"On applying this method to the determination of caffeine in various samples of coffee we were at first somewhat perplexed by the great discrepancy of the published statements as to the amount of this constituent that is present, as will be seen from the following quotations:—

	Caffeine in raw coffee beans per cent.
Robiquet	0·32 to 0·64
Liebig	0·23 to 0·46
Zenneck	0·75
Graham, Campbell and Stenhouse	0·88 to 1·00
Dragendorff	0·99 to 1·22
Squibb	1·00 to 1·03
Bell	1·08 to 1·11
Allen	0·50 to 2·00

"The discrepancy between the data given as applying to roasted coffee is still greater, and in the *Allgemeine Kaffee-Zeitung* for 1884 the amount of caffeine in roasted coffee is stated to range from 2·00 to 3·64 per cent.

"The first result with which we were struck on carrying out a number of experiments with several different samples of raw coffee beans was the very narrow range within which the amount of caffeine appeared to vary. Instead of being a varying amount, it was more nearly a constant quantity in those kinds of coffee beans we had an opportunity of examining, which were the following:—

	Caffeine per cent.
Coorg	1·10
Guatemala	1·18
Travancore	1·16
Liberian	1·20
,,	1·28

"In making these determinations the raw coffee berries were not dried, but taken just as they came to hand and powdered. A difference in the amount of water might therefore have altered the amount of caffeine in the dry material, but there is not much reason for expecting that the foregoing data would have thus been materially affected. It would be desirable to extend these determinations of caffeine to a number of other samples of coffee from various sources, and it is to a great extent with the hope of obtaining samples for examination that we now make known the results that have been so far arrived at. In a future communication we propose to deal with the determination of some of the other constituents of coffee.

"The above determinations were all made with unroasted coffee, and it may be added that in experiments with roasted coffee we found a similar uniformity in the results obtained, so that a determination of the amount of this constituent may probably furnish a means of detecting the adulteration that is now so largely practised in the sale of ground coffee according to the custom that is general in this country. It has been stated that in the ordinary roasting of coffee the caffeine is to a great extent volatilised and lost. We have strong reason for believing that this statement is entirely incorrect, for in a number of experiments made by roasting coffee beans in which the amount of caffeine had been previously determined in the raw state we ascertained that there was an increase in the amount of caffeine in the roasted coffee and that this increase was uniformly proportionate to the loss of weight experienced by the coffee in roasting. As a general rule the amount of caffeine in pure roasted coffee is about 1·3 per cent. This may be more or less to some slight extent, according as the coffee is slightly or highly roasted, but there did not appear to be any evidence of the volatilisation of caffeine during roasting." (B. H. Paul and A. J. Cownley.)

Coffee-leaves.—A decoction made from the leaves of the coffee shrub has long been used in the Eastern Archipelago, and has more recently been introduced to the coolies in Southern India. A few years since, it attracted considerable notice, and was recommended as a new article of import, to become a cheap substitute for tea. There seems to be no doubt that coffee-leaves contain the principle caffeine in sufficient abundance to make a valuable beverage, but the presence of an unpleasant senna-like odour would militate greatly against its popularity. As regards price, it is said that coffee-leaves could be prepared (like tea) and shipped at 2*d.* a lb., as against teas at 6*d.* to 10*d.* There exists, however, the difficulty that depriving the tree of its foliage damages the crop of berries, and injures the tree itself; on berry-producing trees, therefore, only the leaves obtained in the ordinary pruning operations would be available, and these would seem to yield so small a supply as not to be worth the cost of collection. Growing the shrubs for leaf alone would be a very questionable undertaking; but there appears to be no valid reason why, in the event of the berry crop failing, a portion at least of the leaves might not be gathered and prepared, if any means can be found for removing the objectionable odour. It has been urged that the product would chiefly be employed to adulterate tea; but, even if such were the case, it is manifestly better than many of the adulterants now in common use, and it is very doubtful whether the supply or the price would meet the requirements of the case.

Adulterants and Substitutes.—Scarcely any dietetic article is so persistently adulterated. Its sophistication by means of chicory seems to be a recognised custom. Recently, a substitute for chicory has been introduced, under the name of "mochara," which is said to consist simply of ripe figs, roasted and pulverised. The preparation is stated to have been for some time in use on the Continent; but its introduction to English markets was, till now, rendered impossible by Customs restrictions. It is sold at about half the price of coffee. Another illustration of the modern craze for replacing every genuine article by an inferior substitute is to be found in the formation of a company (since come to the end it deserved) to work Henley's patent for making coffee out of dates! In New Zealand, the berries of *Coprosma Baueriana* have been proposed as a coffee substitute. The seeds of *Cassia occidentalis* have been imported into Liverpool from the river Gambia, under the name of "negro coffee," and are said to be used to some extent in Dominica.

Consumption and Prospects.—The following figures, taken from official returns, show the total consumption (in millions of lbs.) of coffee in the chief countries where it is used, and the estimated consumption per head of the population; the figures in brackets indicate the estimated per capita consumption in 1873:—United States, 310 : 6·5 (7·6); German Empire, 218½ : 5·0 (——); France, 120 : 3·25 (2·73); Holland, 70 : 18·0 (21·0); Belgium, 50 : 10·0 (13·48); Austro-Hungary, 36¼ : 1·0 (2·13); United Kingdom, 34¾ : 1·0 (1·0); Italy, 28 : 1·0 (1·0); Sweden, 25 : 5·0 (6·11); Switzerland, 18 : 6·0 (7·0); Norway, 13½ : 7·0 (9·8); Russia, 10⅓ : 0·15 (0·19); Denmark, 9 : 4·5 (13·89); Greece, 1¾ : 1·0 (1·42). From this, it would seem that the consumption of coffee does not increase at the same rate as the population, at least in the non-producing countries. In the East, on the other hand, it is said to be daily gaining favour with the natives. The comparatively trifling consumption in the United Kingdom may probably be ascribed to three causes:—the competition experienced from cocoa and good cheap tea; the comparative ease with which these are prepared; and the extent to which coffee is adulterated. The spread of the coffee-house movement, and education of the people in the preparation of the beverage, should effect a revival. Meantime there is abundant scope in foreign markets; and if the Ceylon planters will only make a real and combined effort to stamp out the leaf disease, they may reap a double benefit, while Brazil, their great rival, is struggling against a disturbed labour market.

The subjoined figures are from a report on the coffee trade of the world by United States Consul General Merritt, of London, dated March 26, 1883.

"There are no reliable data wherefrom a complete estimate can be formed of the total produce of coffee in all parts of the globe. The fluctuations of the annual output are great, and the distances far and wide apart in respect to the countries where coffee is cultivated. Admitting this, it may be asserted, however, with certainty that with the exception of the island of Ceylon there has been more coffee produced in all countries during the past five years than at any previous period. This growth has been in sympathy with an increased demand for home consumption in Europe and in the United States. In British India coffee growing has made progress, though on a small scale. (See Table K.)

"No continuity of shipments can be tabulated from either Singapore or Manilla. Those from Java and Sumatra are, as far as Europe is interested, embodied in the statistics under the head of the Netherlands. The retrograde movement in Ceylon becomes apparent by the table marked K. Tea and quinine are now under cultivation there in lieu of coffee over large tracts of land.

"As a rough estimate of the entire production of the berry, the following table may be given, showing average of one year in two quinquennial periods:—

Where produced.	1873–77.	1878–82.
	Tons.	Tons.
Brazil	200,000	290,000
Java and Sumatra	50,000	65,000
Ceylon	40,000	36,000
British India and Africa	24,000	30,000
British West Indies	1,800	2,000
Cuba and Porto Rico	2,500	3,000

"The statistics of production of Domingo and Hayti, Costa Rica, Venezuela, Guatemala, and Colombia are not at hand for comparison. As bearing on the probable production of Brazil it may be said that the exports in 1881, on consular authority, were 4,139,419 bags, of which about 50 per cent. went to the United States.

"On a basis of 145,000,000 population of Europe in 1866, exclusive of Russia, where coffee is not in general use, it has been ascertained from official sources that the consumption of coffee was 443,000,000 lb., or a fraction over 3 lb. per capita. In 1881, the total consumption had increased within the same radius to 763,636,000 lb., and the population to about 175,000,000, and the average per capita consumption to about 4·40 lb. The total supply of coffee to the United States was in 1866, 174,281,000 lb.; in 1881, 455,190,000 lb. Deducting a limited quantity for re-exportation, the average consumption per capita in the United States: 1866, 5·60 lb.; 1881, 9·10 lb.

"In other words, the United States average per head is nearly double that of Europe, and is constantly increasing.

"Table A.—*Summary of detailed statements showing the supply of coffee, in number of pounds avoirdupois, received for domestic consumption in various countries during sixteen years.*

Countries.	1866.	1867.	1868.	1869.
	lb.	lb.	lb.	lb.
France	98,650,000	103,988,000	105,066,000	110,721,000
Germany	90,915,700	120,187,300	138,851,700	148,918,000
Netherlands ..	27,841,000	45,918,000	48,314,000	47,146,000
Belgium	42,598,000	47,282,000	51,917,500	45,170,000
Denmark	9,608,500	9,842,000	13,804,400	4,790,700
Norway	12,781,700	13,352,500	12,600,400	12,739,300
Sweden	14,142,900	17,470,400	14,818,400	15,757,000
Russia	12,377,300	14,658,900	11,445,200	16,799,900
Austria	42,508,000	46,595,200	51,523,800	52,606,100
Italy	27,629,600	25,498,200	27,105,100	30,195,400
Switzerland ..	16,267,700	17,833,700	19,256,200	17,680,500
Spain, Portugal, Turkey, Greece, and Balkan States	4,000,000	4,000,000	5,000,000	5,000,000
Total	399,320,400	466,626,200	499,702,500	507,523,900
Great Britain ..	33,658,344	40,224,856	38,836,224	45,283,680
Total Europe	432,978,744	506,851,056	538,538,724	552,807,580
United States ..	174,281,000	187,237,000	208,984,000	264,161,500

TABLE A.—*Summary of detailed statements showing the supply of Coffee, &c.—cont.*

Countries.	1870.	1871.	1872.	1873.
	lb.	lb.	lb.	lb.
France	167,322,600	88,293,600	36,757,800	98,636,800
Germany	119,453,400	159,974,000	204,090,000	216,208,000
Netherlands ..	38,557,000	438,872,000	22,743,000	78,395,000
Belgium	49,368,000	51,546,000	49,020,000	49,748,000
Denmark	6,783,000	12,487,800	6,344,400	16,266,400
Norway	11,847,400	13,995,000	14,664,400	17,123,600
Sweden	17,471,500	19,245,400	17,982,800	24,695,000
Russia	15,856,600	17,716,800	16,110,500	14,740,900
Austria	58,193,300	67,612,900	70,737,400	75,503,600
Italy	27,753,000	28,847,500	27,218,900	28,511,600
Switzerland ..	14,882,500	20,641,900	16,860,300	18,444,400
Spain, Portugal, Turkey, Greece, & Balkan States	5,000,000	6,000,000	5,000,000	5,000,000
Total	532,488,300	530,222,900	487,535,400	644,273,200
Great Britain ..	35,080,624	19,343,056	7,599,312	28,908,392
Total Europe	567,568,924	549,565,956	495,135,712	673,176,592
United States ..	235,257,200	317,992,000	298,806,000	293,883,900

Countries.	1874.	1875.	1876.	1877.
	lb.	lb.	lb.	lb.
France	85,159,600	105,628,800	117,671,400	105,184,200
Germany	198,091,000	221,683,000	234,080,000	210,793,000
Netherlands ..	52,396,000	93,365,000	23,205,000	75,374,000
Belgium	41,848,000	48,162,000	58,240,000	44,849,000
Denmark	5,202,700	9,544,600	9,193,200	8,221,500
Norway	10,751,600	15,070,000	15,895,500	16,373,400
Sweden	19,853,000	21,851,000	24,738,000	23,885,700
Russia	16,467,300	18,021,000	18,021,200	10,333,400
Austria	71,689,800	69,784,000	71,944,900	74,475,700
Italy	23,529,000	29,876,100	32,720,000	27,764,000
Switzerland ..	14,497,700	20,659,300	21,924,200	17,131,600
Spain, Portugal, Turkey, Greece, & Balkan States	6,000,000	7,000,000	6,000,000	7,000,000
Total	545,485,900	660,376,200	633,633,800	621,385,500
Great Britain ..	38,415,568	72,775,840	15,327,648	55,622,128
Total Europe	583,901,468	733,152,240	648,961,448	677,007,628
United States ..	285,271,700	321,970,800	341,089,200	331,639,000

TABLE A.—*Summary of detailed statements showing the supply of Coffee, &c.—cont.*

Countries.	1878.	1879.	1880.	1881.
	lb.	lb.	lb.	lb.
France	119,031,000	125,017,200	127,012,600	142,331,000
Germany	218,713,000	248,266,000	207,284,000	229,141,000
Netherlands ..	85,209,000	52,079,000	65,975,000	73,022,000
Belgium	50,773,000	54,916,000	50,061,000	52,500,000
Denmark	8,236,700	10,705,900	9,615,700	9,000,000
Norway	13,422,000	15,903,500	15,969,400	16,725,000
Sweden	23,485,200	23,830,300	25,168,000	24,000,000
Russia	16,049,900	17,008,200	18,362,300	18,000,400
Austria	87,788,600	42,479,200	69,519,100	78,562,000
Italy	27,933,400	34,089,000	23,480,000	31,103,000
Switzerland ..	18,332,200	21,191,700	18,547,100	21,523,500
Spain, Portugal, Turkey, Greece, and Balkan States	7,000,000	8,000,000	9,000,000	10,000,000
Total	675,974,400	653,486,900	639,994,300	705,907,900
Great Britain ..	27,368,544	35,514,304	40,015,114	57,728,000
Total Europe	703,342,944	689,001,200	680,009,414	763,635,900
United States ..	309,882,000	377,848,000	446,851,000	455,190,000

"Great Britain.

"Table B has the tendency to show the difference between the relative consumption of tea and coffee. While the first-named article commands an average of 4½ lb. per head of population, the consumption of coffee is confined to a rate less than 1 lb.

"The tables marked C and D show, respectively, the imports from British possessions and foreign countries. The table marked E explains the uses of the trade, while in Table F the re-export of surplus import is illustrated.

"The total results are summarised in the table marked G, and are designed to show the actual consumption throughout Europe; while another compilation, marked H, explains the position which obtains between Europe and the United States relative to production.

" Table B.—*The consumption in Great Britain of Coffee, Cocoa, and Tea, distinguishing the number of pounds entered for home consumption on which duties have been collected.*

Years.	Coffee.	Cocoa.	Tea.
	lb.	lb.	lb.
1841	28,370,857	1,938,847	36,675,667
1842	28,519,646	2,246,569	37,355,911
1843	30,979,404	2,547,034	40,293,393
1844	31,352,332	2,589,977	41,363,770
1845	34,293,190	2,579,407	44,193,433
1846	36,754,554	2,951,206	46,740,344
1847	37,441,373	3,079,198	46,314,821
1848	37,077,646	2,919,591	48,734,789
1849	34,399,374	3,206,746	50,021,576
1850	31,161,358	3,080,641	51,179,302
1851	32,501,545	2,978,344	53,949,059
1852	34,978,432	3,228,627	54,713,054
1853	36,983,122	3,997,108	58,834,087
1854	37,350,934	4,452,529	61,953,041
1855	35,764,564	4,383,023	63,429,286
1856	34,995,944	3,634,155	63,278,212
1857	34,353,133	2,647,470	69,132,101
1858	35,208,932	2,860,034	73,195,685
1859	34,328,876	2,015,859	76,863,661
1860	35,497,960	3,230,978	76,816,394
1861	35,202,040	3,407,672	77,927,750
1862	34,451,700	3,622,433	78,793,977
1863	32,763,095	3,712,231	85,183,280
1864	31,360,450	3,862,273	88,590,235
1865	30,511,109	3,826,425	97,834,874
1866	30,630,236	4,053,133	102,265,531
1867	31,282,023	4,228,554	110,988,209
1868	30,356,818	5,115,766	106,815,262
1869	28,839,100	5,701,880	111,726,491
1870	30,330,572	6,153,983	117,551,152
1871	30,662,023	7,252,035	123,401,889
1872	31,173,555	7,771,763	127,661,360
1873	31,791,332	8,284,260	131,881,470
1874	31,249,368	8,854,690	137,279,891
1875	32,078,018	9,957,610	145,327,432
1876	32,894,400	10,399,522	149,104,194
1877	32,286,016	10,043,605	151,114,886
1878	32,835,552	9,996,290	157,396,661
1879	34,072,032	10,076,504	160,432,284
1880	31,868,480	10,566,150	158,570,842
1881	31,208,240	10,897,795	160,225,911
1882	31,178,560	11,996,850	165,079,881

"TABLE C.—*Coffee imports from British possessions.*

Years.	British East Indies.	Ceylon.	Singapore.	Mauritius.	South Africa.	Aden.	British West Indies.	British Honduras.
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
1856	4,470,928	34,969,017	550,386	..	15,082	..	2,130,784	..
1857	3,625,551	32,777,053	63,393	..	71,000	..	3,054,028	..
1858	2,831,586	43,755,163	165,523	..	11,967	853,792	2,961,443	..
1859	5,088,405	42,364,978	1,703,890	..	1,465	1,244	8,576,549	..
1860	6,035,515	59,322,797	1,527,332	..	70,168	585	2,831,010	..
1861	7,560,462	53,505,973	1,482,403	..	586,000		4,431,369	..
1862	10,470,746	55,285,723	3,547,747	..	18,000	..	3,545,405	..
1863	10,740,619	79,793,201	1,620,477	..	37,000	25	5,486,262	..
1864	17,131,620	69,011,290	1,253,020	..	48,000	68,277	2,466,488	..
1865	15,927,100	90,458,468	1,665,947	160	88,000	..	4,022,954	105,440
1866	13,096,176	81,428,370	971,524	1,353	401,213	5,355	4,514,929	166,545
1867	14,001,622	83,472,850	2,301,814	463,578	681,959	100	2,655,029	196,681
1868	23,628,887	101,929,153	3,367,006	383,766	265,100	..	6,288,987	216,942
1869	21,318,222	95,103,970	2,678,006	1,003,627	413,336	11,487	3,675,022	277,950
1870	19,523,616	97,964,944	1,670,704	195,324	418,096	36,288	7,138,096	507,808
1871	33,413,073	90,680,576	2,843,232	231,504	357,728	299,040	4,235,952	169,792
1872	29,900,080	72,664,816	1,009,568	6,384	286,608	156,800	6,607,328	295,120
1873	18,415,376	95,190,032	4,145,232	112	41,552	182,672	6,572,720	182,112
1874	22,521,184	60,644,304	3,381,840	298,480	42,896	674,464	7,556,976	445,200
1875	16,629,312	84,006,150	2,238,656	36,400	224	1,686,496	6,194,098	535,014
1876	21,703,024	56,559,104	3,640,000	224	286,832	1,081,584	7,049,854	697,088
1877	17,912,384	87,332,448	2,318,848	336	530,384	1,876,320	7,597,856	815,920
1878	19,229,264	56,678,496	1,598,640	12,320	1,060,670	1,458,776	6,336,288	561,568
1879	21,382,144	69,941,088	548,800	758,912	13,664	2,288,384	8,090,656	1,216,992
1880	25,952,080	60,452,784	3,236,688	703,248	485,072	1,540,448	7,887,376	386,288

"TABLE D.—*Coffee imports from foreign countries into Great Britain.*

Years.	Central America.	New Granada.	Venezuela.	Hayti and Saint Domingo.	Dutch West Indies.	Cuba and Porto Rico.
	lb.	lb.	lb.	lb.	lb.	lb.
1856	3,627,677	..	49,549	672,819	..	1,688
1857	4,560,555	..	233,018	553,372	..	13,222
1858	1,713,142	..	187,359	390,880	..	59,295
1859	1,715,684	..	148,905	492,561	..	608,240
1860	3,459,668	502,594	1,956	111,452	..	11,068
1861	3,232,987	65,904	458	102,835	..	19,160
1862	4,016,915	373,751	421	335,695	..	2,806
1863	3,239,149	1,574,439	785	3,469,929	..	19,934
1864	3,701,900	997,372	291,787	952,987	..	35,684
1865	5,278,604	2,580,452	44,016	1,736,213	..	383,013
1866	7,160,387	2,981,816	145,303	3,223,177	..	521,051
1867	7,302,359	4,829,459	123	1,262,111	..	270,223
1868	10,183,146	6,295,386	965	720,045	..	381,904
1869	12,649,706	3,215,396	23,276	3,013,854	..	4,068
1870	14,020,112	8,592,672	170,116	4,270,672	..	1,916,526
1871	19,544,560	2,660,448	76,608	3,448,592	..	458,192
1872	14,923,598	3,031,168	195,552	7,365,008	..	3,472
1873	23,144,640	1,888,992	1,196,720	5,555,312	..	23,296
1874	16,972,256	2,433,088	880,656	5,676,608	..	1,132,086
1875	23,629,648	1,640,352	242,144	8,654,688	2,744	739,984
1876	14,365,344	3,265,920	294,448	7,763,616	..	3,356,640
1877	25,609,808	1,330,000	220,304	3,806,544	..	659,680
1878	17,417,568	1,827,840	544,096	2,866,416	..	329,056
1879	29,179,024	2,261,952	243,926	787,360	49,280	1,752,016
1880	23,454,816	1,918,113	427,504	961,968	16,128	1,771,280

" TABLE D.—*Coffee imports from foreign countries into Great Britain—continued.*

Years.	Brazil.	Mexico.	Chili.	United States.	Manila.	Java.	Egypt.
	lb.	lb.	lb.	lb.	lb.	lb.	lb.
1856	9,126,656	..	118,394	..	..	265	90,049
1857	6,747,630	..	68	..	..	953	147,370
1858	3,145,954	..	22,714	..	..	280	2,835
1859	4,675,700	..	288	..	..	995	12,377
1860	6,236,398	..	131,766	..	89,271	92,323	468,359
1861	10,315,538	..	..	12,282	240,784	69,270	597,614
1862	13,080,877	..	..	591,807	418,957	1,472	371,605
1863	9,409,720	..	..	122,049	636,646	311	131,366
1864	8,959,025	..	..	3,562,453	81,899	262	24,827
1865	10,959,553	..	..	25,774	3,082,091	..	80,892
1866	9,261,491	..	..	1,873,561	726,978	..	375,121
1867	17,442,125	..	..	302,105	746,717	258,086	543,257
1868	15,882,501	..	..	227,169	2,067,882	791,623	560,134
1869	22,267,953	..	..	364,369	4,199,564	1,581	278,029
1870	14,057,393	..	..	902,832	1,400,326	344,978	1,060,752
1871	23,066,400	..	..	1,352,400	2,867,760	224	1,869,392
1872	17,829,840	..	..	280,832	2,437,344	672	1,825,488
1873	16,099,888	..	..	1,657,040	3,056,704	259,056	2,978,640
1874	22,413,880	..	..	1,049,216	2,632,672	1,059,296	507,248
1875	24,906,000	..	..	1,128,400	2,267,168	1,232	206,416
1876	22,912,960	1,393,840	..	3,074,512	625,856	64,064	47,040
1877	20,967,520	408,240	..	1,619,296	1,110,032	448	124,432
1878	22,537,984	163,744	..	2,892,176	343,504	4,256	95,872
1879	28,677,488	500,640	..	4,362,624	21,392	672	138,320
1880	28,946,960	307,328	..	5,246,304	524,048	2,688	160,272

"*Total imports and exports of Coffee into and from Great Britain.*

Years.	Quantities.		Values.	
	Imports.	Exports.	Imports.	Exports.
	lb.	lb.	£	£
1856	56,992,116	27,602,836	1,498,108	712,212
1857	58,892,726	15,782,710	1,720,465	466,894
1858	60,697,265	25,761,314	1,742,252	785,175
1859	65,353,030	29,586,054	1,955,592	877,295
1860	82,797,746	45,661,520	2,543,307	1,440,089
1861	83,532,425	46,800,365	2,628,776	1,461,278
1862	94,041,883	56,899,830	3,303,387	1,967,730
1863	117,354,217	70,385,233	4,153,330	2,530,684
1864	109,277,382	71,309,279	3,606,286	2,590,427
1865	137,997,440	79,884,182	4,600,887	3,249,534
1866	127,044,818	99,655,344	4,098,329	3,060,577
1867	137,729,760	94,595,904	4,362,760	3,035,267
1868	173,902,512	135,066,288	4,858,107	3,740,373
1869	173,416,320	128,152,640	4,927,805	3,644,055
1870	179,901,904	144,821,264	4,942,769	3,936,268
1871	191,992,304	172,648,896	5,394,511	4,682,332
1872	166,269,040	158,669,728	5,257,403	4,606,674
1873	183,402,576	154,499,184	7,230,351	5,822,333
1874	157,351,376	120,935,808	7,064,788	5,233,684
1875	178,049,984	135,274,944	7,513,053	5,690,117
1876	152,503,904	137,176,256	6,377,829	5,791,656
1877	180,127,584	124,506,256	7,768,928	5,200,814
1878	142,203,824	114,835,380	5,918,481	4,732,210
1879	180,251,232	144,736,928	7,089,100	5,830,092
1880	173,202,512	133,187,488	6,861,130	5,258,446
1881	137,648,396	108,163,785	4,761,369	4,081,045
1882	152,204,391	111,621,972	5,188,947	3,905,775

"*Quantities imported, exported, and retained for home consumption during each quinquennial period.*

Years.	Imports.	Exports.	Stock and consumption.
	lb.	lb.	lb.
1851–1855	294,242,740	122,662,948	177,578,587
1856–1860	324,732,883	147,394,434	174,384,835
1861–1865	542,203,407	354,278,889	164,288,394
1866–1870	791,995,304	600,291,440	151,338,749
1871–1875	877,865,728	742,028,560	156,954,294
1876–1880	828,259,056	654,442,208	163,956,970
1881	137,648,336	108,164,784	29,473,552
1882	153,324,192	(?)	(*)

* The quantity taken for home consumption in 1882, and on which duty has been paid, was 31,962,780 lb.

"REDISTRIBUTION OF IMPORTED COFFEE.

"TABLE F.—*Statement of the export of Coffee from Great Britain to other European countries showing the progress of 25 years.*

Years.	France.	Germany.	Netherlands.	Belgium.	Scandinavia.
	lb.	lb.	lb.	lb.	lb.
1856-1860	5,461,457	42,109,221	35,094,688	11,537,767	5,333,491
1861-1865	54,234,468	80,729,903	100,460,763	22,909,298	7,445,574
1866-1870	94,315,523	114,816,603	218,374,198	41,578,081	23,379,414
1871-1875	58,103,585	172,074,896	254,783,796	59,273,984	50,702,048
1876-1880	47,344,640	154,649,086	203,304,752	63,063,840	57,823,032
1881	4,762,352	26,456,220	31,840,480	8,163,680	11,292,452
1882*	..	..	..	..	..

Years.	Russia.	Italy.	Turkey, Greece, Roumania.	Austria.	Spain.
	lb.	lb.	lb.	lb.	lb.
1856-1860	15,632,142	..	..	..	..
1861-1865	27,387,748	7,880,878	11,426,438	8,282,492	..
1866-1870	38,695,490	12,871,487	14,587,430	5,707,118	..
1871-1875	48,890,688	18,107,152	25,723,152	8,233,792	2,439,472
1876-1880	29,067,024	15,099,992	20,211,743	9,415,792	2,208,528
1881	4,762,352	5,465,152	3,390,576	1,647,744	..
1882*	..	..	..	..	..

* Not yet recorded.

"THE CONSUMPTION OF COFFEE IN EUROPE.

"TABLE G.—*Statement of the average annual consumption of Coffee as supplied to the undermentioned countries, distinguishing the average total number of pounds' weight and the proportion per head of population.*

Countries.	1867 to 1871. Average of five years.	1867 to 1871. Proportion per head of population.	1872 to 1876. Average of five years.	1872 to 1876. Per head of population.	1877 to 1881. Average of five years.	1877 to 1881. Per head of population.
	lb.	lb.	lb.	lb.	lb.	lb.
France	117,058,000	3·01	88,760,000	2·47	123,715,000	3·25
Germany	140,000,000	4·87	214,818,000	5·20	222,239,000	4·94
Netherlands ..	74,807,000	13·56	67,802,400	15·50	69,045,200	16·33
Belgium	45,263,500	9·43	48,069,400	9·62	51,767,800	9·41
Norway	12,862,300	7·56	14,706,900	..	15,618,400	..
Sweden	15,931,600	4·14	20,472,700	4·99	24,011,400	5·30
Denmark	8,159,600	..	9,969,200	..	9,194,600	..
Russia	14,227,600	..	16,342,400	..	15,995,000	..
Switzerland ..	18,059,000	7·00	18,477,100	6·10	19,345,300	6·98
Italy	27,859,900	1·11	28,371,200	1·07	29,874,200	1·06
Austria-Hungary	55,303,400	1·73	71,931,900	2·00	70,578,200	1·90
Spain, Portugal, Turkey, Greece, and Balkan ..	5,000,000	..	5,800,000	..	8,200,000	..
Total	534,531,900	3·70	605,525,200	3·90	659,584,100	3·88
Great Britain ..	30,266,774	1·00	31,390,859	0·94	32,791,394	0·93
Total Europe	554,798,674	3·16	636,916,059	3·41	692,375,494	3·37
United States of America	250,726,500	7·90	307,886,360	7·69	384,283,800	7·01

"TABLE H.—*Statement showing the relative proportion of consumption of Coffee in Great Britain and other European countries compared with the United States of America.*

Countries.	1866–1870.	1871–1875.	1876–1880.
	lb.	lb.	lb.
Great Britain:			
Imports	791,995,300	877,065,728	828,289,000
Re-exports	600,291,400	742,028,560	654,442,200
Retained for consumption	191,703,900	135,037,200	173,846,800
The European countries, except Russia, Spain, Portugal, and Turkey:			
Details as per tables in round numbers	2,660,000,000	2,900,000,000	3,150,000,000
Average per annum ..	532,000,000	580,000,000	630,000,000
United States of America:			
Total import	1,253,631,700	1,539,431,800	1,921,419,000
Average per annum each five years	250,726,530	307,886,360	384,283,100

"TABLE I.—*The consumption of coffee in Europe and the United States of America, distinguishing the totals and the percentage of supply during sixteen years.*

Years.	Europe.	United States.	Total.	Proportion to Europe.	Proportion to United States.
	lb.	lb.	lb.	Per cent.	Per cent.
1866	432,978,744	174,281,000	607,279,744	71·3	28·7
1867	501,851,056	187,237,000	693,188,056	73·0	27·0
1868	358,538,724	208,984,000	747,522,724	72·0	28·0
1869	552,807,580	264,164,000	816,969,080	67·6	32·4
1870	567,568,924	235,257,500	802,826,124	70·7	29·3
1871	549,565,956	317,992,200	867,557,956	63·3	36·7
1872	495,135,700	298,806,000	793,941,700	62·0	38·0
1873	673,176,592	293,883,900	967,060,492	70·0	30·0
1874	583,901,468	285,271,700	879,173,168	67·4	32·6
1875	733,152,240	321,970,800	1,055,122,040	70·0	30·0
1876	648,961,448	341,809,200	990,050,648	65·5	34·5
1877	677,007,628	331,639,000	1,008,646,628	67·0	33·0
1878	703,342,944	309,882,300	1,014,225,144	69·3	30·5
1879	689,001,200	377,848,000	1,066,849,200	64·6	35·4
1880	680,009,400	446,851,000	1,126,860,400	60·5	39·5
1881	763,635,900	455,190,000	1,218,826,000	62·6	37·4

" Jamaica.

" TABLE J.—*Exports of Coffee from Jamaica.*

Years.	Quantity.	Value in English money.	Value in American money.
	lb.	£	Dollars.
1850	6,264,472	118,603	593,015
1851	5,594,585	102,252	511,260
1852	5,584,573	98,026	490,130
1853	4,822,651	80,519	402,595
1854	6,122,866	109,553	547,765
1855	5,666,202	96,191	480,955
1856	3,721,720	83,021	415,125
1857	6,761,075	146,162	730,810
1858	5,943,708	97,257	486,258
1859	5,055,089	91,514	457,570
1860	6,176,598	113,848	569,240
1861	6,715,500	151,061	755,305
1862	5,467,302	162,727	813,635
1863	8,184,849	177,839	889,195
1864	4,141,903	111,748	558,740
1865	6,229,712	159,499	799,995
1866	8,513,532	188,864	944,320
1867	6,264,861	172,816	864,080
1868	7,855,488	169,774	848,870
1869	5,501,887	129,984	649,920
1870	9,671,564	237,990	1,189,950
1871	5,611,245	150,301	751,505
1872	9,510,739	252,358	1,261,790
1873	7,199,144	214,055	1,070,275
1874	10,351,570	338,165	1,690,825
1875	7,136,327	219,092	1,095,460
1876	8,707,552	270,066	1,350,330
1877	9,532,887	270,960	1,354,800
1878	9,572,714	274,676	1,373,380
1879	10,833,867	249,175	1,245,875
1880	10,188,397	254,722	1,273,610

" Recapitulation.

1851–1855	27,790,877	486,541	2,432,705
1856–1860	27,658,190	531,806	1,659,030
1861–1865	30,739,266	763,374	3,816,870
1866–1870	37,807,332	899,428	4,497,140
1871–1875	39,808,425	1,173,971	5,869,855
1876–1880	48,835,917	1,219,599	6,597,995

"TABLE J.—*Exports of Coffee from Jamaica—continued.*

"Average for each year.

Years.	Quantity.	Value in English money.	Value in American money.
	lb.	£	Dollars.
1851–1855	5,558,175	97,308	486,541
1856–1860	5,531,638	106,361	531,806
1861–1865	6,147,853	152,675	763,374
1866–1870	7,561,466	179,885	899,428
1871–1875	7,961,686	234,794	1,173,911
1876–1880	9,767,183	263,920	1,319,599

"Ceylon.

"TABLE K.—*Statement of the shipment of Coffee, the produce of the island of Ceylon, distinguishing the decrease in both plantation and native produce.*

	Plantation.		Native.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	cwt.	£	cwt.	£	cwt.	Dollars.
1850	..	279,112	..	..	..	..
1851	..	350,585	..	..	..	..
1852	..	374,031	..	..	..	..
1853	..	328,972	..	..	..	..
1854	..	408,895	..	..	..	..
1855	..	506,732	..	..	..	..
1856	312,435	725,809	133,135	266,584	445,570	4,958,965
1857	431,241	1,127,299	172,204	372,837	603,415	7,500,670
1858	354,567	957,330	190,068	380,136	544,635	6,687,330
1859	411,562	1,111,221	178,436	356,872	590,000	7,340,460
1860	477,606	1,289,537	154,843	309,687	632,449	7,997,120
1861	517,499	1,397,248	132,818	265,626	650,317	8,314,370
1862	478,634	1,292,312	127,075	254,149	605,709	7,732,305
1863	670,068	1,803,186	158,517	317,034	828,585	10,631,100
1864	576,315	1,555,513	95,548	190,897	671,863	8,732,050
1865	695,934	1,874,012	233,268	468,044	929,202	11,735,280

"TABLE K.—*Statement of the shipment of Coffee, &c.—continued.*

	Plantation.		Native.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	cwt.	£	cwt.	£	cwt.	Dollars.
1866	701,189	1,901,309	195,291	390,583	896,490	11,459,460
1867	776,218	2,095,788	167,374	334,748	943,592	12,152,680
1868	784,889	2,119,202	222,590	445,181	1,007,479	12,821,915
1869	792,569	2,139,987	127,643	254,286	920,212	11,971,345
1870	921,506	2,488,082	132,524	264,923	1,054,030	13,765,025
1871	775,454	2,093,667	170,396	338,760	945,850	12,157,135
1872	582,432	1,572,468	140,623	281,246	723,055	9,268,570
1873	830,261	3,736,176	122,077	488,311	952,333	21,122,435
1874	635,983	2,683,055	97,020	341,088	733,003	15,120,715
1875	813,401	3,812,817	115,205	430,021	928,606	21,214,190
1876	586,580	2,914,573	80,585	302,194	667,165	16,083,835
1877	896,534	4,370,603	82,281	316,268	978,815	23,434,355
1878	586,917	3,026,292	46,237	164,719	633,154	15,955,055
1879	725,325	3,603,958	54,414	173,445	779,739	18,887,015
1880	611,842	2,982,938	45,753	142,650	657,595	15,641,940
1881	..	..	..	..	..	..

"Recapitulation.

Periods.	Plantation coffee.	Native coffee.	Total quantity.	Total value.
	cwt.	cwt.	cwt.	Dollars.
1856–1860	1,987,381	828,686	2,816,067	34,483,560
1861–1865	2,938,450	747,226	3,685,676	47,145,105
1866–1870	3,976,371	845,423	4,321,793	62,170,425
1871–1875	3,657,531	645,315	4,302,846	78,883,045
1876–1880	3,407,198	309,270	3,716,468	90,002,200

"Average for each year.

1856–1860	397,476	165,737	568,213	6,896,712
1861–1865	587,690	149,445	737,135	9,429,021
1866–1870	795,274	169,084	964,359	12,434,085
1871–1875	531,526	129,063	860,569	15,770,609
1876–1880	681,440	61,854	743,294	18,000,440

"British India.

"TABLE L.—*Exports of Coffee from British India.*

Years.	Quantity.	Value in English money.	Value in American money.
	lbs.	£	Dollars.
1852	8,714,500	48,307	241,537
1853	7,865,600	47,485	237,425
1854	7,737,800	109,762	548,810
1855	7,411,900	82,804	414,020
1856	9,206,100	120,201	501,005
1857	10,117,000	132,819	664,095
1858	6,123,800	99,727	498,635
1859	11,693,200	135,036	675,180
1860	14,345,800	188,532	942,660
1861	19,119,000	332,485	1,662,475
1862	21,505,100	467,991	2,339,955
1863	21,045,700	513,257	2,566,285
1864	26,752,900	657,672	3,288,360
1965	32,287,900	801,908	4,009,540
1866	34,700,200	788,102	3,940,510
1867	17,641,100	414,217	2,071,085
1868	31,812,300	761,395	3,806,975
1869	48,036,800	1,121,032	5,605,160
1870	36,493,100	870,189	4,350,945
1871	33,816,700	809,701	4,048,505
1872	56,817,200	1,380,410	6,902,050
1873	42,099,300	1,146,219	5,731,095
1874	41,118,800	1,499,498	7,497,490
1875	35,041,900	1,307,919	6,539,590
1876	41,831,900	1,633,395	8,166,693
1877	34,065,700	1,353,588	6,767,940
1878	33,446,100	1,394,638	6,973,190
1879	38,234,900	1,548,481	7,742,405
1880	40,436,900	1,633,032	8,165,160
1881	41,519,200	1,602,594	8,012,995

"Recapitulation.

1852–1856	40,935,900	408,559	2,042,775
1857–1861	61,398,800	888,599	4,442,945
1862–1866	136,291,800	3,228,930	16,149,650
1867–1871	167,800,000	3,976,534	19,882,670
1872–1876	216,909,100	6,967,441	34,837,205
1877–1881	187,697,600	7,532,343	37,661,690

"TABLE L.—*Exports of Coffee from British India—continued.*

"Average for each year.

Years.	Quantity.	Value in English money.	Value in American money.
	lb.	£	Dollars.
1852–1856	8,187,180	..	408,555
1857–1861	12,379,760	..	885,589
1862–1866	27,258,360	..	3,229,930
1867–1871	33,560,000	..	6,976,534
1872–1876	43,381,820	..	7,532,343
1877–1880	37,539,520	..	..

"The United States.

"TABLE M.—*Imports of Coffee into the United States.*

Years.	Quantities.	Value.
	lb.	Dollars.
1866	174,281,000	19,729,281
1867	187,237,000	20,696,259
1868	248,984,000	25,288,451
1869	264,161,500	24,531,743
1870	235,257,200	24,234,879
1871	317,992,000	30,992,869
1872	298,806,000	37,942,225
1873	293,293,000	44,103,814
1874	285,271,700	55,040,965
1875	321,970,800	50,591,488
1876	340,089,000	56,788,997
1877	331,639,000	53,634,991
1878	309,882,000	51,914,000
1879	377,848,000	47,357,000
1880	446,851,000	60,361,000
1881	455,190,000	56,784,000

"Recapitulation.

1867–1871	1,253,631,700	125,744,201
1872–1876	1,539,431,800	244,467,484
1877–1881	1,921,419,000	270,050,991

"TABLE M.—*Imports of Coffee into the United States—continued.*

" Average during each year.

Years.	Quantities.	Value.
	lb.	Dollars.
1867–1871	250,726,530	125,744,201
1872–1876	307,886,360	244,467,484
1877–1881	384,283,800	270,050,991

" Average percentage per head of population.

	lb.	Cents.
1867–1871	7·90	3·30·9
1872–1876	7·69	6·11·2
1877–1881	7·01	5·40·0

" France.

" The fluctuations in regard to the consumption of coffee have been somewhat violent in consequence of the war, but now the old rate per capita has again been resumed, namely, a fraction over 3 lb.

" TABLE No. 1.—*Imports of Coffee into France for home consumption.*

Years.	Quantities.		Values.	
	Kilograms.	lb.	Francs.	Dollars.
1861	37,580,000	82,676,000	68,200,000	13,640,000
1862	27,791,000	83,140,200	76,000,000	16,200,000
1863	39,701,000	87,392,000	79,800,000	15,960,000
1864	40,457,000	89,005,000	83,400,000	16,680,000
1865	43,501,000	95,703,200	85,400,000	17,080,000
1866	44,841,000	98,650,000	79,100,000	15,520,000
1867	47,261,000	103,985,000	71,600,000	14,320,000
1868	52,303,000	115,066,600	73,900,000	14,780,000
1869	50,328,000	110,721,600	73,700,000	14,740,000
1870	76,010,000	167,223,600	105,000,000	23,000,000
1871	40,129,000	88,293,800	64,700,000	12,940,000
1872	16,708,000	36,757,000	31,400,000	6,280,000
1873	44,834,000	98,686,000	99,500,000	19,909,000
1874	38,709,000	85,159,000	88,256,000	17,651,000
1875	48,013,000	105,628,000	105,159,000	21,029,000
1876	53,487,000	117,671,000	108,000,000	21,600,000
1877	47,811,000	105,184,000	99,000,000	19,600,000
1878	54,105,000	119,031,000	101,176,000	20,235,000
1879	56,526,000	125,017,000	101,150,000	20,230,000
1880	57,733,000	127,012,000	97,569,000	19,513,800
1881	64,696,000	142,331,000	97,691,000	19,338,200

"TABLE No. 1.—*Imports of Coffee in France, &c.—continued.*

"Recapitulation.

Years.	Quantities.		Values.	
	Kilograms.	lb.	Francs.	Dollars.
1861–1866	..	453,840,000	..	80,744,000
1867–1871	..	585,290,000	..	79,780,000
1872–1876	..	443,822,000	..	86,461,000
1877–1881	..	618,576,000	..	97,317,000

"Average for each year.

1861–1866	..	90,768,000	..	16,140,800
1867–1871	..	117,058,000	..	15,956,000
1872–1876	..	88,764,000	..	17,292,200
1877–1881	..	123,715,000	..	19,863,400

"Proportion per head of population.

				Cents.
1861–1866	..	2·42	..	43·15
1867–1871	..	3·01	..	43·84
1872–1876	..	2·47	..	48·01
1877–1881	..	3·25	..	52·10

"Germany.

"There are no statistics available prior to the date of the present empire. As the free city of Hamburg is the central depot for the coffee trade of Germany and Central Europe, a special table of her imports is given. Despite competition, caused by increased railway facilities between other shipping ports along the North Sea, Hamburg has not only held her former position, but has considerably augmented her operations in coffee, chiefly with Brazil and some of the West Indian possessions.

" *Imports of Coffee into Germany for domestic use.*

Years.	Quantities.		Values.	
	Centners.	lb.	Marks.	Dollars.
1872	1,855,367	204,090,000	136,500,000	34,125,000
1873	1,965,261	216,178,700	177,000,000	44,250,000
1874	1,800,830	198,091,300	167,400,000	41,850,000
1875	2,015,000	221,650,000	199,000,000	49,750,000
1876	2,128,000	234,080,000	192,000,000	48,000,000
1877	1,916,300	210,793,000	172,000,000	43,000,000
1878	1,988,300	218,713,000	169,000,000	42,250,000
1879	2,229,700	245,267,000	190,000,000	47,500,000
1880	1,884,400	207,284,000	159,750,000	37,687,500
1881	2,083,100	229,141,000	135,400,000	33,850,000

" Recapitulation.

	lb.	Dollars.
1872–1876	1,074,090,000	217,975,000
1877–1881	1,111,198,000	204,287,000

" Average for each year.

	lb.	Dollars.
1872–1876	214,818,000	43,595,000
1877–1881	202,239,600	40,857,400

" Proportion per head of population.

	lb.	Cents.
1872–1876	5·24	106·2
1877–1881	4·94	90·9

"Table No. 2.—*Imports of Coffee into Hamburg.*

Years.	Quantities.		Values.	
	Centners.	lb.	Marks.	Dollars.
1866	826,961	90,915,700	50,355,000	12,571,000
1867	1,092,612	120,187,300	59,553,000	14,888,250
1868	1,262,277	138,851,700	60,891,000	15,222,750
1869	1,353,807	148,918,000	70,050,000	17,512,500
1870	1,085,948	119,453,400	54,606,000	13,651,500
1871	1,454,309	159,974,000	81,264,000	20,316,000
1872	1,276,325	140,393,000	93,320,000	23,330,000
1873	1,595,678	175,524,000	141,524,000	35,381,000
1874	1,563,000	171,930,000	145,416,000	36,354,000
1875	1,737,000	191,070,000	156,897,000	39,224,250
1876	1,761,000	193,710,000	140,650,000	36,662,500
1877	1,825,000	201,850,000	157,938,000	39,434,500
1878	1,881,000	206,910,000	140,512,000	35,128,000
1879	2,052,000	225,720,000	139,751,000	34,437,500
1880	2,027,000	222,970,000	145,066,000	36,266,500
1881	2,338,000	357,180,000	145,492,000	36,373,000

"Recapitulation.

	lb.	Dollars.
1867–1871	673,384,400	81,591,000
1872–1876	872,627,000	170,951,000
1877–1881	1,114,630,000	182,189,000

"Average for each year.

1867–1871	134,671,658	16,318,200
1872–1876	174,525,400	34,190,200
1877–1881	222,926,000	36,437,800

"Netherlands.

"The tables distinguish the values and quantities respectively of imports and exports and the stock available for consumption. The estimate per capita must be taken with some degree of consideration. It has not really gone into consumption, but large quantities are kept in bond at the disposal of speculators. Nevertheless, as the inhabitants are interested in the coffee trade of Java, there is comparatively a larger quantity consumed than in other European countries.

" *Import and export of Coffee, Netherlands.*

Years.	Import.	Export.	Stock and consumption.	
	Kilograms.	Kilograms.	Kilograms.	lb.
1863	69,885,000	56,141,000	13,745,000	..
1864	82,043,000	66,919,000	15,129,000	..
1865	78,061,000	70,683,000	7,376,000	..
1866	85,097,000	72,442,000	12,655,000	..
1867	91,954,000	71,088,000	20,873,000	45,918,000
1868	96,584,000	74,623,000	21,961,000	48,314,000
1869	86,863,000	64,933,000	21,430,000	47,146,000
1870	97,110,000	79,584,000	17,526,000	38,557,000
1871	103,754,000	83,813,000	19,942,000	43,872,000
1872	78,870,000	68,532,000	10,538,000	22,746,400
1873	104,892,000	68,803,000	36,089,000	79,395,600
1874	83,958,000	60,187,000	23,771,000	52,296,800
1875	110,037,000	67,598,000	42,439,000	93,365,200
1876	84,540,000	73,992,000	10,548,000	23,205,800
1877	110,620,000	76,368,000	34,261,000	75,374,200
1878	93,465,000	68,373,000	25,945,000	55,202,900
1879	95,935,000	69,990,000	25,092,000	52,079,000
1880	96,583,000	66,594,000	29,989,000	65,975,800
1881	94,094,000	61,902,000	32,192,000	73,022,400

" Recapitulation.

	Export.	Stock and consumption.
	Kilograms.	lb.
1867–1871	374,035,000	223,807,000
1872–1876	339,012,000	271,010,000
1877–1881	345,237,000	326,654,000

" Proportion of supply per capita.

1867–1871	..	13·56
1872–1876	..	15·50
1877–1881	..	16·33

"TABLE No. 3.—*Imports of Coffee into the Netherlands, by value.*

Years.	Imports.	Exports.	Stock and consumption.	
	Florins.	Florins.	Florins.	Dollars.
1872	34,703,000	30,154,000	4,549,000	18,955,000
1873	46,153,000	30,273,000	15,880,000	66,165,000
1874	36,941,000	26,482,000	10,459,000	43,575,000
1875	48,416,000	29,743,000	18,673,000	77,805,000
1876	37,198,000	32,557,000	4,641,000	19,385,000
1877	48,677,000	33,602,000	15,075,000	62,810,000
1878	41,125,000	30,084,000	11,041,000	46,005,000
1879	42,211,000	30,796,000	11,415,000	47,562,000
1880	42,497,000	29,301,000	13,196,000	54,993,000
1881	41,401,000	27,237,000	14,164,000	59,010,000

"Recapitulation.

1872–1876	..	149,209,000	..	225,845,000
1877-1881	..	151,030,000	..	270,380,000

"Average during each of the five years.

1872–1876	..	29,841,800	..	45,169,000
1877–1881	..	30,206,000	..	54,076,000

1872–1876 :—Proportion of money value, $12·54.
1877–1881 :—Expended on coffee per capita, $13·54.

"Belgium.

"This country has a large consumption of coffee. Still, the rate per capita is not necessarily used by the inhabitants, as the border localities of Germany, France, and Holland are largely supplied by the Belgian grocers.

" TABLE No. 4.—*Imports of Coffee into Belgium for domestic use.*

Years.	Quantities.		Values.	
	Kilograms.	lb.	Francs.	Dollars.
1863	..	..	..	..
1864	..	..	..	..
1865	..	..	..	..
1866	19,354,000	42,578,800	33,038,000	6,607,600
1867	21,492,000	47,382,400	36,609,000	7,321,800
1868	23,599,000	51,917,800	32,178,000	6,435,600
1869	20,532,000	45,170,400	27,918,000	5,583,600
1870	22,440,000	49,368,000	31,174,000	6,234,800
1871	23,430,000	51,546,000	38,336,000	7,667,200
1872	22,282,000	49,020,000	42,642,000	8,528,400
1873	22,623,000	49,770,000	54,214,000	10,842,800
1874	19,022,000	41,848,000	45,183,000	9,036,600
1875	21,822,000	48,162,000	53,681,000	10,736,200
1876	26,473,000	58,240,000	61,516,000	12,303,200
1877	20,386,000	44,849,000	48,835,000	9,767,400
1878	23,079,000	50,773,000	48,143,000	9,628,600
1879	24,962,000	54,916,000	45,097,000	9,019,400
1880	22,755,000	50,061,000	45,323,000	9,064,600
1881	23,864,000	52,500,000	43,576,000	8,715,200

" Recapitulation.

1866–1870	107,417,000	226,317,400	161,917,000	32,383,400
1871–1875	109,247,000	240,347,000	234,056,000	46,811,200
1876–1880	117,655,000	258,839,000	248,914,000	49,782,800

" Average total for each year.

1866–1870	21,483,400	45,263,500	32,383,400	6,476,680
1871–1875	21,849,400	48,069,400	46,811,200	9,362,240
1876–1880	23,531,000	51,767,800	49,782,800	9,956,560

" Proportion per cent. per head of population.

Years.	Quantities.	
	Kilograms.	lb.
1866–1870	..	9·430
1871–1875	..	9·620
1876–1880	..	9·410

"Denmark.

"There are no statistics issued in Denmark stating the values of imports. There is a small export trade from Denmark, probably confined to the colonies in the Arctic regions. The *pro rata* consumption is larger in Denmark in sympathy with all Scandinavian states than elsewhere on the continent of Europe.

"TABLE No. 5.—*Imports and exports of Coffee, Denmark.*
[Quantities only.]

Years.	Imports.	Exports.	Stock and consumption.
	lb.	lb.	lb.
1866	14,998,577	5,770,077	8,728,500
1867	14,299,123	5,290,690	8,998,154
1868	17,035,055	4,483,825	12,549,350
1869	10,080,170	5,724,968	4,350,202
1870	13,425,885	7,258,920	6,166,965
1871	13,281,400	5,993,559	12,487,841
1872	14,866,000	7,671,639	6,344,361
1873	23,668,000	7,401,679	16,266,321
1874	14,354,500	9,151,786	5,202,714
1875	15,907,100	6,362,384	9,544,716
1876	15,966,500	6,767,341	9,193,159
1877	15,122,900	6,901,378	8,221,585
1878	13,162,038	4,925,262	8,236,776
1879	14,738,400	4,032,428	10,705,999
1880	13,264,126	3,648,398	9,615,728

"Recapitulation.

1866–1870	69,336,810	..	..
1871–1875	86,227,000	31,381,000	49,845,900
1876–1880	72,247,000	26,274,800	45,973,200

"Average for each year.

1866–1870	13,867,300	..	..
1871–1875	17,245,400	6,276,200	9,969,200
1876–1880	14,459,400	5,254,500	9,194,600

1871–1875: 6·16 lb. per head of population.
1876–1880: 5·25 lb. per head of population.

"Norway.

"TABLE No. 6.—*Imports of Coffee into Norway for domestic use.*

Years.	Quantities.		Values.	
	Centners.	lb.	Kroner.	Dollars.
1863	108,926	..	..	..
1864	86,107	..	..	..
1865	109,672	..	..	..
1866	116,197	..	..	..
1867	122,491	13,352,500	..	..
1868	115,594	12,600,400	..	..
1869	107,701	11,739,300	..	..
1870	115,855	12,627,400	..	..
1871	128,381	13,995,000	..	..
1872	124,536	14,664,400	9,509,000	2,641,950
1873	157,465	17,123,600	12,597,000	3,493,510
1874	89,786	10,751,600	8,493,000	2,414,500
	Kilograms.			
1875	6,850,000	15,070,000	11,752,000	3,172,750
1876	7,225,000	15,895,000	11,532,000	2,204,350
1877	7,392,000	16,273,000	12,575,000	3,493,050
1878	6,101,000	13,422,000	8,663,000	2,406,400
1879	7,229,000	15,903,500	9,398,000	2,610,555
1880	7,167,000	16,767,400	8,815,000	2,448,600
1881	7,603,000	16,725,600	7,983,000	2,217,500

"Recapitulation.

1867–1871	..	64,313	..	..
1872–1876	..	72,706	..	14,927,080
1877–1881	..	78,091	..	13,176,700

"Average of year.

1867–1871	..	12,862,300	..	..
1872–1876	..	14,706,920	..	2,985,412
1877–1881	..	15,618,380	..	2,652,734

		Per Capita.		Per Capita.
1867–1871	..	7·56	..	..
1872–1876	..	8·17	..	160 cents.
1877–1881	..	8·21	..	139 ,,

"Sweden.

"TABLE 7.—*Imports of Coffee into Sweden for domestic use.*

Years.	Quantities.		Values.	
	Skalpund.	lb.	Kroner.	Dollars.
1866	15,207,400	14,142,900	..	..
1867	18,677,700	17,470,400	..	..
1868	15,933,400	14,818,400	..	..
1869	16,983,100	15,757,000	..	..
1870	18,611,300	17,471,500	..	..
1871	21,693,700	19,245,400	10,553,000	2,932,100
1872	19,336,000	17,982,800	11,214,000	3,115,000
1873	26,555,200	24,695,500	20,447,000	5,680,000
1874	21,455,900	19,853,300	15,018,000	4,170,800
1875	23,337,000	21,586,800	17,502,000	4,861,550
1876	26,600,800	24,738,000	18,620,000	5,167,000
1877	25,439,200	23,885,700	16,535,000	4,591,600
1878	24,920,400	23,485,200	14,952,000	4,153,300
1879	24,235,900	23,830,300	14,056,000	3,404,500
1880	21,604,700	25,168,000	14,367,000	3,999,100

"Recapitulation.

Years.	Total for consumption.	Valued at—
	lb.	Dollars.
1866–1870	79,659,200	..
1871–1875	102,363,400	20,759,500
1876–1880	120,057,200	21,807,300

"Average of each year.

1866–1870	15,931,840	..
1871–1875	20,472,680	4,151,900
1876–1880	24,011,400	5,361,400

"The proportion calculated per head has been therefore as follows:

1866–1870, average of each year, 4·14 lb. per capita .. ..
1871–1875, „ „ 4·99 „ „ .. 109·3 cents.
1876–1880, „ „ 5·33 „ „ .. 119·0 „

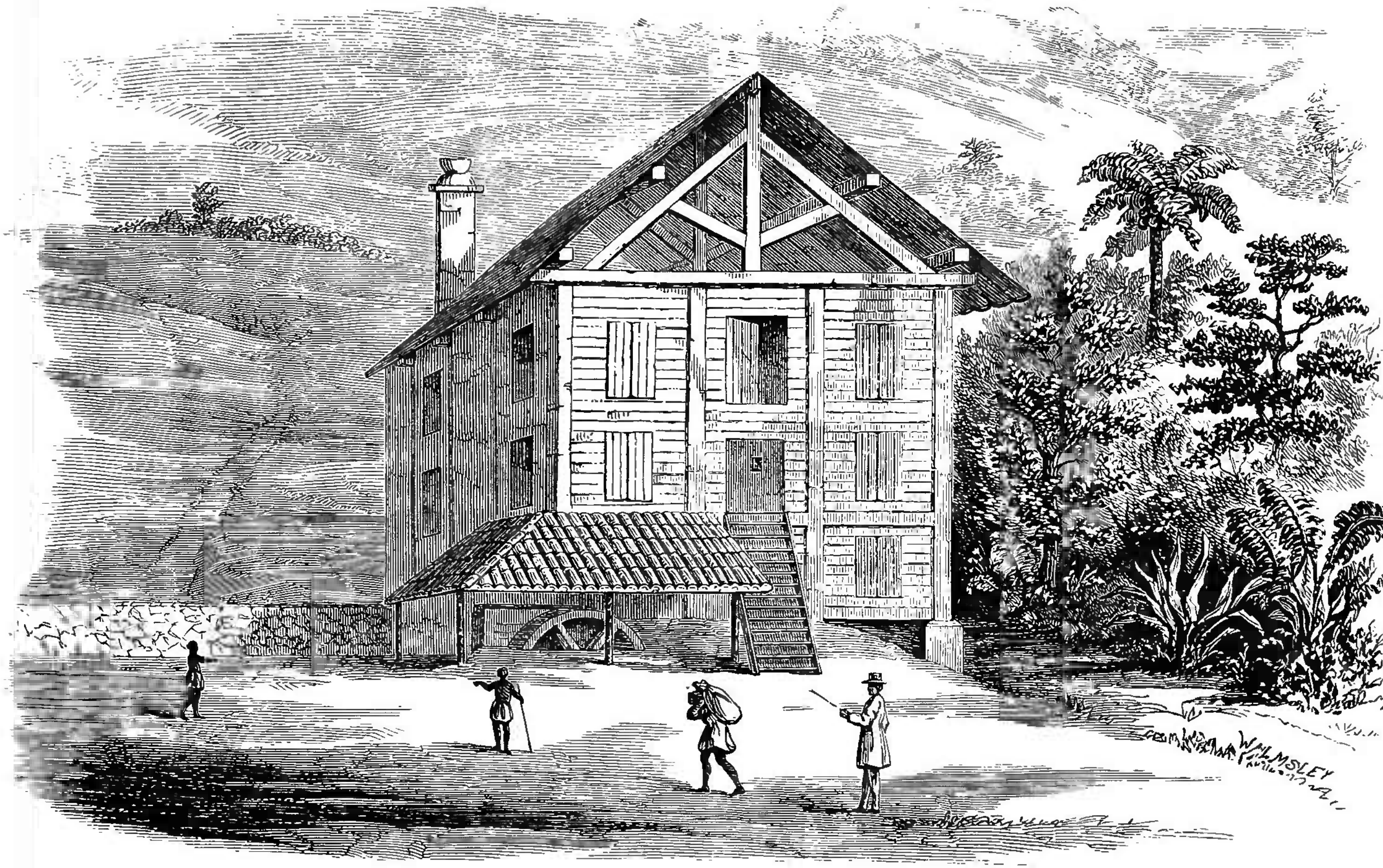


PLATE IX.—EXTERIOR VIEW OF PULPING HOUSE, CEYLON.

[*To face p.* 144.

"Russia.

"No calculations can be made in regard to consumption, there being probably few coffee-drinkers outside the greater cities, as Moscow, Riga, and others, in addition to St. Petersburg. The pood is taken at 36 lb. avoirdupois. The rouble value varies, but as the customs dues are paid in gold there is no criterion for a proper comparison with other countries.

"TABLE NO. 8.—*Imports of Coffee into Russia for domestic use.*

Years.	Quantities.		Values.	
	Poods.	lb.	Roubles.	Dollars.
1866	343,815	12,377,340	3,781,977	598,813
1867	407,193	14,658,948	4,479,128	708,778
1868	317,928	11,445,308	3,497,195	554,223
1869	466,664	16,799,904	5,133,297	812,770
1870	440,461	15,856,596	4,845,082	767,137
1871	492,132	17,716,752	5,413,458	857,630
1872	447,680	16,116,480	4,970,866	787,054
1873	409,470	14,740,920	5,034,264	796,793
1874	443,065	16,670,340	5,415,598	857,465
1875	457,396	16,467,256	5,638,110	892,703
1876	500,589	18,021,200	5,617,074	889,370
1877	287,038	10,333,368	3,211,317	508,858
1878	447,227	16,049,956	5,704,782	903,265
1879	472,448	17,008,128	6,840,401	1,083,610
1880	510,064	18,362,304	7,129,000	1,125,750

"Recapitulation.

	lb.
1866–1870	71,138,096
1871–1875	81,711,048
1876–1880	79,974,956

"Average of each year.

	lb.
1866–1870	14,227,619
1871–1875	16,322,349
1876–1880	15,953,390

"Austria-Hungary.

"The Austrian capital, Vienna, enjoys a great reputation in supplying most excellent coffee. The country is provided mostly with Java coffee from Amsterdam. Latterly Trieste has paid more attention to imports from Brazil, but the development of railroads favours the competition of German ports, notably Hamburg. Again there is an increased consumption of chicory, largely imported from Germany, but this drug is likely to be placed on the shelf, since strenuous efforts are made to cultivate a trade with South American states, whither large exports of Hungarian flour are shipped, despite that a nearer supply could be had from the United States.

"Population, 38,500,000 in 1880, against 31,000,000 in 1865.

"TABLE No. 9.—*Imports of Coffee into Austria-Hungary for home use.*

Years.	Quantities.		Values.	
	Metric Centners.	lb.	Gulden.	Dollars.
1867	211,705	46,595,200	16,130,000	8,065,000
1868	234,199	51,523,200	14,681,000	7,365,500
1869	239,164	52,606,100	17,707,000	8,858,500
1870	264,515	58,193,300	17,859,000	8,929,500
1871	307,355	67,612,900	19,575,000	9,787,500
1872	321,531	70,737,400	23,468,000	11,734,000
1873	343,199	75,503,600	24,889,000	12,444,500
1874	327,859	71,689,800	23,250,000	11,625,000
1875	317,201	69,784,000	34,904,000	17,450,000
1876	327,022	71,944,900	35,976,000	17,988,000
1877	338,526	74,475,700	37,240,000	18,620,000
1878	399,040	87,788,800	37,911,000	18,955,000
1879	193,087	42,499,200	17,378,000	8,689,000
1880	215,996	69,519,100	27,801,000	13,900,500
1881	357,100	78,567,000	30,997,000	15,498,000

"Recapitulation.

1867–1871	1,256,908	276,516,900	86,412,000	43,206,000
1872–1876	1,636,800	359,659,700	142,484,000	71,242,000
1877–1881	1,604,700	352,880,800	151,327,000	75,663,500

"TABLE NO. 9.—*Imports of Coffee into Austria-Hungary, &c.—continued.*

"Average total during each year.

Years.	Quantities.		Values.	
	Metric Centners.	lb.	Gulden.	Dollars.
1867–1871	..	55,303,380	..	8,641,200
1872–1876	..	71,931,940	..	14,248,400
1877–1881	..	70,578,160	..	15,132,700

"Proportion per cent. per head of population.

				Cents.
1867–1871	..	1,728	..	27·0
1872–1876	..	2,000	..	39·6
1877–1881	..	1,900	..	39·3

"Italy.

"The consumption of coffee is limited to a fraction over one pound per head of population. The shipments, however, show a fair increase, commensurate with influx of population and the changes brought since specie payment was resumed. The population has increased from 22,000,000 in 1865 to 28,400,000 in 1881.

"TABLE NO. 10.—*Imports of Coffee into Italy for domestic use.*

Years.	Quantities.		Values.	
	Kilograms.	lb.	Lire.	Dollars.
1863	10,842,000	..	..	..
1864	14,642,000	..	..	..
1865	7,577,000	..	..	..
1866	12,559,000	..	..	..
1867	11,590,091	25,498,200	20,398,200	4,079,620
1868	12,320,815	27,105,800	21,684,900	4,336,980
1869	13,679,731	30,195,400	22,316,400	4,463,280
1870	12,615,023	27,753,000	22,262,800	4,452,560
1871	13,112,400	28,847,500	23,077,200	4,613,120
1872	12,372,200	27,218,000	24,125,900	4,825,180

"TABLE No. 10.—*Imports of Coffee into Italy, &c.—continued.*

Years.	Quantities.		Values.	
	Kilograms.	lb.	Lire.	Dollars.
1873	12,959,800	28,511,000	32,399,000	6,479,800
1874	10,695,000	23,529,000	27,806,000	5,561,200
1875	13,580,000	29,876,000	33,949,000	6,789,800
1876	14,873,000	32,720,000	32,721,000	6,546,200
1877	12,620,000	27,764,000	29,329,000	5,865,800
1878	12,697,000	27,933,000	27,398,000	5,479,400
1879	15,495,000	34,089,400	33,314,000	6,662,800
1880	10,673,000	23,480,000	32,947,000	6,589,400
1881	14,135,000	31,103,000	26,863,000	5,372,600

" Recapitulation.

1867–1871	63,318,400	139,299,900	109,740,100	21,948,140
1872–1876	64,480,000	141,855,500	151,851,900	30,200,018
1877–1881	65,623,000	149,370,700	149,591,000	29,970,200

"Average total during each year.

1867–1871	12,663,600	27,859,900	21,948,000	4,389,628
1872–1876	12,896,000	28,371,200	30,370,380	6,040,000
1877–1881	13,124,600	29,874,200	29,918,200	5,999,404

" Proportion per cent. per head of population.

				Cents.
1867–1871	..	1·11	..	17·5
1872–1876	..	1·07	..	21·0
1877–1881	..	1·06	..	21·2

" Switzerland.

" The customs returns give the imports in quantities only without reference to a declared value. The metric centner is equal to 220 lb. avoirdupois. Supply and consumption fluctuate according to the change in season and consequent influx of visits of strangers.

TABLE No. 11.—*Imports of Coffee into Switzerland for domestic use.*

[No returns of values published.]

Years.	Metric Centners.	lb.
1865	75,132	..
1866	73,944	..
1867	81,063	17,833,750
1868	87,528	19,256,160
1869	80,361	17,680,520
1870	67,648	14,882,560
1871	93,827	20,641,940
1872	76,651	16,860,320
1873	83,838	18,444,360
1874	65,892	14,497,780
1875	93,902	20,659,320
1876	99,655	21,924,200
1877	77,871	17,131,600
1878	83,329	18,332,200
1879	96,325	21,191,700
1880	84,305	18,547,100
1881	97,834	21,523,500

"Recapitulation.

	lb.
1867–1871	90,294,940
1872–1876	92,383,480
1877–1881	96,726,100

"Average of each year.

1867–1871	18,058,988
1872–1876	18,477,096
1877–1881	19,345,220

"Proportion per cent. of per capita.

1867–1871	7·20
1872–1876	7·10
1877–1881	6·98

"Portugal.

"The port of Lisbon has, during late years, made some progress and established a coffee market. The imports from Portuguese settlements in Africa are now on a somewhat larger scale, and enabled a re-export, as shown in the table marked B. These exports comprise about 50 per cent. of the total of Portuguese imports from Africa, while the remaining 50 per cent. are retained for home consumption. In addition thereto a small quantity is imported from Brazil, and European ports, the total of which is enumerated in the table marked B. The quantities show the weight on which duty has been paid, and consequently leave to infer that the consumption per capita is now a fraction over 1 lb., the population of Portugal numbering 4,300,000.

"TABLE No. 12.—*Imports of Coffee into Portugal for domestic use.*

Years.	Kilograms.	Milreis.	lb.	Dollars.
1871	892,691	495,692	1,962,876	550,217
1872	1,576,227	380,828	3,465,704	422,567
1873	1,582,414	491,290	3,181,310	545,831
1874	1,547,741	520,064	3,405,030	577,270
1875	1,691,107	518,184	3,720,424	575,186
1876	1,776,906	531,268	3,909,312	595,706
1877	1,702,271	511,443	3,744,996	567,701
1878	2,074,896	278,863	4,564,771	309,537
1879	2,097,699	535,719	4,614,940	594,647
1880	1,919,295	473,879	4,222,450	526,004
1881	2,096,487	489,004	4,601,127	542,792

"Recapitulation.

1872–1876	..	..	17,981,776	2,716,560
1877–1881	..	..	21,718,284	2,540,681

"Average of each year.

1872–1876	..	..	2,596,355	543,312
1877–1881	..	..	4,349,657	508,136

"Proportion per head of population.

1872–1876 .. .. 0·90 lb. per capita.
1877–1881 .. .. 1·10 " "

"*Re-export of produce of Portuguese possessions in Africa.*

Years.	Kilograms.	Milreis.	lb.	Dollars.
1861	52,808	12,628,000	115,739	14,017
1865	739,419	141,891,900	1,626,721	157,498
1866	634,513	144,109,800	1,395,938	160,810
1867	759,443	166,954,000	1,666,379	185,318
1868	1,006,938	193,370,000	2,215,263	214,840
1869	1,533,612	273,323,000	2,372,046	263,296
1870	443,185	30,843,000	975,007	34,235
1871	1,627,749	318,900,000	3,581,000	358,760
1872	1,971,253	492,485,000	4,347,600	554,060
1873	1,938,210	561,769,000	4,264,100	631,915
1874	2,730,945	801,719,000	6,000,848	901,590
1875	2,597,110	582,162,000	5,713,620	654,860
1876	1,661,785	894,807,000	3,655,960	555,750
1877	2,089,292	626,813,000	4,596,460	705,150
1878	1,067,500	324,731,000	2,348,500	365,290
1879	1,230,080	369,978,000	2,706,200	415,125
1880	1,905,559	506,046,000	4,192,300	569,250
1881	1,062,099	259,223,000	2,363,600	300,200

" Recapitulation.

1867–1871	5,370,929	..	10,809,700	1,056,450
1872–1876	10,899,303	..	23,982,100	3,298,175
1877–1881	7,354,440	..	16,206,060	2,355,015

" Average each year.

1867–1871	..	..	2,161,940	213,290
1872–1876	..	..	4,786,420	659,635
1877–1881	..	..	3,241,212	471,003

The following report by Henry Pasteur, on the coffees shown at the Indian and Colonial Exhibition, published in the Planters' Gazette, June 1st, 1887, is full of interest.

" The total production of coffee in the world is roughly estimated at about 600,000 tons to 650,000 tons, of which Brazil alone produces between 340,000 and 380,000 tons and Java 60,000 tons to 90,000 tons, the proportion of British-grown coffee being only about 35,000 tons, of which India contributes 15,000 to 18,000 tons, Ceylon 10,000 to 12,000 tons, and Jamaica 4000 to 5000. Although numerically very small, the productions of our Colonies and of India occupy the front rank, owing to their excellence. Nowhere is finer coffee grown than in India and Jamaica, and its value, as well as that of Ceylon, is firmly established above that of all other kinds, even of Mocha, which at one time stood above all others.

"A considerable amount of work and preparation has to be expended on coffee, from the moment it is picked from the trees until it is in a fit state to be sent to market. The berries, as may be seen from the numerous samples exhibited at South Kensington, are enveloped in an outer, coarse, thick, fleshy substance, the cherry, and an inner loose envelope of thin, hard skin, called parchment, from its resemblance to that substance. When allowed to grow to complete maturity on the trees, as in the case of Mocha, the cherry withers and dries, and is then easily removed by crushing or pounding, the berry inside having by that time become of a pale greenish or yellowish colour. The usual course, however, is to pick the cherry before complete maturity, when it is of a deep red or cherry colour, the berry inside being then found to be of a fine dark green or bluish-green, which it is the endeavour of the planter to preserve as carefully as possible, the value of his coffee depending chiefly on the depth and brightness of the colour.

"On gardens and plantations cultivated by Europeans, the cherry is removed as quickly as possible after being picked, being put through pulpers, and undergoing a very careful and delicate process of mashing and washing, until the berries are left with their parchment envelope perfectly clean. In many cases, however, there are neither appliances, nor time or labour, to put the fresh gathered fruit through this process, and under a tropical sun the cherry dries quickly, and has then to be pounded, to the great detriment of the colour, as well as the quality of the bean; hence the difference betweed *unwashed* or ordinary pale, and *washed* or coloured or plantation coffee, the taste of the *washed* coffee being, as a rule, much more delicate, and free from the earthiness and common rough flavour of the *unwashed*. A large portion of the crops from Brazil, Java, St. Domingo, to a less extent Central America and Guatemala, in fact fully three-fourths of the world's production, are prepared as *unwashed* or pale coffee; whilst nearly the whole of the Ceylon crop, three-fourths of the Indian, and one-fourth to one-third of the Java, are prepared as *washed* or green coffee. The clean parchment has to be dried with the utmost care, and taken to the curing mills on or near the estate, or more generally at the port of shipment; it is then put through the peelers, which break the parchment, and remove as much as possible of the thin silver-skin adherent to the bean itself; then through sizers, which divide the berries into the various sizes, and after being handpicked by a number of women and children, who remove the defective, broken, black, or light beans, the coffee is ready for packing in bags or casks for shipment. All those various operations require to be carried out with the utmost care and nicety, the slightest neglect or mistake in any one of them being liable to injure the quality to the extent of 5, 10, or even 20 per cent.

"The above remarks, to some extent, explain the reasons for the superiority of British-grown coffee over that of most other countries, and also the great variety existing in the appearance, quality, and value of the sample, exhibited by our various colonies and dependencies.

"India.—India now stands first and foremost amongst British possessions, both for the quantity and quality of its production. The samples prepared by the Indian Coffee Planters' Committee have been carefully selected in London from the earlier arrivals of the crop of 1885–6, and represent the produce of British plantations in the four chief districts of Mysore, Coorg, Neilgherry and Wynaad, as well as the less important one of Travancore. The exhibits from the first-named districts are remarkable for their high average excellence, and for the presence of many of the points which, in the eyes of connoisseurs, constitute the nearest approach to perfection, viz. size, colour, smoothness, plumpness, and weight of the berries. These coffees have always been, and are likely to continue, in high favour with the buyers for home consumption. Next to them come the Wynaad exhibits, which, if they lack some of the weight and fine shape of the others, are nearly equal in size, colour, and smoothness, and find favour with home as well as export buyers. Travancore is a comparatively new district where plantations are generally at a lower elevation; it has suffered much of late years from repeated attacks of leaf-disease, which has destroyed many estates and weakened the trees on most others, and the result is seen in a small crop, deficient in colour, size, and quality. Leaf-disease has likewise been raging in the other districts of India, to the serious detriment of crops, both in extent and quality; fortunately the severity of its attacks has greatly diminished during the past few years, and it has almost disappeared in many parts of the country. It has, however, in many places affected the vitality and shaken the strength of the trees, so that they have been less able to resist periods of drought or of heavy monsoon weather, and small and irregular crops have been the consequence. It would seem, however, as if plantations were gradually recovering their former strength, and with good cultivation and manuring and fair seasons India may hope to maintain its position as our largest and best field for the production of fine coffee. A hopeful sign for the future may be gathered from the superior average quality of the crop of 1885–6 over that of the two or three previous ones.

"Among the samples of Wynaad coffee, those from the Eva Estate deserve special attention, one half of that crop having been despatched in parchment, to be peeled and sized in London. The experiment has proved quite successful, the coffee represented by the sizes 1st, 2nd and Pea-berry, being fully equal in colour and appearance to the corresponding sizes prepared in India. The whole was sold at the same public auction, the London *cured* realising a rather better price than the other half. Similar and more recent experiments, made with some shipments from Costa Rica, Guatemala, and New Grenada, have shown startling results, the portion prepared in London having realised from 10*s*. to 14*s*. per cwt. more than that cured in Central America. These experiments would tend to show that the parchment preserves in a remarkable degree the colour and the quality of the berry against the incidents or accidents of a land and sea transport.

"In the case of the Costa Rica and New Grenada shipments cured in London, the berries seemed fuller and of better shape and weight than the others, as if (which is by no means improbable) the parchment, left for two or three months longer than usual around the berries, had acted as a kind of natural preserver, inside of which the berry had time, as it were, to mature more completely than when deprived of its outer and inner coating almost immediately after being picked. The curing requires machinery, motive power, drying grounds, delicate manipulation, and constant supervision; where any of these requisites fail, the coffee suffers in appearance, and consequently in value. Suitable machinery for treating parchment has been erected at two of the London wharves; and there is every reason to hope that this is only the beginning of a new and profitable home industry. Growers will not be slow to perceive that the small increase of freight which they have to pay on parchment, is more than compensated by the enhanced price which the improvement in the quality of their coffee will enable them to obtain.

"In addition to the produce of British Plantations, India grows native coffee, chiefly in the districts of Coorg, Mysore, and Wynaad. Of late years the greater part has found its way to the French markets, where it is much appreciated, and latterly also to Trieste. It is a matter for regret that shippers from the Malabar coast have not sent any specimens of those kinds to the Exhibition; they are quite suitable for our home consumption, and form an important item of the Indian production.

"Mysore is represented by 105 samples from twenty-seven estates; four samples—viz. *large size*, *bulk*, *small size*, and *Peaberry*—being in most cases shown from each estate. Rather less than one-half appears to be of the true, rounded, heavy silvered-skin Mysore berry, the remainder partaking more of the character of the large, flat, deep-coloured Coorg type. This is the result of the extensive planting of Coorg seed, the old chick or Mysore having become weak and unable to bear fruit or to be propagated as easily as formerly; the hardier Coorg plants grow more quickly and yield larger crops, although not of such fine quality as the real Mysore plant. It would seem, however, as if the produce of the Coorg trees, on getting better acclimatised, showed some tendency to assimilate to the old Mysore, the finest and most esteemed of the Indian types. Of Neilgherry there are twenty-four samples from seven estates: of Coorg, forty-five samples from thirteen estates; of Wynaad, nineteen samples from five estates; and from Travancore, eight samples from three estates; a total of 201 samples from fifty-five estates, besides twenty-eight samples in parchment or cherry.

"Taking 90*s*. per cwt. as the average value of the bulk from the estates of true Mysore type, the Coorg Mysore estates would be worth 80*s*. for bulk, the Neilgherry 83*s*., the Coorg 82*s*., Wynaad 78*s*., and Travancore 70*s*. per cwt.; while native Mysore of average quality would be worth 63*s*., and native Coorg or Wynaad 60*s*. per cwt. The finest qualities of Mysore range in value from 100*s*. to 135*s*. per cwt.

"The export of coffee from India in 1885 amounted to 328,317 cwt.

"Ceylon.—When looking at the fine samples which were exhibited in the Ceylon Court in the neat barrels prepared under the direction of the Planters' Association, one could not avoid a feeling of sadness and regret at the thought that they represented only the fast vanishing remains of what was but nine years ago the most extensive and flourishing of the coffee crops raised on British soil by British enterprise and capital. The production which in 1873 amounted to nearly 1,000,000 cwt., declined to 665,000 cwt. in 1876, 312,000 cwt. in 1884, and 230,000 cwt. in 1885. The scourge of leaf-disease, a fungus (the *Hemileia vastatrix*) which first made its appearance in 1869, has gradually swept over the whole island, weakening the trees, undermining the crop capabilities, and leading to the gradual extinction of the plantations over many of the best districts. Coffee, however, has been able to maintain its ground in some parts, notably in Haputale, Badulla, &c., which are more favourably situated as regards soil and rainfall, and crops of from 150,000 to 200,000 cwt. may fairly be looked for for a few years to come, though it is not probable that cultivation can again extend in the island, as there is but little suitable forest land remaining unopened.

"The variety known as Liberian coffee, which was planted extensively in the low country some years ago, under the belief that it would resist leaf-disease, has succumbed to it; besides which the quality is not appreciated in the home markets, on account of its coarseness, oily taste, and want of strength and aroma; and the prices realised for this sort are not likely to give a fair return to the growers.

"Twenty-seven barrels exhibited by the Planters' Association of Ceylon, the produce of eight different estates, showed to what degree of excellence the preparation of coffee has attained in the curing establishments of Colombo. Three specimens from each mark—large size, bulk and Peaberry, were shown, the former ranging in value from 90*s.* to 105*s.*, and the latter from 87*s.* to 95*s.* The samples of bulk range from 75*s.* to 85*s.*, averaging 80*s.* per cwt., according to the depth and brightness of the colour, smoothness and size, and weight and hardness of the berries; these latter characteristics vary according to the soil and height of the estates, high-grown coffee being the most esteemed in the English market. Four barrels were shown of low grown, the produce of native gardens, cured and prepared like estate coffee, a very good and useful quality, though inferior in appearance and value to the produce of European plantations. Five samples were shown of pale or native coffee, extremely well sized and picked, and of an average value of 58*s.* per cwt. There were, further, five samples from two European plantations, and one of Liberian sort, of very large bean, smooth and well picked, worth 60*s.* per cwt., or about 8*s.* to 10*s.* per cwt. more than the average Liberian quality.

"Straits Settlements.—Coffee does not appear to grow in the British Settlements of Singapore, Penang, and Malacca, except in gardens on a very small scale; but in the three Native States of Perak, Sunjei-Ujong, and Selangor, taken under our protection in 1874, its cultivation has been introduced, and some interesting exhibits from Perak testify to the adaptability of the soil and climate for its production.

"In Perak, where mountain ranges, reaching to 7000 feet, occupy a large portion of a well-watered country, a considerable acreage, above 1000 feet elevation, is reported to be suitable for coffee cultivation, whilst the Liberian sort thrives on the lower slopes and the plains. In Selangor, planting has only been introduced during the last few years, whilst in Sunjei-Ujong estates have been established on the slopes of the Berumbun range, which rises to a height of 3000 to 4000 feet, and the cultivation of Liberian has been introduced on the lowlands. Of the fourteen exhibits from Perak, five are from the experimental hill gardens opened by Government; the sample marked Hill-garden is strong and full flavoured, and worth 90*s.*; those marked Waterloo and Hermitage have probably suffered somewhat in drying, being coarse and musty in the cup, and worth 70*s.* and 76*s.*

"Such kinds, if purposely prepared on the spot, or in London, should the necessary appliances not exist at the plantations, and if perfectly sweet and clean, would supply an extremely good quality, suitable for home consumption as well as export, the coffee being, for size, colour, and general appearance, on a par with good Ceylon plantation. The climate, soil, and rainfall are all that can be wished on the Perak hills, but the great drawback hitherto has been the cost of labour, which, however, has now been arranged satisfactorily, and the difficulty of transport. One sample of large pale berries, very smooth, but out of condition and mildewed, would be worth 60*s.* if sound; two of Liberian, viz. Lindum Estate, in Sungei-Ujong, and Waterloo were very large, and worth 53*s.* to 55*s.*; and three of ordinary Liberian quality, 48*s.* to 52*s.* per cwt.; the remainder consisted of parchment and cherry.

"The growth of Liberian is not to be encouraged, for the reasons stated above under the head of Ceylon.

"Samples of Bâli, Bonthyne, and Philippine coffee, exhibited in the division of Straits Settlements, were probably not British-grown, but the produce of some of the Dutch islands in the neighbourhood of the Straits.

"Queensland.—The climate and soil of this Colony appear to be well suited to the growth of coffee, which is found growing in various parts without any special care other than weeding. It is cultivated on some farms, but only as an adjunct to other crops, and the eight specimens shown in the Exhibition are such as should encourage its extension. A sample from Stanmore, Yatala, although not properly picked, showed a fair greenish quality, worth, as it is, 63*s.* per cwt., and which might probably be improved by cultivation and careful preparation. A sample from Buderum Mountain Mooloolah, was still better in quality.

"Fiji.—A considerable portion of the interior of the islands of Viti Levu, Vanua Levu, and Taviuni, appears to be well adapted for the cultivation of coffee. There is an abundance of rich soil, and favourable conditions of climate, moisture, &c.; the plant grows quickly and yields good crops. The pest of leaf-disease, which visited the islands four or five years ago, led to the destruction or abandonment of several estates, but now that it has disappeared, growers anticipate a prosperous future and increasing production.

"Of fourteen samples exhibited, one showed a good quality of washed or plantation coffee, well grown and of large bean, but deficient in colour, and worth about 68*s.* per cwt.; one Peaberry, worth 75*s.*; one sound though rather rough and discoloured, 63*s.* per cwt.; they were all three of strong, clean, good roasting quality. The remainder in parchment were somewhat similar, though mostly of a dark blackish colour, owing probably to insufficient drying.

"Natal.—Judging from the exhibits of Natal coffee, eleven in number, it would appear that the soil and climate of some portions of the Colony are eminently suited to its growth. The samples from Umzinto and Umzimkulu, to the south and extreme south of Durban, were of excellent quality, well prepared, heavy, round berries of good size and colour, and not unlike Coorg in appearance; such qualities would find a ready sale here for home consumption and export, and are worth from 73*s.* to 83*s.* per cwt. The samples from Tongaat and Riet Valley, in Victoria county, north of Durban, were also of useful quality, hard, greyish, roasting and tasting well, though not so well picked and prepared as the others, and rather deficient in colour; their value was from 60*s.* to 65*s.* per cwt.

"The Natal plantations are mostly in the valleys, and on the hill-slopes along the sea-coast. The cultivation began some thirty years ago, had assumed rather large proportions in 1870 (there were then upwards of 4000 acres planted, and the annual production amounted to 12,000 cwt.); but disease of the trees and failure of crops have since led to the gradual abandonment of the plantations, and the produce now is not estimated at much more than 2000 cwt. annually.

"In a country which can produce such fine coffee as that exhibited from Natal, there ought to be a promising field for future success open to the planter who devotes care and intelligence to the choice of the land, the quality of the seed, the growth and cultivation of his fields, and the preparation of his crop.

"West Africa Settlements—Mauritius.—The exhibits from Sierra Leone, the Gold Coast and Gambia were few in number and of poor quality, consisting chiefly of Liberian and of the small brown Casenga kind; the former worth 48*s.* to 50*s.*, and the latter 42*s.* to 45*s.* per cwt. One sample from the Gold Coast raised at the Bâli Mission at Akropong, showed rather better quality of pale brownish native kind, worth 53*s.* per cwt. From the appearance of the samples, coffee seems to be cultivated in a very primitive way, and on a small scale only, and the varieties grown are those of lowest commercial value in the European markets.

"From Mauritius, one sample of good yellow Liberian was shown, and from the Andaman Islands also one sample of Liberian of large size, both worth about 54*s.* per cwt.

"West Indies—Jamaica.—Coffee is grown in almost every one of the West India Islands, but Jamaica is the only one where the cultivation is carried out on an extensive scale, the quantity exported in 1885 amounting to 80,600 cwt., and occupying the third rank in value of the products exported from the island. From 8000 to 10,000 cwt. are produced annually on plantations situated on the high lands of the Blue Mountains, which have long been known as one of the finest coffee-growing districts in the world, thanks to a fine rich soil and a favourable climate, combined with all the care and intelligence which the means of European planters can command. The coffee from those favoured localities is all consumed in this country, and realises almost the highest prices in the market—say from 90*s.* to 140*s.* per cwt. The remaining 60,000 to 70,000 cwt. are grown in various parts of the island; some in the Manchester district is of medium quality and well prepared, but the portion is cultivated in small patches or gardens by settlers and small proprietors who do not possess the knowledge or the means of preparing their crops properly, or in the low country, where an inferior quality is raised; hence the great difference in prices between fine mountain and the ordinary Jamaica.

"The want of proper curing establishments is much felt in many parts; it is probable, too, that the plants are not raised from good seed, and that better cultivation and manuring are needed. But even this will not suffice to ensure the good quality of the crop, unless due attention is paid to picking at the right moment, and to immediate pulping and through drying of the parchment. This should ensure the proper colour, but, in the absence of the necessary appliances, the planter would best consult his interests by sending his parchment to be peeled, &c., at the nearest works, or better still by shipping it to London for treatment. Ordinary Jamaica coffee is now selling here at 50*s.* to 53*s.* per cwt., and there is every reason to believe that with better care in picking and curing, and with quick despatch of the parchment to London, the grower might obtain from 10*s.* to 12*s.* per cwt. more than he does at present. There does not seem to be any good reason why, in a country where the highest priced coffee is grown, the bulk of the production should rank on a par with common Brazil or the lowest known qualities.

"The extensive planting of the Liberian variety, which appears to be going on in Jamaica and other places, will most probably lead to disappointment; the quality is so poor, so deficient in strength and aroma, and so little appreciated in the home markets, that any material increase in the supply must inevitably lead to a lower range of prices which will fail to repay the outlay.

"The Jamaica plantations appear to have been so far quite free from leaf disease, bug, or other enemies of the coffee-tree, and there is an abundance of forest lands of proper elevation in the St. Ann and Clarendon districts and the northern slopes of the Blue Mountains, suitable for extending the cultivation of the finer classes, which ought to give handsome returns for the capital so invested.

"Of the sixty-nine samples exhibited in the Jamaica Court, sixteen were parchment and cherry; nine from the finest estates were worth from 110*s.* to 140*s.* per cwt., averaging 120*s.* to 125*s.*; eight average 90*s.* per cwt.; eight more 75*s.* per cwt.; eight were worth from 54*s.* to 65*s.*; and two about 47*s.* There were also twelve samples of pea-berry from 70*s.* for the lowest to 105*s.* for the best; and two samples of Liberian worth 56*s.* and 50*s.* per cwt.

"In addition to the above, ten samples were shown in the Indian Court, mostly duplicates of some of the finest estates, and twenty-seven jars of average samples, also from the finer marks of extremely good quality, and of a value not less than 120*s.* per cwt.

"Proceeding from Jamaica in a south-easterly direction towards the continent of South America, I found amongst the British West India Islands which have sent specimens of coffee to the Exhibition:—

"St. Kitts and Nevis, with two samples of nice palish green, soft quality, worth 60*s.*

"Antigua.—Two samples of pale greyish, somewhat uneven, worth 54*s.*

"Montserrat.—One sample ordinary native kind, 50*s.*, and one greenish, of good size, 58*s.*

"Dominica.—Coffee was at the beginning of this century the leading article of export from this island, and it was then considered one of the best kinds produced in the West Indies. The trees, however, were attacked some forty years ago by an insect blight which spread devastation among the plantations, and destroyed the greater portion of them, so reducing the production that at the present time it is hardly equal to the consumption of the island. Cultivation is now reviving to some extent, and it appears that the blight, although still in existence, is comparatively harmless at high elevations. The Liberian variety has also been introduced. There is an abundance of fine forest land and rich soil on the slopes of the bold mountains which cover the country, with plenty of moisture, conditions which are eminently favourable to the growth of coffee.

"Of the ten samples exhibited, two were of a very small, hard, heavy, greenish bean worth about 70*s.* per cwt., one pale native kind 50*s.*, one Liberian 52*s.*; the remainder were of good size, greenish to rather good green colour, and if properly picked and prepared, would be worth from 63*s.* to 76*s.* per cwt. As it is, they were of a very indifferent quality in the cup, and not worth more than from 56*s.* to 68*s.*

"St. Lucia.—One sample, small close brownish, native kind, 52*s.*

"Barbados.—One sample, ordinary pale uneven native sort, 52*s.*, and one small of very well prepared good bluish plantation, of even size, though a little rough, worth 80*s.* per cwt.

"Grenada.—One sample, large pale greenish, useful quality, 54*s.*

"Tobago.—Two samples of dull greenish and brownish Creole coffee, not sized, but good of its kind, worth 56*s.* to 58*s.* per cwt.

"Trinidad.—Ten samples were exhibited: two of them consisted of very common dull brown and red badly prepared coffee, worth 47*s.*; four were Creole or pale native kind, of a useful quality, ranging in value from 52*s.* to 54*s.*; the others were better, and with more care in their preparation might be turned into good coffee, worth probably 60*s.* or 70*s.*; but being imperfectly picked and of a brownish colour, their value was reduced to 58*s.* to 60*s.* per cwt.

"There appears to be a good deal of land suitable for opening into coffee gardens or plantations, and planting has been carried on lately on a larger scale. It is to be hoped that the Botanic Gardens, which supply plants from their nurseries, will endeavour to provide none but those grown from the best seed of *Coffea arabica*, which can easily be procured from Jamaica or from New Grenada. In an island where the cultivation and preparation of cocoa has been brought to such a degree of perfection, there ought to be no lack of skilled labour to prepare coffee much better than is apparent from the samples exhibited. The shape and size of the berries show that the soil and climate are favourable, and that it is only labour, care, and skill which are required to give the coffee its proper value.

"British Guiana.—British Guiana, situated on the north-east coast of South America, comprises the Colonies of Essequibo, Demerara, and Berbice, the two latter well known some forty or fifty years ago as producing coffee of esteemed quality. The cultivation, however, diminished steadily, until in recent years, of Demerara or Berbice coffee the name alone remained. The decrease is ascribed more to the cost and want of labour than to climate or soil, which are both favourable; and the few samples shown, from plantations which have again been started in the last few years, tend to prove that excellent coffee can be grown in the colony. The cultivated part of the country is a flat alluvial plain of forty miles extent, between the sea and the rising ground, at and even below the sea-level, and traversed by large rivers; cultivation is restricted to the river banks and the coast.

"Of the six samples exhibited, three of extremely useful pale bean, very well prepared, would be worth 58*s.* to 63*s.* per cwt., if perfectly clean and sweet and unaffected by sugar, which is not the case with the samples shown; one was pea-berry and two Liberian, of average sort, valued at about 45*s.* to 52*s.* per cwt.

"British Honduras.—Coffee cultivation does not appear to have begun until within the last four or five years, when one or two plantations were established. Probably not more than a few hundred acres are planted; but *Coffea arabica* grows wild in some parts. Two bags were exhibited of very good pale greenish native kind, strong and roasting well, worth 63*s.* per cwt., and one sample of parchment. The adjoining state of Guatemala is gradually becoming one of the leading coffee-growing countries, and British Honduras should be a very suitable place for a more extended cultivation.

"In concluding this report it is difficult to avoid alluding to the extraordinary treatment to which coffee is subjected at the hands of the British Government. Had it had extended to it the same amount of fair play and protection against fraud as is accorded to tea, it is probable that the greater portion of the 35,000 tons of British-grown coffee would be retained for home consumption, instead of a paltry 14,000 tons, or at the rate of about 15 oz. per head of population per annum, against $2\frac{3}{4}$ lb. per head in France, 5 lb. in Germany, $7\frac{3}{4}$ lb. in the United States, &c. It would almost seem as if the Treasury, which is directly responsible for the legislation on the subject, was bent upon discouraging by every means in its power the use of one of the most delicious and beneficent of the non-alcoholic drinks, by the sanction which it gives to its adulteration with any vegetable matter; it is impossible to recognise coffee in the wretched mixtures which are sold in every shop or store, or in the thick dark liquid which is served under that name in many of the coffee palaces and temperance houses throughout the kingdom. No wonder that consumption decreases year by year, not of coffee alone, but even of chicory and mixtures. The Local Government Board and the Board of H.M.'s Customs join, in their annual reports, in ascribing the diminishing revenue from coffee and chicory to adulteration, and in condemning the present state of legislation on the subject. Surely those who are engaged in the cultivation, importation, and trade in coffee, ought to make an effort to obtain redress for what is acknowledged almost on all hands to be a crying injustice."—(H. PASTEUR.)

Our imports of coffee in 1884 were as follows:—

From	cwt.	£
Central America	285,358	908,714
Ceylon	251,148	975,816
Brazil	189,476	489,814
Madras	174,392	646,687
Bombay and Scinde	50,585	186,392
West Africa (foreign)	35,194	64,463
United States	26,382	76,501
France	19,092	56,357
United States of Colombia	17,129	57,750
Aden	17,091	72,512
Germany	13,915	41,853
British West Indies	12,315	37,223
British South Africa	7,678	21,793
Holland	7,421	25,606
Philippines	6,991	19,990
Belgium	4,122	13,537
China and Hong Kong	3,026	8,082
Portugal	3,014	7,165
Straits Settlements	2,650	7,185
Ecuador	2,485	9,518
Hayti	1,732	3,944
Mexico	1,470	4,441
Spanish West Indies	1,364	4,805
Malta	1,315	3,185
Bengal and Burma	251	592
Other countries	2,059	6,488
	1,137,655	3,750,413

Our exports of coffee in 1884 were:—

To	cwt.	£
Holland	214,498	792,373
Germany	188,360	706,441
Sweden	83,610	239,549
Belgium	69,556	224,308
Austria	65,822	241,561
Russia	63,982	209,213
France	62,193	214,950
Turkey	54,847	145,090
Italy	50,777	148,499
Norway	28,698	79,551
United States	24,460	68,615
Denmark	12,992	35,142
Egypt	12,239	33,216
Greece	8,030	19,896
Malta	5,818	14,759
Bulgaria	4,943	12,480
British North America	4,942	16,736
Other countries	17,237	49,505
	973,004	3,251,884

CHAPTER VII.

LOCAL DETAILS OF CULTURE AND PRODUCTION.

THE chief details of the local variations from the general modes of cultivation and preparation described above, together with special remarks on the peculiarities of soil and climate, and the latest available returns of the production, of the principal coffee-growing countries, are as follow:—

Arabia.—The culture of coffee in Arabia is almost confined to the district of Yemen, and is seen to greatest perfection in the Wady Nejran and the neighbourhood of Mecca. It is generally grown on terraces, up to an altitude of 3000 ft. on the slopes of the hills; but some is cultivated on lower ground, surrounded by large shade trees. The soil is kept moist by irrigation. The harvest is gathered at three periods of the year, the principal being May. Cloths are spread under the trees, which latter are shaken, that the ripe fruit may drop. The cherries are then collected, and exposed on mats to dry in the sun. A heavy roller is afterwards passed over them to break the envelopes, and the parchment is winnowed away with a fan. They are further dried before being stored. The pulp is thus shrivelled up, and constitutes about 20 per cent. of the mass of prepared coffee. This method is peculiar to Arabia, and the produce is known by a distinct name—Kishr,—a decoction of which is the common beverage of the Arabs. The coffee is said to be improved by this way of curing; but the plan is possible only in a very dry climate. Most of the Arabian coffee is pea-berry. The high reputation it long held in European markets is not to be ascribed to superior cultivation or improved stock, but to the fact that the coffee was first shipped to India, and thence by round-about ways to Europe, so that it was generally two to three years old when it reached its destination;—it has already been remarked how much coffee improves by keeping. Nowadays, genuine "Mocha," or Yemen, coffee is never seen westward of Constantinople; two-thirds of the total yield is consumed in Arabia, Syria, and Egypt, and the remainder in Turkey and Armenia. Even in Arabia itself, the bales undergo so much sifting and picking *en route*, that the quality deteriorates perceptibly as one leaves the centre of production. At the port of shipment, it is systematically adulterated or replaced by Abyssinian and other growths. The modern "Mocha" of the English market is principally contributed by the East Indies, and in a minor degree by South American States.

In reputation, Mocha coffee has always undoubtedly stood high, and is one of the choicest kinds grown in any part of the globe—in short, the palm for excellence in unroasted coffee may be said to lie between yellow Mocha (short or long berry), finest Blue Mountain (Jamaica), and Cannon's East India plantation Mysore. Neilgherry Hill, Naidoobatum, and plantation Ceylon coffees may be classed next for weight and boldness of bean, and washed Rio, Costa Rica, Guatemala, and other Central American sorts are also much liked by the home and export trade here for being of good colour and closely made; but none has ever gained the name that Mocha has, and singular to add, none has sunk into such obscurity as Mocha has in Europe for many years past. As far back as 1864, the year's imports, deliveries, and stocks of that description were of small extent. The figures for the first forty-one weeks of 1880–1–2 were as under:—

	Imports.	Home Consumption.	Exports.	Stock.
	tons.	tons.	tons.	tons.
1882	170	480	200	265
1881	430	210	260	140
1880	550	290	500	220

This statement shows more clearly than any argument how insignificant a position Mocha coffee occupies as compared with other kinds, and also how undue an amount of interest has been directed to an article that has become almost entirely neglected and out of date in the United Kingdom. Mocha coffee is seldom or never drunk by itself, its scarcity and dearness here standing in the way of that, and it is principally used for blending with other grades that require greater strength and fulness of aroma and flavour. When skilfully mixed with fine East India plantation growths, it is pronounced by experts to be the perfection of coffee. From the scanty supply that comes in from abroad, it can easily be understood that the consumption of pure Mocha coffee by the general population is an impossibility, without reckoning the almost prohibitory prices now ruling, which are, as they mostly have been in years gone by, much higher than those current for other descriptions.

Australia.—The mountain ranges on the northern coast of Australia, from Moreton Bay to Torres Straits, and other parts, are recommended for coffee cultivation. In Queensland, the plant has long been successfully grown; but it has not yet become an article of export, and the plantations have recently suffered much from disease. Though it thrives well in the neighbourhood of Brisbane, Cardwell and the northern districts, especially the sheltered ridges of the Herbert and Endeavour rivers, offer the most favourable conditions. *C. Liberica* is doing well.

Bolivia.—Coffee of several varieties is grown throughout the whole of the Yungas district, and the best produce is reckoned not inferior to "Mocha." That cultivated in the plains yields the larger berries, but of inferior flavour; that on the hills gives smaller fruit, but of improved quality. Very superior coffee grows at El Chaco; but it does not appear to be be largely cultivated, owing, doubtless, to the greater profit yielded by coca.

Borneo.—Coffee has been tried here in the gardens of the and well-flavoured berry. The Malays say that it is grown by the Dyaks of the Pontianak River, for the use of that settlement; but its cultivation on an extensive and systematic scale has not been encouraged, the Government probably not wishing to create a competition with Java, which so largely produces this berry. The hills on the mainland, opposite Labuan, would be well adapted for the cultivation, since here coffee might be grown without the trouble and expense of raising trees amongst the plantations, to protect the bushes from the sun, as is done in Java. On the lowlands, Liberian coffee has been introduced, and is doing well.

Bourbon.—The coffee grown on this island once enjoyed a European reputation, and was the mainstay of local prosperity; but hurricanes, the decay of the trees used for shade, and the preference now given to sugar cultivation, have caused a great decline in the production of coffee. In 1817, the crop exceeded 7,250,000 lb., but in 1875, only 467,500 lb. were shipped. The land under cultivation with coffee is but about 5000 acres. Five varieties of the coffee shrub are distinguished by the natives, viz.:—1. Mocha, the first introduced into the island, superior to all others, easy to grow, but requiring shade trees for shelter; 2. Leroy, the Sierra Leone species, a hardy kind, growing readily without shade, having a seed of inferior quality, pointed at one end; 3. Myrtle, a Mocha variety, especially remarkable for longevity, and abundant crops; 4. Aden, with small regular berries, and a peculiar aroma, cultivated in very small quantities; 5. Marron, an indigenous variety, common in the forests of the elevated interior, with a curious pointed berry, of so strong and bitter flavour that it cannot be used alone.

Brazil.—Brazil produces about as much coffee as all the remainder of the world. In 1874, it was calculated that nearly 1½ million acres were under coffee, and that the trees numbered about 530 million. The provinces where the culture is mainly followed are Rio de Janeiro, Sao

Paulo, and Bahia; the ports are Rio, Santos, Pernambuco, and Bahia. More recently, the industry has assumed considerable proportions in Minas Geraes and in Ceara, notably in the hills of Maranguape, Aratana, Batunte, Ararife, Machada, and Uraburotama. The total exports, besides a very large home consumption in 1878, were about 500 million lb.

Coffee flourishes in most parts of Brazil, even where exposed to cold; but in the latter case, its fruitfulness diminishes, and becomes too irregular to repay for cultivation. The ground is prepared by clearing and burning, or leaving the felled timber to rot, which it does in a year or two. The young plants are usually procured from old plantations, and are put out at two years. Corn and mandioca are grown between the rows till the fourth year, when the trees are about 6 ft. high, and bear the maiden crop. At six years, they bear fully, the crop reaching 1½ lb. a tree, on poor land; 3 lb. on medium land; and 4½ lb. on superior land. An acre contains about 350 trees. The duration of an estate, even under the best circumstances, very seldom exceeds thirty years, and where the soil is light, eight to ten years is the common limit. Five to 10 per cent. of the trees are annually destroyed by fungoid pests; and planters have now to contend against a rising labour market, and want of hands. Owing to carelessness, little more than half the crop is really harvested. Foreign cultivators adopt the usual pulping and other machinery for the preparation of the coffee; but the Brazilians generally follow another plan:—The cherry coffee is spread on *terreiros*, large, smooth concrete pavements, or on bamboo frames, to dry in the sun. The berries become black and crisp; at this stage, they are rubbed, to remove the pulp, and are then washed. The pea-berries are carefully separated, to be employed in the adulteration of Mocha coffee. Much of the remainder is sent into Europe under the name of Java, Ceylon, Martinique, and St. Domingo. It is also said that in Italy, Santos and Rio growths, especially the former, are largely imported for admixture with the more expensive Porto Rico. In France, it is becoming a formidable rival to Malabar, Java, and St. Domingo. From its strong flavour, due probably to the mode of preparation, Brazilian coffee improves more than any other by keeping.

Following is a report on the Brazilian coffee trade, by Consul-General Andrews, for the year 1882.

"The present remarkable cheapness of Brazilian coffee makes it of interest to consider the economical situation of the trade.

"The price, including freight to New York, of 'good-first' coffee in this market now is 40*s.* for 112 pounds, which is equivalent to 8½ cents. per pound; the price of good-second being 6½ cents. a pound. It has not been so low since the year 1857. It gradually rose after that year to be worth 17 cents a pound for 'good-first in 1864, then declined and remained for several years at about 11 cents a pound, after which it rose to 17 cents in 1871–1872, and to 23 cents in 1873–1874, a period when the crop was light.

"The crop of this year was about 800,000,000 pounds, and nothing has yet occurred to indicate that the crop of next year will be less.

"Fortunately there is no disposition here to speculate in this staple, it being considered unwise to attempt anything of the sort with an article so large in quantity and which can be had from so many and so extensive sources.

"The main causes of the low price now are the extremely large production, the large quantity on hand, and the medium quality of the coffee itself. The one remarkable fact in regard to the crop of the season just past was the absence of superior qualities, such as are termed 'prime good-first.' The lack of these qualities—and they are scarcely to be had—is probably owing to a lack of labour in cultivating, and to the planter undertaking to do too much.

"The profit to the planter has become so small that he thinks the crop is not worth spending money on.

"The number of hands on the plantations is yearly growing less and also growing worse. Many of the lower qualities of coffee do not now pay expenses.

"I regret here to state that the practice obtains among some dealers of applying artificial colour to coffee. This is done by mixing a relatively very small quantity of black-lead with coffee of a light colour to give it a somewhat dark-green colour, the coffee being finally brushed to brighten it up.

"The process of counterfeiting is all done by machinery, and raises the price of the counterfeit goods 10 per cent.

"Although Brazil stands at the head of coffee-producing countries, its culture therein does not enjoy the benefits either of small farms or of free labour.

"The plantations are very extensive, and are worked almost wholly by slaves. The bulk of the crop is grown in the province of Rio de Janeiro and the adjoining provinces of San Paulo and Minas Geraes, and mostly on hillsides.

"The soil is tolerably well hoed, but not manured. The first blossoming of the coffee tree occurs in September and a second one in November. Harvesting commences about April or May, and the crop begins to arrive in the market in June or July. It is sometimes injured by being left too long a time on the ground after it has been picked.

"What is known in the market as 'washed' coffee, being, however, but a small proportion, is that which has been picked before fully ripe and while the fruit has a red and cherry-like appearance, and then put into water and the kernels separated from the hull by washing.

"In the market it has an almost polished and silvery appearance, and is a fancy article. But usually coffee is hulled or threshed—and mechanically—after it is ripe and dry. From the plantation it is taken in coarse sacks, which bear the planter's name, and are afterwards returned to him, on mules or in ox-carts to the nearest railway station, whence it is carried on the government railroad at very high rates of transportation to the seaport.

"Arrived at the market, it has before shipment to go through several hands, each taking a liberal profit. First, into the hands of the planter's agent, generally the creditor of the planter, and whom he charges from 6 to 12 per cent. interest for loans.

"The agent sells the coffee to the 'dealer' and charges the planter 3 per cent. of the price for his services.

"The 'dealer' manipulates the coffee, mixing different sorts together, and puts it into bags. He sells to the exporter through a broker, who receives 50 reis (at present, a little over 2 cents) from the dealer and a like amount from the exporter on each bag.

"The broker's charge has by law been reduced to one-fifth per cent. of the value of the coffee, but as yet the regulation is not complied with. Besides these several charges there are heavy expenses for cartage.

"After the coffee arrives here it is conveyed from the railway station to the agent's store; afterwards to the dealer's store, and from thence to the docks or place of shipment, being transported each time through narrow streets by mule power and handled by costly labour.

"In all the various cartages from the time it leaves the plantation, there is considerable wastage.

"Actual experiments have shown that the soil and climate of this country are favourable to the growth of jute. Still the material of which coffee bags are made is brought from a great distance.

"The jute is grown in India, then carried to Dundee, Scotland, where it is spun and woven, and from there imported into Brazil in the web.

"Here, too, an import duty is charged on it of 240 reis per kilo, amounting fully to 3 cents per bag.

"The manufacture of the bags is rather a monopoly enjoyed by the 'dealers,' who exact a profit of 20 cents on each bag.

"An export duty on coffee has to be paid into the treasury of Brazil. For a considerable period this tax remained at 13 per cent. on an average valuation fixed by the govern-

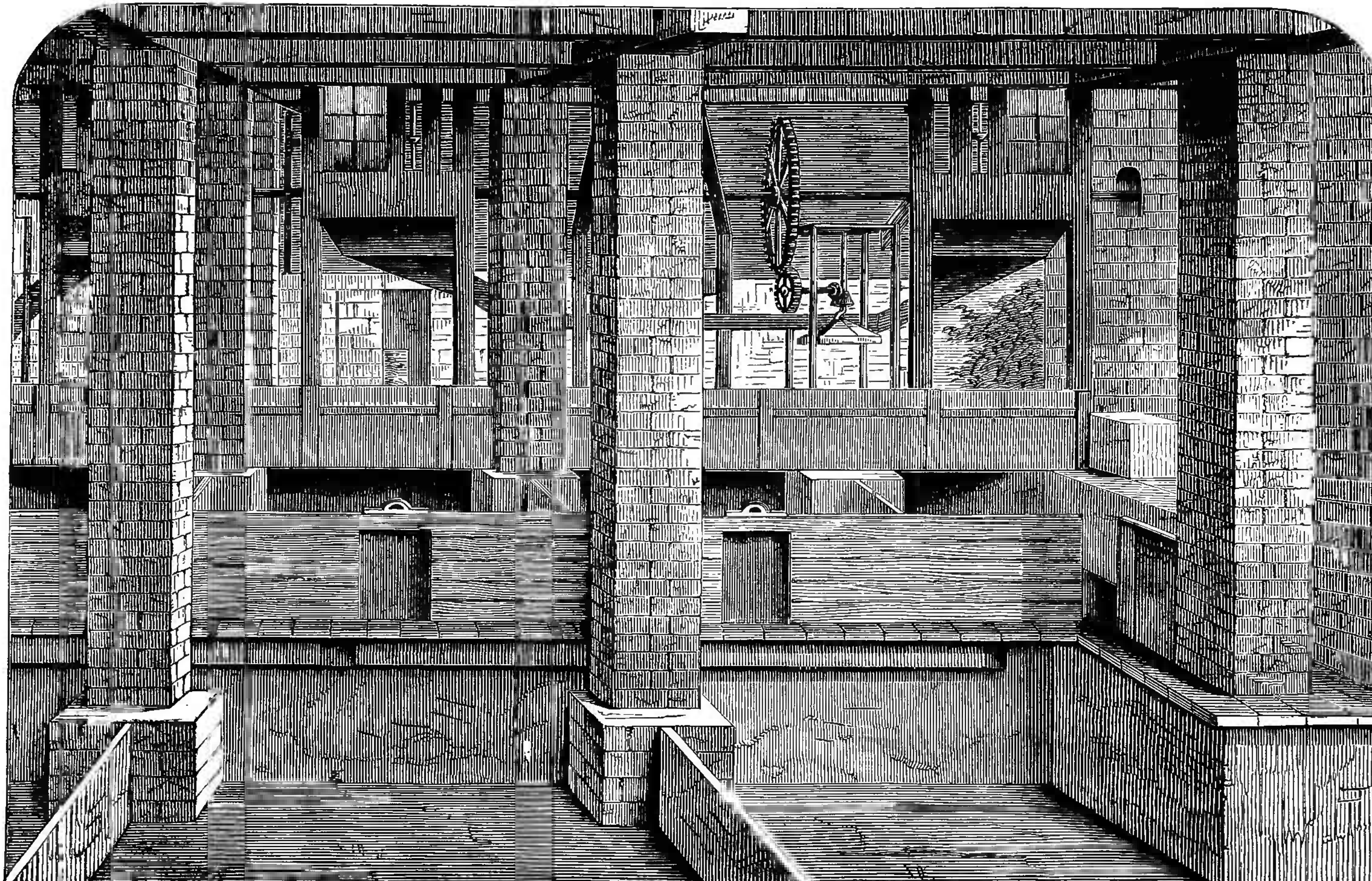


PLATE X.—INTERIOR VIEW OF PULPING HOUSE, CEYLON.

[To face p. 176.

ment, but was reduced the 6th of November, 1882, to 11 per cent. During the year ending June 30, 1881, the total export of coffee from Brazil was 546,401,964 pounds, on which the total export duty was $4,186,635.

"Sixty and one-half per cent. of the total export, namely, 330,938,634 pounds, went to the United States, and on that quantity there was paid into the treasury of Brazil export duties amounting to $2,532,000, which probably fell about equally on the American consumer and the Brazilian producer.

"The policy of the United States in admitting coffee free of duty is different from that of probably every other country. The duty collected per pound on raw coffee in several European countries is as follows, namely: Belgium, 1¼ cents; Denmark, 2 cents; Great Britain, 3 cents; Sweden, 3 cents; Russia, 3½ cents; Germany, 4½ cents; Norway, 5 cents; Austria-Hungary, 7 cents; Italy, 10 cents; and France, 14 cents.

"While the United States have for ten years been admitting Brazil's great staple free of duty, the latter country has been steadily increasing her duty on imports, including those from the United States.

"A fresh increase of 10 per cent. on all imports took effect the 6th instant."

Annexed is a report on the coffee trade of Santos, by Consul Wright, for the same year.

"The production of coffee was already fast outstripping consumption when, early in 1880, the Brazilian Government saw fit to become an exporter of the article, with the view of placing funds abroad to meet its obligations, instead of, as hitherto, making remittances in bills of exchange; thus entering the Rio market as a buyer in competition with legitimate exporters, and upsetting for the time being all calculations as to exchanges, not only preventing the then natural decline of prices out here, but really causing an advance to a point relatively above the simultaneous market value abroad, and depressing all foreign markets by throwing

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their shipments almost *in toto* upon one, New York, especially at that time, when a combination was endeavouring to 'corner' coffee, thereby causing greater caution on the part of the general trade and anxiety in Europe that New York might be compelled to ship part of her stocks thither.

"The operation of the government resulted in a loss stated to amount to at least 800,000 milreis, to say nothing of its consequences upon legitimate mercantile trade. As a matter of course, I would not allude thus to this transaction had it not been so freely discussed in and out of Parliament, and in commercial circles everywhere for some time past, as to place it beyond the pale of official reserve.

"Looking at the then tremulous state of the coffee trade (so often before afflicted by speculative rings which resulted disastrously), owing to the visible and increasing over production everywhere as compared with consumption, it is considered to have been unwise on the part of the government to have struck the first blow at the downward tendency, because if left to merchants regularly and legitimately in the trade, they would have known how to have met the anticipated natural changes. But even this was denied them by the public assertion of the successor to the minister of finance who executed the commercial measure alluded to, that he approved of the course of his predecessor, and would repeat the operation if he saw fit, whilst the operation has lately been defended in the Imperial House of Representatives, although ably contested. All this causes nervousness in the trade now, as for some time past, lest such an operation might suddenly be predicated.

"There are those who believe that the Brazilian Government is interested in the great Havre ring, but I am not one of them, however plausible their deductions drawn from the past may appear. It may be that the operation I have alluded to may have given birth to the hope of these wealthy French speculators that it might be repeated either wholly or on account with them, but they have apparently been left to carry their own burden. They may have been and may still be influenced by the hope that the reported negotiations between Brazil and France may result in a commercial treaty, resulting in a diminution of the exorbitant French duty on coffee, amounting to more than the invoice cost, with freight and marine insurance added, so as to offset some recompense on this side for the importation of real French wines, instead of the Hamburg concoctions imported and sold as French.

"In my No. 66, dated January 16, I spoke of the Havre ring, with its enormous coffee stock hanging as an incubus over the trade, and so it has continued. In September its Havre stocks were represented to have cost 3,000,000*l.* sterling, against the market estimated value 2,000,000*l.* sterling, or a straight loss of 1,000,000*l.* sterling, not including expenses of 'carrying,' previous losses, &c.

"Several large failures also have occurred there; yet a reinforced concern seems to have been organised, and are apparently determined to continue the same course. Why Santos and Santos coffee should have been alone selected for these speculative operations is puzzling, but so it is. Certain is it also that the Brazilian coffee trade has changed, assumed a new form; for whereas formerly the large importers sent out orders and letters of credit for purchases of large parcels and cargoes for sale there to jobbers, nowadays these very jobbers have become importers, and to such an extent that the old importers are almost driven from the field. Nearly all the firms in Santos and Rio have head or branch houses, or partners, or agents abroad, through whom they offer to sell for immediate or future shipment a given quantity of coffee, quality as per type sample there shown, at a fixed price in foreign money, this price including invoice cost on board and freight. This enables the jobbers and retailers to buy out here instead of there, where they were so often in the meshes of speculative cliques. Now they know that on a certain day they will have their supply and its cost, they running no risk except the loss of the vessel, and hence their expected supply, all other risks falling upon the vendor here. They obtain letters of credit just as others do, and settle for the draughts drawn in virtue thereof payable at ninety days after sight in London, Paris, Frankfort, &c., just as readily as if they made the purchase in warehouse at New York, Havre, Antwerp, Hamburg, &c., on sixty days' credit, to be paid for in cash as 'taken from store, with discount.' But the system is a bad one, and may yet result seriously, and this seems to be the opinion of many who shun such, on a principle well founded. The risks run by the party out here are many and serious; amongst them, quality sold not obtainable, prices advanced, exchange rates advanced, rates of freight advanced, absence of steamers and vessels, rainy weather preventing shipments within specified time, fires, &c. If all these are to be feared in contracting for shipping 'short,' how much more for 'long' delivery?

"I am informed that coffee has been sold to Havre, quality and price agreed upon, for shipment here all along up to end of March 1883. Coffee is therefore sold which may not exist, as myriads of pods or dried berries are still on the bushes, and may or may not inclose beans or burnt, oilless kernels. Then again, this is a rainy climate, and the main stem of our railroad system may again be damaged on the Serra and traffic interrupted, as we have often seen before, thus stopping supplies, which would of course interfere with the fulfilment of these future delivery contracts. Nothing can show more plainly how the trade has been cut up than Table V., in my despatch No. 84, made up from the invoice book of this consulate, containing the number of invoices certified to. The number for 1882 would have been greater had not a large buyer in New York, for its roasting purposes, opened branch houses at Rio and here and ship their coffees in large invoices. The small invoices then point to the fact that the consignees are many, and perhaps a number of them are in our interior cities and towns.

"Laying aside the Havre operations, the same is the case with Europe, where it seems many cities and towns have their respective little combinations for importation and division amongst individual members thereof. A house here not long ago shipped per steamer to Hamburg 2000 bags, divided or cut up into fifteen invoices for delivery all over Germany, at different points. I was told that the largest invoice was for 1000 bags. This house is one of the oldest, wealthiest, and most reliable import and export firms here, able to do what they wish, but nothing with type samples, futures, or speculation as now conducted. You will thus see that the Brazilian coffee trade has been brought down nearly to a Ceylon writer's notion of 'plantation to cup.'

"The prices of coffee here are very low as compared with former years, and much is being said and written about it both here and abroad, and the Government and associations are engaged in promoting the display of samples in Europe and the United States, with the view of bringing Brazilian, especially Santos, coffee better before consumers. If an exportation of 1,500,000 bags cannot show what Santos coffee really is, I fail to see how a few finger-picked samples, showing what it can and ought to be, but representing what cannot be had, can have any good effect. Far better would it be to have an exhibition of samples of coffee from other producing countries at some central point in the province, where the planters might go and see that planters in those countries send to consuming markets for *sale* the same coffee that their own cooks, after picking and washing out stones, chaff, &c., roast and prepare for the table. No one can or will deny that the flavour of Santos coffee is not equal to any other, but it hurts the planter to see it quoted so much below others abroad, and to be told that it is mixed with and sold as some other kind at the quoted market price for such kind. Nothing more reasonable than this, for if the planter deems it more to his interest to send down for sale his crop containing one-fourth stones, dirt, unsightly, valueless, black, and ashy beans and husk, he ought to expect it to be sold at a price here which will allow some margin for cleaning it abroad and putting it into the same condition for roasting and drinking as he himself uses.

"Too many coffee trees have been planted, and hence the fruit not properly harvested and prepared for market, and planters are reported as confessing this. Well-prepared coffees are sent down and fetch relatively high prices, both here and abroad, but being exceptions, are not generally quoted. And if the actual low prices here leave a loss to the planter, which, however, I do not believe, he must blame himself in tacitly protecting the high and exorbitant railroad freight charges. These railroads pay dividends at the rate of ten to fourteen per centum per annum. All but one are native enterprises, in many instances many planters being large shareholders, who grumble at low coffee prices, but not at their railroad dividends. The railroad freight and charges average 5 milreis on every bag of coffee sent to Santos; the average sale price to-day is about 17 milreis per bag (60 kilograms or 132 pounds), not including very ordinary and triage, of which there is a large quantity in store, not worth on an average over 9 or 10 milreis per bag, which, deducting all other charges, will leave little or nothing for the planter. The planter must now clean his crop very much better so as to send down a better quality, send down a smaller quantity, and obtain comparatively higher prices, paying, or rather not paying freight on unsent trash, and cause railroads to be satisfied with less income and smaller dividends; otherwise Mexico may teach them a severe lesson."

Cayenne.—Coffee was at one time an important staple of this country, the variety grown being Mocha, for the cultivation of which the country is especially adapted; it is now chiefly grown as a shade tree for cocoa, annatto, and other crops, though a few Government plantations are maintained. The average production is scarcely 100,000 lb. a year; the shipments, in 1875, were but 752 lb. The product is not however, quite lost; although temporarily abandoned, the trees continue to thrive in a wild state, and may be reclaimed hereafter. They attain a height of about 15–16 ft., with a trunk 30 in. round at a few feet from the ground; they are rich in foliage, but do not flower; they also appear to be safe from the ravages of insects.

Celebes.—The Minahassa district produces a very superior coffee; the kernels, instead of being opaque, and having a tinge of bronze, are translucent, and of a greenish-blue colour. The best are those which have these characters, and, at the same time, are very hard; this coffee commands a much higher price than that of Java, and is superior to any raised in the Archipelago, unless it may be some that comes from the highlands in the interior of Sumatra. The general character of the produce, however, is not good, too little care being bestowed upon its preparation. The crop is subject to some variation, but the average yield of the Government gardens is never less than 5,000,000 lb. The whole number of trees belonging to the Government is over 6 million; but a large proportion of these are young, and therefore bear little or no fruit. Several private individuals also own large plantations. The trees are found to thrive best above an elevation of 1000 ft. In some districts, the produce amounts to 2–4 lb. a tree, while in others it is only $\frac{1}{2}$–$\frac{3}{4}$ lb. It is packed in bags on the plantations, and is transported from the small storehouses in the interior to the large ones at Menado, where it is put on board vessels either directly for foreign ports, or to be taken to Macassar, and thence be reshipped to Europe.

Ceylon.—This island is now by far the most important coffee producer of all the British possessions, occupying the rank once held by the West Indies. In 1877, it was esti mated that the capital invested in Ceylon coffee culture was nearly 14,000,000*l.*, and a notable increase has taken place since. The hill region, covering an area of about 4000 square miles, is somewhat circular in form, and its most elevated parts rise to 8280 ft. above the level of the sea. Systematic coffee cultivation is almost exclusively confined to these hills, although irregular native garden plantations are found everywhere in the south-western portion of the island, even close to the sea beach. The favourite and most fruitful elevation is between 3000 and 4500 ft.; but, in a few exceptional cases, estates descend almost to the foot of the hills, whilst others are situated at 5500 ft., and even higher. Native gardens, sometimes bearing good crops, may be met with along the coast actually at sea-level. In these cases, however, the plants will invariably be found growing under the shade of suitable trees, without which protection all chance of their thriving permanently would be out of the question. These native gardens are, moreover, limited in extent, and are generally richly manured, and often well-watered during the dry season. These conclusions are borne out in those districts where coffee cultivation has been attempted below 1000 ft. elevation, abandoned properties on every side bearing evidence that humidity and rainfall have been insufficient to neutralise the high temperature. In the neighbourhood of Kandy, there are properties which, even at 1800 ft., seem to owe their present existence chiefly to shade and irrigation. In fact, the climate which is most favourable for coffee, is that in which an Englishman will find little to complain of, except occasional malaria.

There are now some forty districts in which the cultivation is carried on, containing in all about 1400 properties, of which over 1200 are in course of cultivation; these have a total area of about 300,000 acres. The average crop per acre of land in bearing has ranged, during the twenty years from 1856 to 1875, from 5·07 cwt. an acre (in 1868), to 2·75 cwt. (in 1874)—the general average for the twenty years being rather under 4·25 cwt. an acre. In 1856, the production, taking the average of two years (a good and a bad season), was 5 cwt. an acre; in 1877, this had dwindled down to 3·43 cwt. At the average yield of twenty years ago, the island should, in 1877, have exported 1,120,000 cwt. of plantation coffee, whereas it fell short by 30 per cent. This reduced production per acre is greatly due to disease, but also to inefficient transport accommodation. With these remedied, the standard of 4 cwt. an acre all round could doubtless be maintained. The native cultivation of coffee has usually been calculated to extend over 50,000 acres; but it varies very much, according to the character of the season, the prices of produce, and the cheapness of money.

The most suitable soil is that which grows soft timber, and is dark chocolate-coloured, mixed with small stones, and dotted with granite boulders. As the strongest and most continuous wind comes from the south-west, it will be evident that this aspect is the worst that can be chosen; neither would it be wise to select one directly opposite, this being exposed for some months of the year to the north-east monsoon. A bleak and exposed aspect is one of those evils that can neither be mitigated nor remedied. The monsoons, blowing incessantly for three or four months together, are assailants which coffee bushes cannot withstand. Northerly or easterly facings are perhaps the best, not being directly exposed to violent wind for any lengthened period; the latter also gets the benefit of the morning sun. The season for beginning agricultural operations is October, or the early part of November, while the buildings should be finished by the middle of January. Felling is usually commenced in October to November, and the felled timber is left for fully six or eight weeks to dry. The best time for firing is 1st to 15th of February, when the prevalent dry weather and not too violent north-east wind are favourable. Pitting should begin as soon as possible after the land has been cleared, say in January or February, and may be continued up to the end of June, or until the rainy season sets in. This wet season, extending more or less through June, July, and August, is the only safe time for putting out the plants. Abundant supplies of plants of all sizes are generally to be found growing wild in the forest, in the vicinity of old estates. These, having grown up in the shade, are generally lanky and straggling, and consequently require, before being planted out in the estate, to be "stumped"; they are then very independent, and usually come on well. Where wild plants are not to be had, others can frequently be got from native gardens at a trifling rate per thousand. When plants in sufficient number are obtainable in either of these ways, a nursery is but little required; but in case the planter should not find his wants thus supplied, it will be advisable to begin making a nursery. The nursery is usually made in May to June, and should yield plants fit for putting out at the same time in the following year. The best time to obtain seed is the end of October, when a few bushels of fresh berries of the new crop can be obtained from neighbouring estates. Over the planted seeds, a layer of rotten leaves may be spread two inches thick, the bed being then well watered at least once every three days, if the weather be dry, until germination takes place. In about six weeks, the seeds will begin to force their way above ground, and to send a root downwards, when the layer of decayed leaves may be gently and carefully removed. If it is intended to put out plants that have grown for three years in the nursery, Hull recommends their being cut down to stumps in the beds in the December or January before the planting season; they will then throw out suckers, which, by July, will be 9–10 in. high. When these plants are put out, a couple of the most promising suckers may be selected, the rest being pulled off. These two (being those nearest the roots) may then grow together for a month, after which the weaker of the two is taken off, the other being left to develop into the tree. By this plan he was able, in one case, to pick a maiden crop of 2–3 cwt. an acre off plants that had been hardly eighteen months in the ground. Once the rains commence, the sooner the plants are in their places the better. Early planting is most desirable, as upon it a maiden crop may often depend. When the climate is hot, it will be necessary to erect a "pandall," or awning, to protect the young plants from the sun during the dry months. The shade must, however, be removed on the approach of the rainy season, otherwise the drip will prove injurious to the plants, which, moreover, will be strengthened by such sun and air as they are likely to get at this time of year. Staking should be performed by the middle of May, before the commencement of the south-west monsoon. The blossom generally bursts forth in March, under the influence of the showers which usually fall in that month. About October, every preparation ought to be complete for gathering in the crop. The berries begin to ripen in October or early November, and continue to come on until the middle or end of January. In some low-lying districts, however, the crop ripens more rapidly, and all must be got in within about a month or six weeks. The labourers employed on the plantations are largely drawn from Southern India, chiefly from the districts of Madura, Tinnevelly, Tanjore, and Trichinopoly, though Mysore furnishes a considerable contingent. These coolies are brought over by *Kanganies*, or native "gangers," who receive advances from the estate managers, to enable them to furnish funds for preliminary expenses, to each cooly who enrols himself. The usual time for their arrival in Ceylon is between May and October; and for their return home, after the harvest. Local labour is also available for carpenters' and similar work.

The advantage of providing coffee with shade trees, at any elevation less than 2000 ft., is gradually being appreciated, and, in 1877, it was estimated that about 3000 acres of plantation coffee were growing under shade. It is evident, however, from experience gained at Hantane, Nilambie and Matale, that success depends much upon the kind of tree, and that the natural forest will seldom do, the coffee not prospering, and the falling trees doing much damage in some cases. In Dumbara, cocoa has been planted among the coffee, profiting by the shade of the latter for some years, and then expanding sufficiently to return the favour. It is said that under this shade some of the worst weeds do not flourish; but, remembering how very necessary is shade to cocoa itself at all stages of its growth, it is difficult to see what ultimate good can arise. Cocoa and coffee do not prosper on the same ground elsewhere, e.g. Central America, West Indies, Natal.

In Lower Matale, coffee growing under coco-nut palms is doing well up to the age of six years, and the coco-nuts are flourishing. More worthy of encouragement is the growth of shade-giving timber trees, especially subsoil feeders. Perhaps the best adapted for this purpose in Ceylon is the native jack (*Artocarpus integrifolia*), which attains a large size, and resembles, and belongs to the same family as the bread-fruit tree. Its presence seems to be actually beneficial to the coffee-plant, it is a subsoil feeder, it produces a fruit much valued as fruit by the natives, its timber is valuable for cabinet-making and building purposes, and it flourishes best precisely in those situations where its shade is most required. As it will not bear transplanting, a few seeds must be placed, a couple of inches below the surface, in each spot where a tree is required to grow, the strongest sapling being retained. The loquat tree is planted along the roadsides on many estates, and coffee appears to thrive well under it; it yields a useful fruit, but its timber is not apparently of much value. The castor-oil plant, which grows 6–10 ft. high in a year, bearing a crop in the first year, might perhaps be found useful in some cases, as it requires little care in cultivation, but it cannot be strongly recommended for growth with coffee, being apparently a surface-feeder. Plantains or bananas, as planted for shade in St. Domingo, will not injure the coffee; perhaps, for the first few years, till the jacks have had time to grow, they might be useful. Trees for shade should not be so near each other as to prevent a free circulation of air, nor entirely to exclude the sun's rays. They may, however, in hot situations, be grown tolerably close at first, it being easy to thin them out afterwards. In order to make the trees throw out wide leafy heads, they should be trained to single stems till 10–12 ft. high, all lateral branches being kept off. This will also tend to produce large straight timber.

Estimates.—In the following estimates for the purchase of 300 A. forest land, and 200 A. grass land, bringing 200 of the former into cultivation and full bearing, the price of the former is calculated at 10*l.* an acre, the latter at 4*l.*, and labour at 9*d.* a day, including Kanganies' wages:—

First year: 1st October to 30th September following:—Land, 3,800*l.*; felling, burning, and clearing 50 A. at 45*s.*, 112*l.* 10*s.*; tools, 35*l.*; coolie lines, 80*l.*; conductor's house, &c., 50*l.*; temporary bungalow, 50*l.*; nursery for second year's extension (100,000 plants), 37*l.* 10*s.*; roads, 34*l.* 10*s.*; lining out 50 A. at 5*s.*, 12*l.* 10*s.*; holing 50 A. at 5 ft. × 6 ft. = 1452 holes per A. at 25 for 9*d.*, 108*l.* 15*s.*: filling in, at 120 holes for 9*d.*, 22*l.* 13*s.* 9*d.*; 75,000 plants at 10*s.* per 1000, 37*l.* 10*s.*; planting 72,600, at 200 for 9*d.*, 13*l.* 12*s.* 3*d.*; cleaning up and weeding 50 A. at 10*s.*, 25*l.*; superintendent, 120*l.*; allowances, 12*l.*; conductor, 45*l.* 12*s.*; contingencies, 50*l.*; = total, 4647*l.* 3*s.*

Second year (cultivation, 50 A., and extension, 50 A.):—weeding, 50*l.*; supplying vacancies, 10*l.* 8*s.* 6*d.*; repairing buildings, 20*l.*; roads and trenching, 15*l.*; replanting nursery, 20*l.*; additional lines, 50*l.*; tools, 25*l.*; felling, clearing, lining, holing, filling in, and planting as before, 270*l.* 1*s.*; roads, 1 mile, 12*l.*; cleaning and weeding as before, 25*l.*; superintendent, 182*l.*; horse, 40*l.*; conductor, 51*l.* 12*s.*; contingencies, 50*l.*; = total, 821*l.* 1*s.* 6*d.*

Third year (cultivation, 100 A., and extension 50 A.):—weeding, 100*l.*; supplying vacancies, 15*l.* 13*s.*; repairing buildings, 30*l.*; roads and trenching, 22*l.* 10*s.*; replanting and manuring nurseries, 25*l.*; topping and handling 50 A., at 7*s.* 6*d.*, 18*l.* 15*s.*; additional lines, 50*l.*; tools, 25*l.*; felling, &c., 50 A., as before, 270*l.* 1*s.*; roads, 1 mile, 12*l.*; cleaning and weeding, 25*l.*; pulping house, machinery and store, 400*l.*; picking 850 boxes (125 cwt.) cherry, at 7*d.* a box, 24*l.* 15*s.*; curing, at 1*s.* a cwt., 6*l.* 5*s.*; carriage at 1*s.* a bush. parchment, ?1*l.* 5*s.*; superintendent, 262*l.*; conductor, 57*l.* 12*s.*; contingencies, 50*l.*; = total, 1425*l.* 16*s.*

Fourth year (cultivation 150 A., and extension, 50 A.):—weeding, 150*l.*; filling up vacancies, 19*l.* 10*s.* 3*d.*; repairing buildings, 40*l.*; roads and trenching, 33*l.* 15*s.*; partially replanting nursery, 12*l.* 10*s.*; topping and handling 50 A., 18*l.* 15*s.*; pruning 50 A., at 15*s.*, 37*l.* 10*s.*; completing store, &c., 400*l.*; picking 2850 boxes (425 cwt.) cherry, 83*l.* 2*s.* 6*d.*; curing, 21*l.* 5*s.*; carriage, 106*l.* 5*s.*; additional coolie lines, 50*l.*; tools, 25*l.*; felling, &c., as before, 270*l.* 1*s.*; roads, 12*l.*; cleaning and weeding, 25*l.*; permanent cattle sheds, 100*l.*; cattle, 75 head, at 3*l.*, 225*l*; keepers, &c., (6 men), 53*l.* 12*s.*; superintendent, 312*l.*; conductor, 63*l.* 12*s.*; contingencies, 50*l.*; = total, 2108*l.* 17*s.* 9*d.*

Fifth year (cultivation, 200 A.):—weeding, 200*l.*; filling up vacancies, 23*l.* 9*s.* 6*d.*; repairing buildings, 50*l.*; trenching and roads, 42*l.* 10*s.*; nurseries, 12*l.* 10*s.*; topping and handling 50 A., 18*l.* 15*s.*; pruning and handling 100 A., 75*l.*; manuring 40 A., at 5*l.*, 200*l.*; picking 4850 boxes (725 cwt.) cherry, 141*l.* 9*s.*; curing, 36*l.* 5*s.*; carriage, 181*l.* 5*s.*; permanent bungalow, 500*l.*; stock (25 head), 75*l.*; keep of ditto, 53*l.* 12*s.*; superintendent, 362*l.*; conductor, 69*l.* 12*s*; contingencies, 50*l.*; = total, 2091*l.* 7*s.* 6*d.*

Sixth year:—weeding, 250*l.*; filling up vacancies, 25*l.*; keeping up buildings, 50*l.*; trenching and roads, 40*l.*; nurseries, 12*l.* 10*s.*; pruning and handling 150 A. at 1*l.*, 150*l.*; ditto, 50 at 15*s.*, 37*l.* 10*s.*; manuring 40 A., at 6*l.*, 240*l.*; picking 6850 boxes (1025 cwt.) cherry, 199*l.* 6*s.* 6*d.*; curing, 51*l.* 5*s.*; carriage, 257*l.* 10*s.*; stock, 150*l.*; management, 431*l.* 12*s.*; contingencies, 50*l.*; = total, 1944*l.* 13*s.* 6*d.*

Seventh year:—weeding, supplying vacancies, maintenance of buildings and roads, trenching, nurseries, and manure, as before, 617*l.* 10*s.*; pruning, at 1*l.* an A., 200*l.*; picking, curing, and despatching 1200 cwt. crop, 593*l.* 6*s.* 8*d.*; stock, management, and contingencies, 613*l.* 12*s.*; = total, 2024*l.* 8*s.* 8*d.*

The balance sheet will then stand as under:—

		£	*s.*	*d.*		£	*s.*	*d.*
1st year:—	To expenses ..	4647	3	0	By balance	4647	3	0
2nd year:—	„ balance ..	4647	3	0				
	„ expenses ..	821	1	6	„ „	5468	4	6
		5468	4	6		5468	4	6

	£	s.	d.		£	s.	d.
3rd year:—To balance ..	5468	4	6	By 125 cwt. crop, at 90*s.* net	562	10	0
„ expenses ..	1425	16	0	„ balance	6331	10	6
	6894	0	6		6894	0	6
4th year:—To balance ..	6331	10	6	By 425 cwt. crop, at 90*s.*..	1912	10	0
„ expenses ..	2108	17	0	„ balance	6527	17	6
	8440	7	6		8440	7	6
5th year:—To balance ..	6527	17	6	By 725 cwt. crop, at 90*s.* ..	3262	10	0
„ expenses ..	2091	7	6	„ balance	5356	15	0
	8619	5	0		8619	5	0
6th year:—To balance ..	5356	15	0	By 1025 cwt. crop, at 90*s.*	4612	10	0
„ expenses ..	1944	13	6	„ balance	2688	18	6
	7301	8	6		7301	8	6
7th year:—To balance ..	2688	18	6	By 1200 cwt. crop, at 90*s.*	5400	0	0
„ expenses ..	2024	8	8				
„ balance ..	686	12	10				
	5400	0	0		5400	0	0
Subsequent years:—expenses	2000	0	0	By 1200 cwt. crop, at 90*s.*	5400	0	0

The yield of the crop is based on a first harvest of 2½ cwt. an acre, followed annually afterwards by one of 6 cwt. an acre; these figures are now manifestly too high. As to the longevity of coffee estates, there appears to be no necessary limit to the life of the plant in its natural state, and, under suitable conditions of climate, soil, and culture, it may live indefinitely. In native gardens in Ceylon, there are many trees far above half a century old, and several of the earliest European plantations still thrive and yield at upwards of 40 years of age. The price of land has risen considerably since the introduction of Liberian coffee; low-lying plots that ten years since were not worth 4 R. an acre now sell at 20*l.* No export duty is levied in Ceylon. The exports were, in 1874, plantation, 635,935 cwt., native, 97,020; 1875, 813,401 and 115,205; 1876, 586,580 and 80,585; 1877, 896,534 and 82,281.

Colombia.—According to Consul Mallet, the department of Chiriqui, in the interior of Colombia, offers a fine field for coffee culture. Planting has already been introduced, but only in a small way as yet. The fine lands lying along the slopes of the mountain ranges are said to be admirably adapted for the purpose. Land costs nothing, the climate is favourable, transport and labour are efficient and cheap. In other departments of the state, coffee culture is of old standing, the produce, especially from Ocama and Ambalima, being of excellent quality; it is, however, limited in quantity, and chiefly consumed in the country.

Costa Rica.—Coffee raised on the highlands of Costa Rica and Nicaragua is said to be unsurpassed in strength, and to possess an aromatic flavour unknown to the best Eastern growths; that grown at medium elevations is of good quality and though without the plump form and bluish tint of the upland produce, it compares favourably with Javan or Moluccan coffee. The cultivation suffers much from want of labour. The quantities exported in the years 1875–8 respectively were about 23½ million, 10½ million, 24¼ million, and 18 million pounds. The principal consumers appear to be Great Britain, California, and France.

Ecuador.—Increasing attention is being given to coffee cultivation in Ecuador, and the produce is of good quality. The exports from Guayaquil during the years 1873–8 respectively were about 700,000; 1,000,000; 1,000,000; 800,000; 1,000,000; and 100,000 pounds. The crop of 1878 was completely spoilt by heavy rains; the yield was very inferior in quality, and so low in quantity as not to suffice for local needs.

Guatemala.—One of the principal coffee districts has suffered largely from Indian disturbances, exhaustion of the soil, and, perhaps, inadaptability of climate; but for every tree abandoned in this section, 100 have been planted in new and better lands. Probably there have been 2,000,000 new trees planted, consequently the crop of 1880–81 should exhibit a marked increase over that of any previous season. The Vera Paz or Coban district, which has its outlet on the Atlantic, viâ Yzabal and Belize, has been specially sought after by Germans and Americans, and is being industriously developed in its coffee-bearing qualities. The land and labour are cheaper than on the Pacific slope; but the yield per tree is very much less, being an average of 1 lb., while on the Pacific slope it reaches 3 lb., and even 5 lb. in some specially favoured localities. Nevertheless it is questionable which section will, in the end, produce the better results. Boddam-Whetham points out the existence of several disadvantages in the country, viz.:—the want of good roads, and the liability of losing most of the labourers at a moment's notice, in the event of their being required for military service; on some plantations, too, water has to be conveyed in flumes from a distance. The advantages are that the climate is pleasant, as the plantations are situated between 2000 and 4500 ft. above the sea-level, and that hitherto there has been no disease, all the conditions for good crops being favourable. Coban coffee has a peculiar delicate flavour, and the fine plantations that are gradually arising, point to a prosperous future for this section of Vera Paz. The crop of 1878 was exported principally to the following countries:—California, about 7,500,000 lb.; England, 6,300,000; Germany, 2,800,000; France, 2,500,000; Belize (chiefly for England), 800,000; New York, 400,000; Belgium, 200,000; South America, 170,000. It was valued at 16 c. (100 c. = 4*s.*) a lb. at the port, but was barely worth 13 c. In the lower districts, the beans are dried by being spread on a *patio*; at higher altitudes, they are placed in shallow trays with perforated bottoms, and a current of warm, dry air is made to circulate through the building. The coffee is transported mostly on Indians' backs, a bag (100 lb.) is a load, and 18–24 miles constitutes a day's journey, the pay for which is 9*d.*

Guiana.—Coffee culture in this colony seems to have been at its height in 1803, when nearly 10 million pounds were shipped. Since then it has gradually declined, and, in 1874, the exports were but 40,000 lb.

Honduras.—The soil in favoured spots is very fertile, and in the gardens of Machaquila and Peten Sük, are coffee-trees yielding 7 and 8 lb. of berries. In the neighbourhood of the Belize River, Indian labour is available, and this side of the continent is much preferable to the Pacific slope, where much coffee is grown, on account of soil and climate, and more particularly as regards the effect of the sun, for it is more or less cloudy here throughout the year, affording the requisite shade to the plant. The lands here at 500–2000 feet above sea-level, are better than the hills in the interior, if for no other reason on account of the facility of transport.

India.—Coffee cultivation in some parts of Southern India has remarkably increased of late. The following concise statement from official sources shows the condition of the culture in the three provinces of Madras, Mysore, and Coorg, in the season 1876–7 :—

Madras.—Under mature plants, 49,350 acres; under immature plants, 15,711 acres; total yield about $13\frac{1}{4}$ million pounds; average yield per acre of mature plants, 268 lb.

Mysore.—Under cultivation, 115,315 acres; total yield, about $6\frac{1}{2}$ million pounds; yield varies from $1\frac{1}{2}$ to 103 lb. per acre.

Coorg.—Under mature plants, 35,150 acres; under immature plants, 9000 acres; total yield, about 12 million pounds, average yield per acre of mature plants, 339 lb.

Large reserves fit for coffee-growing still exist in the Nilgiri Hills; but the Government is unwilling to encourage further deforestation. In the Wynaad district, there are reckoned to remain 200,000 acres of reserve suitable for coffee. The chief seats of the culture are the Wynaad, the Nilgiris, Mysore, Coorg, and the Shervaroy Hills. The Wynaad, officially divided into north, south, and south-east, is a district in the collectorate of Malabar, about 70 miles by 25. Its coffee is conveyed to the coast for curing and shipment, that from the northern division to Tellicherry and that from the south to Calicut, principally on pack bullocks. The Nilgiris are a spur of the Western Ghat range, running eastward, and form a bold and lofty group of mountains, containing the culminating elevation of this part of India, at upwards of 8000 ft. above the sea-level. The slopes adjacent to the approaches to Ootacamund are covered with coffee plantations on every side. Labour is not over-abundant, the climate being found rather too cold and wet for the natives of the low countries; but many advantages of soil and climate render the district eminently suited for coffee cultivation. Some of the plantations are situated as high as 6000 ft. The port of shipment is Calicut, to which the crops are conveyed for a considerable distance by water. The Shervaroy Hills are situated in the centre of the Madras Presidency. Coffee cultivation has not made great progress so far, nor is the yield large. Possibly these hills are situated too far from the sea-coast, the climate being thus too dry; but by the judicious use of shade, such, for instance, as that of the jack-tree, this difficulty might be overcome. The district possesses great advantages in connection with labour supply and cheap transport, being tapped by the Madras and Beypoor Railway. In Mysore, the principal districts where coffee culture is carried on are Munzerabad and Nugger. The slopes of the hills that rise on the plateau of Mysore are thickly clothed with plantations; and on the Bababuden range, there is hardly a spot fit for coffee raising left unoccupied. The produce fetches the highest price in the London market. The port of shipment is Mangalore. This district furnishes labour to Coorg, and the Wynaad. The district of Coorg is some 60 miles in diameter, and its estates may be divided into three classes, each having peculiar advantages and drawbacks—the Mercara, the Ghat, and the Bamboo districts. The Mercara plateau varies in elevation from 3500 to 4000 ft., and is equally exposed to monsoon rains and dry easterly winds. It is well watered, the rainfall reaching 121 in., and being equally distributed throughout the year. Great precautions are needed against wash; shade is not usually required. The Ghat district was originally covered with thick forest, thus yielding a rich soil, whose fertility was increased by abundant humidity of climate. The estates have, however, been much injured by constant deforestation, by wash, and latterly by drought, and its attendant evils. The Bamboo district has an elevation of 3000–3300 ft., and an annual rainfall of about 65 in., gentle and seasonable. The ground is undulating, and the soil is very rich, not being exposed to wash. Shade is essential.

The seasons and operations in Southern India resemble in general those of Ceylon, but possess some peculiarities worth alluding to. There are distinct zones within which coffee will succeed; this is especially the case in Mysore, as has been admirably illustrated by Lewis Rice, in his exhaustive work on these regions. The raising of nursery plants is much more difficult on account of long drought and dry winds; abundance of water is, therefore, of vital importance. A northern aspect is best, being most moist during the dry season, and possessing the most uniform temperature: but it will be modified either eastwards or westwards, according to the locality, so as to suit the prevailing wind. On the western slopes of the coast ranges, the south-west monsoon bursts with such force that coffee cannot withstand it; in that situation, therefore, an easterly tendency of aspect is imperative. Further inland, the drier and hotter climate will compel a westerly deviation, so as to catch as much as possible of the monsoon rains. In the western or wetter districts, shade is inadmissible; in the eastern or drier districts, it becomes a necessity. The plan of leaving individual trees when the forest is cleared, is an objectionable and obsolete way of securing shade. With the first rains after the burn, there springs up an abundant of saplings of the charcoal tree (*Sponia Wightii*). In two years, it forms an ample shade for the coffee plants; but as it grows older, the foliage becomes thin; the tree, moreover, is but short-lived, and its timber is soft and watery. While, therefore, it affords an excellent temporary shade, it must not be relied upon for permanent shade, but be replaced by other growths; being extremely light, its removal need not damage the coffee. It must be cut down while still living, as its death is said to kill the coffee under it. For permanent shade, preference seems to be given to the jack-tree, as in Ceylon; but the *Bauhinia*, *Poinciana regia*, mango, and others have their admirers. In Mysore, all coffee grown is subject to an excise tax of 4 *annas* (6*d.*) a *maund* (25 lb.); in Coorg, there is no excise tax, but a land tax as follows:—for the first four years, *nil*; 5th–9th year, 1 *rupee* (2*s.*) an acre; thenceforth, 2 *rupees* an acre.

The following estimates (in rupees) for coffee cultivation in Southern India are based on the purchase of 300 A. of forest lands at 50 R., and 200 A. grass land at 25 R., bringing 200 A. of the former into full bearing; labour, 4 annas a day, exclusive of maistries' wages:—

First year:—Land, 20,000; tools, 350; felling and clearing, 50 A. at 20 R., 1000; coolie lines and bungalows, 1203; nursery containing say 1 lac of plants, for 2nd year's extension, 250; roads, to the estate and on the clearing, 230; lining out 50 A. at 3 R., 150; pitting, 50 A. at 5 ft. × 6 ft., say 1452 pits per acre at 4 as. for 20, 907; filling in pits, 151; plants, 75,000 at 7½ R. per 1000, 562; planting, 50 A., 90; cleaning and weeding, till 30th Sept., 50 A. at 6 R., 300; superintendent, 1320; writer, 360; maistries, 10 per cent. on coolie labour, 417; contingencies, 500; = total, 27,790 R.

Second year (cultivation, 50 A., extension, 50 A.): weeding, 900; filling up vacancies, 69; repairing buildings, 150; roads and trenching, 100; re-planting nursery, 133; additional lines, 350; tools, 250; felling, clearing, lining, pitting, filling, planting, cleaning up and weeding 50 A. at last year's rate, 2599; roads and trenching, 120; superintendent, 1800; horse, 400; writer, 420; maistries, 408; contingencies, 500; = total, 8199 R.

Third year (cultivation, 100 A., extension, 50 A.):—weeding 1800; filling up vacancies, 10 per cent. on 50 A., 69; and 5 per cent. on 50 A., 34; repairing buildings, 225; trenching and repairing roads, 150; re-planting nursery, &c., 166; topping and handling 50 A., 125; additional coolie lines, tools, and roads, as before, 720; felling, &c., &c., 50 A., as before, 2599; pulping-house, store, and pulpers, 4000; gathering 1250 bushels cherry (say 125 cwt.), at 4 as., 312; curing at 8 as., per cwt., 62; despatching to coast, at 10 as. per bushel parchment, 390; superintendent, 2620; writer, 480; maistries, 559; contingencies, 500; = total, 14,811 R.

Fourth year (cultivation, 150 A., extension, 50 A.):—weeding, 2700; filling up vacancies, 139; repairing buildings, 400; roads and trenching, 250; nursery, 100; topping, handling, and pruning, 425; additional coolie lines, tools, and roads, as before, 720; felling, &c., &c., 50 A., as before, 2599; completing store and pulping-house, 2000; gathering 4250 bushels cherry (say 425 cwt.), 1062; curing, 212; despatching to coast, 1328; superintendent, 3120; writer, 540; maistries, 789; cattle-shed, 1000; cattle (75 head), at 30 R., 2250; keepers, &c. (6 men), 432; contingencies, 500; = total, 20,566 R.

Fifth year (cultivation, 200 A.):—weeding, 3600; filling up vacancies, 173; repairing buildings, 500; roads and trenching, 400; nursery, 100; topping, handling, and pruning, 850; manuring 50 A. at 40 R., 2000; gathering 7250 bushels cherry (725 cwt.), 1812; curing, 362; despatching to coast, 2265; permanent bungalow, &c., 5000; cattle (25 head), 750; keepers (6 men), 432; superintendent, 3620; writer, 600; maistries, 981; contingencies, 500; = total, 23,945 R.

Sixth year:—weeding, 3600; filling up vacancies, 175; buildings, 500; roads and trenching, 500; nursery, 100; pruning and handling, 2000; manuring, 2500; gathering 10,250 bushels, 2563; curing and despatching, 3715; stock, 1200; superintendent and writer, 4220; maistries, 1000; contingencies, 500; = total, 22,573 R.

Seventh year:—cultivation, 9375; gathering, 12,000 bushels cherry (1200 cwt.), full crop, 3000; curing and despatching, 4350; stock, 1200; management, 5220; contingencies, 500; = total, 23,645 R.

The balance-sheet will then stand as under:—

	Rupees.		Rupees.
1st year:—To expenses ..	27,790	By balance	27,790
2nd year:—To balance ..	27,790	By balance	35,989
„ expenses ..	8,199		
	35,989		35,989
3rd year:—To balance ..	35,989	By 125 cwt. crop, at 45 R.	5,625
„ expenses ..	14,811	„ balance	45,175
	50,800		50,800
4th year:—To balance ..	45,175	By 425 cwt. crop, at 45 R.	19,125
„ expenses ..	20,566	„ balance	46,617
	65,742		65,742
5th year:—To balance ..	46,617	By 725 cwt. crop, at 45 R.	32,625
„ expenses ..	23,945	„ balance	37,937
	70,562		70,562
6th year:—To balance ..	37,937	By 1025 cwt. crop, at 45 R.	46,125
„ expenses ..	22,573	„ balance	14,386
	60,511		60,511
7th year:—To balance ..	14,386	By 1200 cwt. crop, at 45 R.	54,000
„ expenses ..	23,645		
„ balance ..	15,969		
	54,000		54,000
Subsequent years:—To expenses	23,645	By 1200 cwt. crop, at 45 R.	54,000

Among other Indian districts where coffee cultivation has been tried, it is reported from Chittagong that it yields 9, and even 12 cwt. an acre, and that thousands of acres of excellent land can be got near navigable rivers, and where manure and labour are abundant. The joint culture of coffee and tea is strongly recommended in this district, labour being available for each in its season. It has been tried, but with little success, in the neighbourhood of Darjeeling. It seems very doubtful whether occasional cold will not always be a bar to the general spread of coffee in N. India.

The quantities and values of the coffee exports from British India (excluding Ceylon), for the last five years of which statistics have been issued, were respectively:—1874, 40,815,040 lb.; value, 1,487,411*l.*; 1875, 34,925,072 lb.; value, 1,305,335*l.*; 1876, 41,662,432 lb.; value, 1,627,027*l.*; 1877, 33,872,768 lb.; value, 1,345,882*l.*; 1878, 33,300,624 lb. value, 1,338,499*l.*

The drought of 1877–8 affected the coffee plantations, and would of itself sufficiently account for diminished exports, if the leaf disease and the borer did not help to keep down the yield. The average value per cwt. was a little higher than in 1876–77, having been just over 45 rupees as compared with 44·4. The United Kingdom and France are the two largest consumers of Indian coffee, although in both countries it is subject to excessively heavy duties. The Australian colonies consume large quantities of tea and coffee; but they take neither the one nor the other from India. Producers in India have hitherto found a ready market in Europe for their whole production, and have had no inducement to essay the opening of a trade with Australia. Nevertheless the trade would certainly become a source of considerable profit to India, and it would be well worth while to direct attention to the matter. The exhibitions at Sydney and Melbourne offer excellent opportunities for introducing these staples to the notice of the colonists.

Following is an abstract of a paper on Indian coffee read by Frederick Clifford before the Society of Arts on March 25, 1887.

"At the outset we are confronted with the fact that since 1880–1, from various causes, the export of coffee from India, and therefore its production there, has almost continuously declined. In 1885–6, indeed, the quantity shipped was the largest on record, amounting to 43,000 cwt. in excess of 1884–5, but this was a result due to unusually heavy crops, and not to extended cultivation. When the figures for 1886–7 come to be published, the season's crop will, I fear, be found the smallest during the previous decennial period, showing a fall of not less than one-third in the quantity exported, for the short crops which are reported in Brazil and other countries have their counterpart throughout India, and especially in Mysore, to which my own information especially applies. Here are the returns of coffee exported from India during the last ten years :—

	cwt.		cwt.
1876–7..	302,489	1881–2..	346,364
1877–8..	297,327	1882–3..	353,324
1878–9..	341,186	1883–4..	340,025
1879–80	359,313	1884–5..	328,317
1880–1..	369–357	1885–6..	371,027

"Allowing for last year's exceptional crop, these figures do not show satisfactory results. But, considering the drawbacks with which planters have everywhere had to contend it is perhaps something that in Southern India they have been able to hold their own. As it is, placing the principal exports of 1885–6 from India in order according to their estimated value, coffee stands tenth on the list, thus :—

	Lacs of rupees.
1. Grain and pulse	1760·81
2. Cotton, raw	1077·72
3. Opium	1073·55
4. Seeds	994·83
5. Hides and skins	533·46
6. Jute, raw	435·53
7. Tea	430·61
8. Indigo	378·31
9. Cotton twist and manufactures	363·55
10. Coffee	134·84

"Tea-growing, though a younger industry in India, now stands seventh in the list, and during the same ten years the exports of tea have progressively increased as follows:—

	lb.		lb.
1876–7	27,784,124	1881–2	48,691,725
1877–8	33,459,075	1882–3	57,766,225
1878–9	34,432,573	1883–4	59,911,703
1879–80.. ..	38,173,521	1884–5	64,162,055
1880–1	46,413,510	1885–6	68,784,249

"Indian coffee-planters cannot, unfortunately, point to a similar ever-increasing demand in England for their special products.

"Area under cultivation for coffee. In the Statistical Tables for British India, compiled by the Department of Finance and Commerce, and published at Calcutta in 1886, 187,541 acres in Southern India are reported as under coffee cultivation with mature plants in the year 1884. Divided into districts, the following results are shown:—

	acres.		acres.
Mysore	82,462	Travancore	4,305
Madras	56,247	Cochin	2,211
Coorg	42,300		

"The Madras returns include the Nilgiri Hills and the Wynaad, important homes of coffee. Only nine acres are grown in Bengal. These figures do not show the whole area under coffee cultivation, but only that occupied by mature plants. Unfortunately, the figures are so defective that the official compiler himself admits that it is not possible to make any useful comparison with former years.

"It will be of interest to compare these figures with the fuller and far more satisfactory details furnished in this valuable volume as to the growth of tea-growing industry in India. In 1875–6, the first year of the series supplied, 124,836 acres were under tea cultivation; in 1884, the acreage was 267,710. Thus, within these ten years, the acreage under tea in India increased by 115 per cent., while the outturn increased by nearly 149 per cent.

"Outside Mysore, the acreage under coffee seems to have been considerably reduced. For example, 263 plantations in Malabar have been abandoned since 1877. In many cases this land was unsuitable for the growth of coffee through too great rainfall and exposure to the south-west monsoon, and other causes. In Coorg, the area appears likewise to have diminished through disease and unprofitable crops. On the Nilgiris, and in Travancore, the planters have turned their attention to tea; in 1884, 5550 acres were under tea cultivation in those districts.

"Besides the area occupied by mature coffee plants, the returns show approximately, during the three years 1881–3, the acreage under immature plants, and that taken up for planting, but not yet planted, throughout Southern India. The total area occupied by coffee in all stages of growth, and of land taken up for coffee, is as follows:—

	Acres.			
	1881.	1882.	1883.	1884.
Mysore	166,369	144,736	141,215	141,716
Madras (including Malabar and the Nilgiris	133,591	111,468	108,358	110,328
Coorg	77,474	75,922	74,074	73,199
Cochin	7,702	8,251	8,251	7,819
Travancore	14,645	12,894	11,386	13,361
	399,794	353,286	343,346	346,432

"In 1885, the return shows in Madras, in round numbers, a total area under cultivation of 65,000 acres, giving an approximate yield of 12,241,544 lb., and an average yield per acre from mature plants of 218 lb. In Mysore, there was an area of 104,500 acres, yielding 4,892,987 lb., or an average crop from mature plants of 59 lb. per acre! In Coorg, the total yield from 49,300 acres is returned at 8,975,680 lb., or an average yield of 212 lb. per acre;

while Cochin shows an average yield of 414 lb. per acre from 2650 acres, with a total outturn of 920,000 lb.; and Travancore 262 lb. an acre from 4800 acres, with a total crop of 1,129,480 lb. I cannot say upon what basis the estimates of crop rest, but in Mysore half a cwt. per acre is a wholly inadequate yield: six or seven times that quantity would not be too high an average produce.

"Distribution of Exports from India.—Owing to the reduced or stationary consumption at home, efforts have recently been made by Indian planters to open up fresh markets abroad. Some of my own crop last year was, for the first time, consigned to Marseilles, and I know that planters have visited Genoa, Alexandria, Cairo, and other places, in order to establish, if possible, commercial relations there. For many years Indian coffee has been in demand at Mangalore, Calicut, and other ports on the West Coast, for export to Arabia. Native dealers visit the various estates in my own districts (Sullabile and Bali-Honur), buy what is termed 'native' coffee, and send it by bullock-waggons to the coast, where it is re-purchased by Arab merchants, and shipped in their dhows to ports in the Persian Gulf. Here it is treated, and I believe that a good deal of it ultimately finds its way into the English and other markets as Mocha coffee. Thus the Arab traders have little to learn from those of more civilised countries in the art of making the most of their opportunities.

"As little seems to be known in England of the extent to which Indian coffee finds its way direct into foreign markets, I will give here a table showing the quantity exported from British India during nine months of 1886 (from April 1 to December 31), compared with the corresponding periods in 1884 and 1885. These figures are taken from the last report issued by the Government of India (Department of Finance and Commerce), and published by order of the Governor-General in Council :—

	1884.	1885.	1886.
	cwt.	cwt.	cwt.
To United Kingdom.. ..	55,679	55,903	81,611
„ Austria..	586	517	2,875
„ France	101,452	78,205	92,024
„ Egypt	3,904	6,647	9,420
„ Arabia	6,429	11,760	7,325
„ Persia	8,469	9,809	6,624
„ Turkey in Asia	5,800	6,860	5,343
„ Other countries	1,700	8,988	10,120
	184,019	178,689	215,342

"This table does not include the three months, January, February, and March, in which coffee is chiefly shipped to England. It shows, therefore, the apparent anomaly that France receives more than the United Kingdom, a result probably due to the fact that the later shipments consist, to an unusually large extent, of inferior qualities, picked late in the season, or kept apart from the home supply. England and France take the bulk of the exports. In 1884–5 about 34,000 cwt. were sent to Persia, Asiatic Turkey, Arabia, Egypt, and the East African coast.

"It is disappointing to find that the United States make no separate appearance in this return, although they contain a population who are said to drink eight times more coffee than tea. Indian producers may be pardoned for the belief that, in restricting consumption mainly to Brazilian and South American qualities, drinkers of coffee in the United States deny themselves the enjoyment of its more delicate and aromatic properties. But it is difficult to turn the accustomed course of trade, or oust a commodity with which the national palate has become familiar. Three or four years ago a strenuous attempt was made by Indian tea-planters to stimulate a demand for their product in Australia and the United States, but I believe the result has not answered expectations. It will be seen, on the other hand, that Mahomedan drinkers of coffee value Indian growths, and that an appreciable proportion of our exports finds its way to Asiatic Turkey, Egypt, Arabia, and Persia.

"Native Coffee.—Probably the larger part of this consumption consists of the cherry or native coffee before mentioned. This term is not necessarily, as might be supposed, limited to coffee grown by natives, but comprises berries from immature trees, or berries which drop from the trees, and are not sent to the pulping-house. Having no proper appliances for stripping these berries of their pulp, the natives expose it in the sun for about a month, until it is thoroughly dry. The same method is adopted in European plantations when the coffee is not thought good enough for the English market. On a young plantation of my own, in the Bāli-Honur district of Mysore, the whole crop of five tons has been so treated this season, and sold to native dealers. The natives use a primitive process, called 'pounding-out,' for separating this dried pulp from the bean. A small heap of the dried berry (or cherry coffee, as the planters call it, from its resemblance when picked to the black-heart English cherry) is placed in a hole scooped in the ground. A man, or sometimes a woman, pounds this with a pole, until the beans, or the greater number of them, are extracted from their outermost covering, when a fresh lot is taken. The result is a substance resembling chaff, or bran, mixed with coffee-beans. These are separated by women, in a light bamboo tray, shaped not unlike a housemaid's dustpan. By a peculiar action of the hand, difficult to describe, the tray is jerked forward, so that the light refuse-husks approach the front, or lip of the tray. These are then pushed out, the beans are heaped together, and successive trays-full are similarly dealt with, until at length the whole crop is disposed of. Not having seen the process mentioned in any of the planters' books, I give this description of it, sent by one of my sons. In rural districts the natives excel in this method of separating the pulp and bean, as they clean their rice in the same fashion, pounding the grain to free it from the husk. Little of this native or cherry coffee reaches

Mincing-lane from India, except, perhaps, in the guise of Mocha, or mixed with Mocha, but it finds a ready market among Mahomedans outside India, and is also shipped to Trieste and Marseilles.

"Land Tenure.—In British territory, where coffee is grown an acreage tax is always levied. In Coorg this tax is two rupees an acre, but is not paid until twelve years after the land is taken up, so that the planter may have a crop out of which to meet this outgoing. Mysore, as a native State, maintained, until 1885, an Excise duty upon both coffee and cardamoms. On coffee this duty was one rupee per cwt., which, upon a crop of four cwt. per acre, amounted to an onerous tax, and was felt to discourage good cultivation. On the other hand, the Government derived no revenue until crops were yielded. Jungle lands were, therefore, taken up for coffee as a speculation, and often remained long uncleared in the hope that such lands would rise in value, and with a view to re-sale. Thus a tax upon the producer, besides being difficult to collect, diminished the receipts of the Government, and was not in the interests of *bonâ-fide* planting.

"Coffee land in Mysore may now be held either on a perpetual settlement, subject to an average tax of a rupee and a half per acre, or on a thirty years' settlement, with an average duty of one rupee. Grass land not suitable for cultivation, but held along with coffee land for feeding purposes, pays at a lower rate. In grants of jungle, the Government reserve the right to seven timber trees, including sandal, teak, and blackwood; but the occupier may fell, free of charge, any such timber, except sandal, if for his own *bonâ-fide* use. He may also buy all these reserved trees upon the estate, except sandal, at a fair valuation, paying the purchase money by instalments. Or, again excepting sandal, he may fell these trees for sale upon paying a royalty or seignorage. The Government likewise reserve the right to precious stones, gold and other mineral, including coal, but upon re-entry in the exercise of this right full compensation must be given to the occupier for all damage done. When lands are held in perpetuity upon the full average assessment, the owner has a preferential right to work any mines on paying a royalty of not more than 5 per cent. upon the gross proceeds of any gold or other minerals, and of not more than 10 per cent. on the value of any precious stones. On the whole, this Settlement of March 24, 1885, has fairly protected the interests of British planters in this important coffee centre of Southern India, and their tenure is practically as secure as that of their fellow planters in the neighbouring Presidency.

"Supply of Labour.—A difficulty in obtaining labour would not be expected amidst a teeming population like that of India. But this difficulty exists in some districts. Near villages the problem is simple enough. There you can generally have as many hands—men, women, and children—as you want, and when they are wanted. In the jungle, however, where new coffee lands are generally opened, labour has to be attracted from considerable distances. As there are no villages in which coolies can be received, the planter has to begin by building coolie 'lines,' as they are called. Money is well spent in making these abodes comfortable and healthy. Bamboo, easily procured, is chiefly used, and is an excellent material for such buildings. The walls are plaited bamboo, over which clay is plastered till it looks like a wall; the roof is grass-thatched. The coolies cater for themselves at the nearest market or bazaar, but it is necessary for planters to keep a stock of grain in store. In times of scarcity or famine, the people are driven from their villages to seek work, and labour is plentiful enough. At such times, European capital and enterprise, scattered all over India, save thousands of lives, by means far more prompt and certain than any relief camps or other machinery within the reach of Government. If for this beneficent result alone, British investors in India should receive every encouragement.

"When there is no particular stress upon them to work

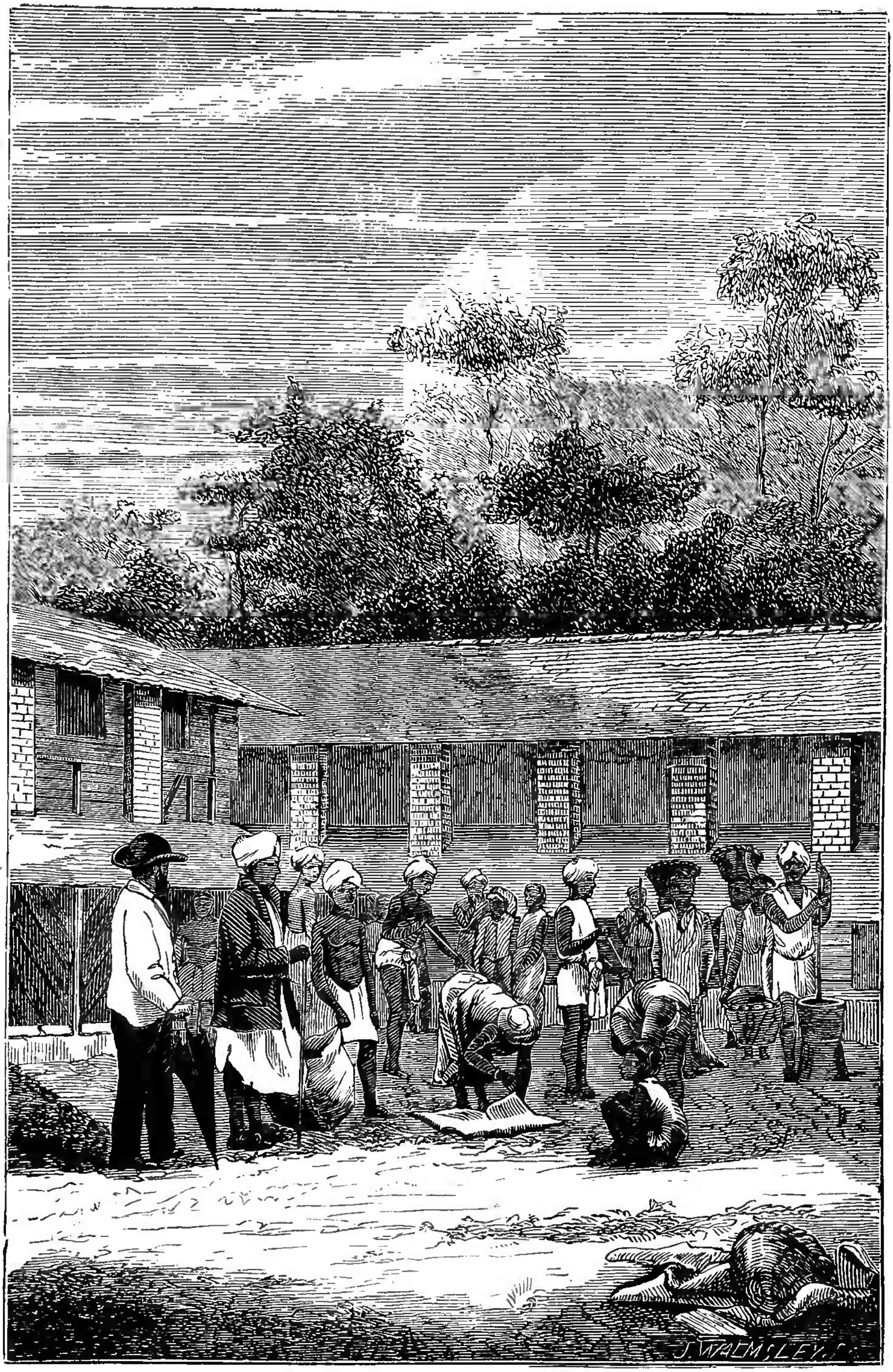

PLATE XI.—DRYING FLOOR, CEYLON.

[To face p. 208.

outside their own village land, the natives, like people in the same condition of life, or, indeed, in every condition of life, all the world over, have no particular inclination to go far afield for employment. But labour must be had, or crops would neither be raised nor gathered. The planter must either himself beat up for recruits, or employ intermediaries to do so. He naturally chooses the latter alternative. Then his troubles begin. His agents cannot act without advances to meet their own expenses. The coolies they engage must be able to leave some rupees behind them to support their families in their absence. These advances at once beget temptation, both among the coolies and the 'maistries' who engage them. Defaulting maistries and runaway coolies vex the souls of most planters. If you pursue them, for example's sake, time and temper are sorely tried, in a dilatory legal process, before a native court, and you get small satisfaction, often none; restitution, hardly ever.

"It is a vicious system. Planters cry out against it, and have tried to dispense with it, but with little success. The advance account on my own estate books, and probably those of most owners, tells a dismal story of bad debts wiped off, and doubtful debts carried to suspense. In a correspondence with the British Resident at Mysore last year, Mr. Buchanan, Honorary Secretary of the North Mysore Planters' Association, stated that he had ascertained that the amounts then outstanding against defaulting labour contractors made a total of over 50,000 rupees in the Kadur district alone; and he added that, under the existing laws, planters were quite unable to recover this money, as no proceedings could be taken against the contractors in question outside Mysore territory; they were safe by just crossing the boundary into Madras. We all protest against the system of advances, but it flourishes in spite of protests. Its worst feature perhaps is that a planter can never feel sure how much, if any, of the advance has reached his coolies. Maistries sometimes exact heavy interest upon money lent by them to coolies, though the money really belongs to the planter. This extortion goes on, of course, without the planter's knowledge, though the coolies are made to believe that he demands and receives the interest. If a planter does not speak Canarese, the local dialect, he is almost at the mercy of roguish maistries and overseers, and cannot protect his workpeople from injustice and robbery.

"We will assume that there is no fraud in the first hiring and the advances made on account of it, and that each maistry starts with his gang of coolies to fulfil their engagements. For police or sanitary purposes, or both, these gangs are stopped on their march at each police-station along the road, and toll is sometimes demanded here before they are allowed to proceed. On reaching the estate, they may find the damper, colder climate in the hills unsuitable to their constitutions. In Balihonur, for example, the thermometer in the early morning is at 52°; at 2 p.m. it may stand at 94°. Natives, again, are quite as liable as Europeans are to attacks from dysentery or jungle fever. They take fright and desert if fever or cholera carries off any of their number; or if, through accident in felling the jungle trees, they think an estate unlucky, and haunted by the wood demons in whom they believe.

"No doubt it must often happen that coolies are deceived by false representations made to them by maistries as to work or wages, or they become home-sick, or anxious about their kith and kin left behind. Supposing that they have worked out their advances, small blame to them if, in some of these cases, they decamp with a few rupees of earnings. A coolie, it is said, can easily feed and clothe himself on one-third his earnings upon a coffee estate in Southern India. Like the negro, he seldom works for the sake of saving money; but here, again, human nature is very much the same in Europe as in India.

"While many excuses can be made for natives who repent their bargains and wish to go home, the planter is probably in despair for want of labour to clear or weed his land, make or mend his roads, attend his nursery, or pick his ripening berries. In a letter received by this week's mail from one estate, the manager says:—'All my Ghaut labourers are leaving me through illness, and I don't know where to turn for more. The labour question is most wearying.' With a view to avoid some of the existing difficulties, the Mysore planters are trying to arrange for a regular supply of Tamil coolies from Tanjore, Tinnevelly, Madura, and other districts in the extreme south of the Madras Presidency which send labour to Ceylon. Although you cannot rely upon the Canarese for labour just when it is wanted, they have many good qualities if their idiosyncrasies are studied, and they are kindly and considerately treated. They seem to work best with their own tools in their own fashion. Some of you may have seen a sketch of three natives toiling at one English shovel. A bare-footed coolie cannot force it into the ground, so in the sketch three of them are struggling with the shovel, one with a rope to haul it over or on the ground. The picture represents, truly enough, no doubt, the failure of many attempts to make natives use model European implements.

"But it is unjust to represent the natives of India as obstinately opposed to all novelties. When they clearly see an advantage from new inventions, they are not slow to adopt them. For example, kerosene oil from the United States is now used everywhere in India, in towns at least, for illuminating purposes, and has largely displaced the vegetable oils formerly employed by natives. In 1885–6, over 20,000,000 gallons of mineral oil were imported from the United States; in the previous year, 26,000,000 gallons. The bazaars are full of cheap glass lamps for burning this mineral oil. Lucifer matches, in value over 20 lacs of rupees, are now imported annually (chiefly, I am sorry to say, the cheap Swedish matches), and have quite displaced the old sulphur-tipped sticks, which required the application of fire to light them.

"Apologising for this little digression, I now return to our coolies. That they shirk work unless well looked after is a failing not confined to Canarese workpeople. 'An

Englishman chafes,' says one of my estate letters, 'to see them potter over a job, leave it for no known cause, begin again, and break off again, with endless delays and impotent excuses. Hindoo, or Mussulman, it is always the same; he cannot finish his work straight away. 'Never do to-day what you can by any pretext put off till to-morrow,' is a maxim he has learned from his earliest youth, and has inherited in practice from countless generations of ancestors. He is sick; it is a festival; something has gone wrong—it is an unlucky day; he wants two or three rupees on account for marketing. Mild and amenable as he seems, you will not, either by kindness or righteous wrath, overcome this ingrained procrastination. The monsoon is at hand, and you are in a fidget to get the tiles or other roof-covering on to your new store or bungalow. At last a beginning is made, and now you hope for steady work. Alas, no! There comes a messenger from the village of your best artisans. Somebody's daughter is going to be married, with great rejoicing. Somebody else's mother-in-law is dead. An old uncle has tumbled down a well; or fifty other events delay your work once more.'

"It will be gathered that, in his dealings with workpeople, a coffee-planter's lot is not entirely a happy one. Patience and forbearance, with firmness, are, in fact, essential. But his reward must be great if he can gain the respect and goodwill of a docile, temperate, and even too submissive people, and if at crop-time he can see men, women, and children earning wages for themselves and bringing fair profit to him. They are paid for each bushel of berries picked, and are thus under a stimulus to do their best. The work is easy; and the women and children with their agile fingers can generally reach the topmost branches and earn nearly as much as the men. It is a harvest in all senses; healthy work, cheerfully performed and fairly paid, bringing comfort and plenty to many hundred native homes. This is piece-work; the ordinary rate of wages on a coffee estate is four annas a day for men and two for women.

"Crops.—Upon a virgin soil, during favourable seasons, crops are recorded, in Southern India, as well as Ceylon, which fill the younger generation of planters with wonder and envy. Mr. Hull tells us that 25 years ago, before leaf disease blighted the prospects of coffee-planting in Ceylon, one estate there yielded a crop of 22 cwt. an acre, and 13 cwt. the year after. I have been told by a planter in Guatemala, that upon the wonderfully deep and rich soil there, 18 cwt. or 20 cwt. per acre can be grown, without manure, almost continuously, and that the planter can count upon a sufficient profit if he obtains an average price of 40*s.* per cwt. In Southern India, planters have learned, by sad experience, that coffee land may be soon exhausted, and requires a liberal return in manure. Another lesson is, that the coffee-plant, which is, we must remember, an exotic in India, requires protection, and flourishes best under shade. It is forced, indeed, into unnatural activity when exposed in the open, and for a time yields more than when grown under shelter, but seems to be soon exhausted, and then, naturally, falls an easier prey to insect plagues and disease. In Mysore, and most other districts in India, the coffee bush alluded to grows to a height of four or five feet, and is protected by such forest trees as are found to be congenial neighbours. Some trees do, and some do not, answer this description, and whether given trees are harmful or beneficial in the shade they give is a point to be studied. When coffee is grown under shade, and so kept from being over-stimulated by sunshine, planters have to be content with an average yield of from three to five cwt. per acre, depending upon soil, situation, and a free or stinted use of manures. A bumper crop is invariably followed by reaction and diminished production; the tree has given up its normal strength in making this effort, and next season requires rest for a fresh departure. Even five cwt. are a sad 'come down' from the glorious crops of old. But according to the proverb, 'he laughs best who laughs last;' and a cultivation to be successful must be based on conditions which promise permanence.

"Effect of low rate of exchange upon production.—It is hardly possible to discuss any economical question concerning India without referring to the depreciated currency. Has a low exchange benefited Indian planters? Speaking from individual experience, I answer 'Yes.' Persons who are paid in rupees, and must remit home rupees, find a low exchange disastrous. A planter, on the other hand, sends home not silver but produce, which he sells for gold. With the proceeds he buys rupees at the rate, say, of 1*s.* 6*d.*, and sends them to defray the cost of cultivation. On his chief expenditure, labour, the rupee goes very nearly as far as ever it did. It seems to follow that a planter in India gains largely from a low exchange. For instance, 75*l.* in gold purchase silver which used to cost 100*l.*; and the equivalent thousand rupees have a purchasing power in India not very appreciably less than when the rupee stood at two shillings. The result must surely be that growers and importers of Indian produce are better able to meet competition in European markets, and that production must also be stimulated in India. Another result of a low exchange, in my case and probably in other cases, has been to lead to the opening out of fresh land for cultivation. Investors naturally think that a time when rupees are so cheap is a favourable time to buy them, and convert them into bits of jungle, materials, and labour, in a country where rupees for such purposes stand nearly at their old value. Hence, fresh capital has been attracted for investment in India, new employment has been found for native labour, and increased produce grown there for European consumption.

"Authorities entitled to respect declare, however, that this reasoning is unsound, and leaves out of sight important factors which affect trade in a greater degree than exchange. Indian exporters, it is contended, do not really receive a larger rupee return for their produce than they received when exchange was higher, because prices of this produce in the home market have fallen in a proportion sometimes even greater than the fall in the exhange. Thus, the average rate of exchange in 1872–3 was 22·18*d.*, in 1885–6 it was 18·25*d.*, or a difference of about twenty per cent. During the same period prices in London fell as follows :—

Coffee ..	42·4 per cent.	Cotton ..	38·6 per cent.
Wheat ..	33·7 "	Rice (Bengal)	18·4 "
Tea	34·0 "	Jute	17·4 "

"Any of my hearers who wish to enter more fully into this field of inquiry or speculation, will find ample materials in an able essay by Mr. J. E. O'Conor, Assistant Secretary to the Government of India in the Department of Finance and Commerce, published in a Blue-book of 1887, upon the trade of British India. Mr. O'Conor's conclusions are that any benefits resulting to Indian producers from the fall of exchange have been neutralised by a still heavier fall in prices brought about by the appreciation of gold. It may be that the price of coffee has fallen, in part, through the appreciation of gold. But I think the chief cause of this fall has been an enlarged area of cultivation in many parts of the world, and increased production, relatively, to consumption. In the essay under notice this factor is ignored.

"Meanwhile, India is, year by year, adding to the appreciation of gold by withdrawing it from the circulation of the world, although Mysore is doing something to restore the balance, by extracting further supplies from its gold mines. In 1885–6, the net imports of gold fell off considerably, but in the previous six years twenty million pounds sterling in gold were absorbed in India, to be hoarded by native producers there.

"Decreased Consumption in the United Kingdom.—I now come to a part of my subject which causes great regret to all producers and importers of coffee, a regret which should be equally shared by all who appreciate this delicious beverage for itself or as a substitute for alcoholic stimulants. First, the total imports of coffee into the United Kingdom have largely diminished, as the figures for the last eight years prove:—

	Imports. Tons.	Exports. Tons.		Imports. Tons.	Exports. Tons.
1879	80,900	64,400	1883	69,900	48,700
1880	77,800	58,700	1884	56,700	48,100
1881	60,600	47,700	1885	51,800	36,800
1882	67,900	49,800	1886	51,400	38,600

"These figures, taken from the returns of the Board of Trade, prove, first, that much coffee which used to come to this country for reshipment now finds its way directly to its place of final destination. A still more serious fact is a stationary or decreasing consumption in the United Kingdom itself. During the foregoing eight years the quantity of coffee taken out of bond for home consumption has been in round numbers:—

	Tons.		Tons.
1879	15,500	1883	14,500
1880	14,500	1884	14,700
1881	14,300	1885	14,900
1882	14,300	1886	14,400

"During January and February of the present year, the Board of Trade returns tell the same tale. The deliveries from bond for consumption during these two months, in 1885, were 53,458 cwt.; in 1886, 52,498 cwt.; and in 1887 they fell to 46,608 cwt.

"Notwithstanding the increase of population, therefore, less coffee is consumed year by year in the United Kingdom, a fact which is even more striking when our retrospect is extended.

"In the year 1874, Mr. W. P. Branson read a paper before this Society, in which he showed that, down to the year 1840, when mixtures of coffee with chicory were for the first time allowed, coffee held an equal place with tea in public estimation, and their consumption was relatively equal. Since then, coffee has rapidly declined in favour, 'strangled,' as Mr. Branson tersely put it, 'by its unholy alliance with chicory.' I may appropriately quote here his Table showing the diminished consumption of coffee from 1847 to 1873 :—

	Duty paid on.	Population.	Average consumption per head.
	lb.		oz.
1847	37,441,373	27,105,000	22
1857	34,352,123	28,278,000	19
1867	31,567,760	30,151,084	16¾
1869	29,109,113	30,541,606	15¼
1873	32,329,920	..	15¾

"Another calculation from a different source, but in substantially the same form, brings down the figures to a later date, and shows the average annual consumption of coffee, per head, of the total population, compared with the consumption of its more prosperous rivals :—

	1860.	1870.	1880.	1883.
Coffee (lb.) ..	1·23	0·98	0·92	0·89
Tea " ..	2·67	3·81	4·59	4·80
Cocoa " ..	0·11	0·20	0·31	0·36

"Causes of diminished consumption. Use of Adulterants.— You may easily suppose that all growers of coffee in India and the Colonies, and all persons interested in the import and sale of coffee, are much dissatisfied with this state of things, and ask to what causes it is due. That tea should increase in favour we can all understand. It is easily made; it is much cheaper than it used to be; and, perhaps, it goes further than coffee of the same value. We do not in the least grudge to tea its wonderful success, but there is room enough for both these refreshing, stimulating beverages. And when every allowance has been made for the natural advantages of tea, we ask, how it is that England is probably the only civilised country in the world in which the consumption of coffee does not increase with its increase of population?

"One answer to this question is, that in the United Kingdom the adulteration of coffee is sanctioned by the Legislature. The Sale of Food and Drugs Act, 1875, on the one hand punishes dealers for adulteration, but, on the other hand, protects them if they sell adulterated coffee bearing a label 'to the effect that the same is mixed (section 8). As regards coffee, the consequences have been disastrous. Coffee mixtures have supplanted pure coffee so largely that, to quote a leaflet distributed to visitors by the Indian Coffee Committee, during the late Exhibition,—

"'Large classes of the population hardly know the flavour of genuine coffee. Chicory is the chief ingredient in the cheap mixtures, because it soon makes hot water black, thick, and bitter, and so gives apparent strength to what may contain little of the coffee berry. Among numerous other substances used to adulterate coffee are burnt sugar, roasted and ground roots of dandelion, carrot, and parsnip, together with beans, lupins, and other seeds.'

"According to the same authority,—

"'An analysis of 43 samples of coffee and coffee mixtures purchased in London during March and April, 1886, showed an average proportion of coffee in these samples of just 50 per cent., added to 50 per cent. of burnt sugar and various vegetable substances. Twenty-two of the samples bore a label very commonly used; and nine of those contained from 62 to 93 per cent. of chicory, &c., averaging 70 per cent. of other substances than coffee. These mixtures are sold at prices ranging from 10*d.* up to 1*s.* 4*d.* per pound. Upon a moderate calculation, the vendors of many of the wretched compounds just mentioned must be realising profits of something like 100 per cent., and the worse the mixture, the greater the profit.'

"Similarly, the annual reports of the Local Government Board show that coffee is one of the chief subjects of adulteration with which the inspectors under the Food and Drugs

Act have to deal. We are told by the Board, in their report for 1884–5, that 'it is no rare thing for so-called 'coffee' to be sold, which proves on analysis to be composed of one-fourth part of coffee, added to three-fourths of chicory,' and as chicory only costs 3*d.* or 4*d.* per pound, the sale of such mixtures is very profitable.

"Mincing-lane is at one with the growers of coffee in the wish to promote consumption by checking what are really more or less fraudulent practices, and an Association has recently been formed with a view to urge the Government to interfere. Chicory, as you know, bears the same duty, 14*s.* a cwt., or 1½*d.* a lb., as is levied on coffee. As far as fiscal arrangements can do so, it is thus raised to the same dignity as coffee, though it does little more than blacken the water and destroy the true aroma of genuine coffee. I will not weary you by entering at length into this vexed question. Some gentlemen in the City are of opinion that our Coffee Association should only ask for legislation requiring all dealers and retailers to declare on their labels the proportions of chicory or other adulterant used. In the view of the majority of its members, however, the Association should ask the Government to prohibit any mixture of other articles with coffee for purposes of sale, leaving the public to buy chicory, if they want it, and mix for themselves, a process perfectly simple and easy. They would then pay for chicory exactly what it is worth for infusion as a beverage, and that is very little. They would gain greatly in pocket by this separation; they would also become accustomed to the taste of genuine coffee; and we hope and believe that, under these combined influences, coffee would recover some of its lost ground. At all events, it would not then be handicapped as it now is, by a hateful union with inferior ingredients; a union which, as magistrates' cases all over the country show, opens the door for innumerable frauds, practised chiefly upon poor consumers, while it depraves the public palate, destroys the aroma and fragrance of genuine coffee, and discredits it as a national beverage.

"Prices and Prospects.—In 1883, average Mysore coffee, of No. 1 quality, fetched, in Mincing-lane, from 90*s.* to 105*s.* per cwt. Since then, whether from appreciation of gold, or from an enlarged area of production outside India, prices have had a lamentable drop, realising no more than from 70*s.* to 85*s.* I omit exceptional brands of Mysore which have an exceptional reputation, and the price of which has undergone hardly any variation. Short crops in 1886–7 have given a welcome fillip to prices, and last week's sales of Indian coffee approached nearly to the old level. With prudent management, if a planter is able to avoid loans at high interest, I believe that coffee estates in Southern India will give a good return for the capital invested in them. Fortunately, the quality of Indian coffee, and the care used in picking and curing it, give it a far better position in the home market than the produce of foreign countries. Fluctuations in prices, as in 1879, and prices per cwt. of Ceylon coffee, relatively to those of coffee grown elsewhere, will be seen from the following Table, taken from a trade circular:—

Years.	Prices 31st December.				
	Middling. Plantation Ceylon.	Good ordinary Foxy. Guatemala.	Good ordinary. Java.	Good Channel. Rio.	Good average. Santos.
	Shillings.	Shillings.	Cents.	Shillings.	Shillings.
1879	101	71	48	69	72
1880	84	59	38	53	58
1881	75	50	33½	42	44
1882	70	41	27	34	35
1883	75	53	35½	54	53
1884	65	47	28	43	43
1885	62	40	25½	37	38
1886	80	65	39½	..	..

"It is somewhat comforting to find that British grown coffee is worth twice that of the inferior coffee grown elsewhere. Compared with the bulk of foreign coffee, British production and home consumption are but as drops in the bucket. For example, the estimate of the world's crop of coffee in 1885–6 was as under:—

	Tons.
British India	17,000
Ceylon	11,000
Dutch India	59,000
Africa, Mocha, and Manilla	14,000
St. Domingo, Port Rico, and Jamaica	50,000
Costa Rica, Venezuela, New Grenada, La Guayra, Maracaibo, Guatemala, Salvador, Honduras, &c.	66,000
Brazil	370,000
Total	587,000

"Or a reduction of 61,000 tons upon the actual crop of 1884–5.

"It is more than a little galling to Indian planters to be told, as they are, that their coffee is so good, that it is comparatively seldom drunk by itself, being chiefly used to keep up the flavour of coffee mixtures which would otherwise be weighed down by the proportion of adulterants, and would possess little flavour of coffee. Rightly or wrongly, we believe, without underrating the claims of tea, that coffee of good quality, carefully made, and with a sufficient quantity for infusion, is, to quote the leaflet already mentioned, 'the most delicious and refreshing of all non-alcoholic beverages;' that 'it produces a buoyancy and exhilaration, followed by no reaction or subsequent depression;' that 'it acts as a stimulus to the mental powers, lightens fatigue, sustains the strength, whether under mental or physical exertion, and contains medicinal and restorative properties long recognised as of the highest value.' To preserve the purity and restore the popularity of such a beverage is surely worth a joint effort, alike by producers, by consumers, and by all of us who wish to promote temperance in drinking."

In the discussion that followed, Mr. Shuttleworth Brown said he had been much struck with some of Mr. Clifford's remarks, especially those in which he called attention to the direct importation of coffee from India to European destinations other than England. Some years ago, he hinted that in

Mincing-lane there was great indifference as to whether coffee was consumed in England or not, it being considered that the broker got his brokerage whether the coffee were re-exported or whether it were consumed in the country, and that perhaps led to some indifference as to adulteration on the part of those who ought to be interested in the subject. He had no Indian experience whatever, but the value of coffee as a beverage was a matter to which he had paid a good deal of attention, and he might point out, in confirmation of what had been already said, as to how the quantity of coffee consumed seemed to have decreased, that this was principally due to the effect of adulteration. There were four Government departments, which dealt with coffee—the Board of Trade, the Inland Revenue, the Customs, and the Local Government Board. Several of these were in favour of purifying coffee, but one was quite indifferent about it; he hoped, however, they might all be won over in time. The beaurocratic aim was to make the most of the revenue, and the beaurocratic view was that pure coffee would do it. The sole question which the Chancellor of the Exchequer had to consider in such matters was the revenue, and he was afraid of making changes for fear of meeting with a loss; but if the unnatural insignificance of the total amount of revenue from coffee were properly brought before him, and still more, the despicable amount derived from chicory, he did not think they need fear much opposition on his part. Of course, Government officials must always be affected by considerations as to how their action would be looked upon by the constituents of the members who put them in office. Those who chiefly profited by adulteration were the shopkeepers, and since each average shopkeeper must have at least 100 customers, it would be much better for the Government to overlook the craving of shopkeepers for illicit profits, and to consider rather the legitimate interests of the consumer. He had always looked upon the word "Coffee" as the trade mark of the planter, and as such his legitimate property, and considered that if coffee were asked for it ought to be obtainable. With regard to the value of chicory and coffee as sources of revenue, he would submit the following figures:—In 1880, the imports of chicory were 16,276,000 lb., the value being set down as 94,600*l.*; coffee, 1,546,000 cwt., and its value 6,861,130*l.*, so that the value of the coffee imported was exactly $72\frac{1}{2}$ times that of the chicory, or the value of the chicory was only $1\frac{1}{3}$ per cent. of that of the coffee. The exports in 1880 were: chicory, 2,388,295 lb., value 26,303*l.*; coffee, 1,189,174 cwt., value 5,258,446*l.* Thus, the value of coffee exported was exactly 202 times that of the chicory, or the value of the chicory was less than $\frac{1}{2}$ per cent. of the value of the coffee. The import and export trade together in coffee was over 12,000,000*l.* sterling, whilst the total trade in chicory was only 120,000*l.*, an absurdly insignificant amount, making a total of 1 per cent. only of the trade done in coffee, and that in an article that was only employed to deceive, and as a source of illegitimate profit. At the same time, three half-pennyworth of foreign chicory shut out what might be ninepennyworth of Indian or Colonial coffee, and this affected seriously the interests of the coffee planters; and they were so important a body as compared with those who profited by dealing in chicory, that it seemed very unjust that their representations had not received more serious consideration. The consumption of coffee in England, in 1880, was 284,540 cwt., or ·92 lb. per head, but the consumption of tea was 4·59 lb. per head, or five times as much. The consumption in the navy of coffee, tea, and cocoa was practically equal, being nearly 1,000,000 lb. of each per annum. The proportion in which chicory was mixed with coffee might be gauged by their relative consumption, chiefly by shopkeepers. Of chicory the consumption was, in 1882, 100,000 cwt.; in 1883, 103,000 cwt.; in 1884, 98,000 cwt. Of coffee, in 1882, 285,380 cwt.; in 1883, 289,715 cwt.; in 1884, 294,788 cwt. Thus, in 1882, rather more than one-third chicory was added to the coffee, which was gradually reduced to exactly one-third in 1884. Every one knew what he wanted when he asked or sent for coffee, viz. a stimulant—not colouring matter—whether he got coffee or chicory, or a mixture of the two, but the demand for coffee had diminished, and the taste had become debased, because of the mixture being so commonly supplied. The net produce to the customs for the year ending March 31, 1884, was from chicory, 68,050*l.*; from coffee, 194,192*l.* 68,000*l.*, therefore, was the whole question the Chancellor of the Exchequer had to consider, but the public had to consider that the value of the chicory, on which they paid to the Chancellor of the Exchequer 68,000*l.* for duty, was only 69,000*l.*; and then they had to consider what they paid for being cheated by it—how many times its commercial value. The remark had been made by Mr. Clifford that chicory was raised to the dignity of coffee by having the same duty placed upon it, but that was not the case in other countries where they are coffee drinkers. In France, coffee paid a duty of 3*l.* 3*s.* 5*d.* per cwt. (as against 14*s.* in England), and chicory, in the dried state, 4$\frac{3}{4}$*d.* only. In England, when roasted, it paid 13*s.* 3*d.*, almost the same as coffee; in France, roasted chicory paid 1*s.* 7$\frac{1}{2}$*d.* In Italy, coffee paid 100 francs per 100 kilos; chicory 5 francs if coming from a country with the most favoured nation clause; if no convention, 20 francs. In Germany, coffee paid 1*l.* per cwt.; chicory only 2*s.* In Austria, coffee paid 40 florins per 100 kilos; chicory, 15 florins. He thought no duty should be drawn from chicory, since it tended to legitimise its use, because it made adulteration to be no offence against the revenue and legalised this offence against the consumer; and he believed that if the duty (which only came to 68,000*l.*) were taken off, not a farthing would be lost to the revenue, because if it were made illegal to sell coffee mixed with chicory, or chicory otherwise than by itself, coffee would be sold in far greater quantity. The purpose of chicory was merely to make the coffee look strong, but its effect was to deprive it of all its refinement of taste, and less coffee was used than if there was no chicory, and people were deceived by their eyes. The amount of revenue derived from chicory was so small that he thought there should be no hesitation in making a change in the law which would give people confidence in coffee, by enabling them to buy it unadulterated.

The Chairman remarked that it was very startling to see the enormous cultivation of chicory. He should like to know where it came from.

Mr. Shuttleworth-Brown said it came almost entirely from Belgium. It used to be cultivated a good deal in Yorkshire, but within the last ten years it had almost ceased to be cultivated there.

Mr. W. P. Branson said the price of coffee in London depended really on the Brazil market. Brazil supplied nearly two-thirds of the total consumption of the world, and though it was mostly of a common quality, the quantity was so immense that, whether the crop were short or otherwise, it made a difference to the price all over the world. If he were a planter, he should not care two straws about the consumption in the United Kingdom so far as his own profits were concerned; the consumption here being only about 1 lb. per head per annum, it was utterly unimportant. In Brazil there had been an extensive system of slavery, which was now coming to an end, the number of slaves not being more than a million at present, and probably in a few years there would be none. The future of Brazil coffee, therefore, was very uncertain, and if the production should fall off, the Indian and other planters would no doubt benefit. The coffee market had shown a considerable rise during the last six months, and although the whole rise might not be sustained, it was probable that a great proportion of it would, and if it held for this year, it probably would for the next four or five years. The coffee market was very peculiar, its fluctuations spreading over a period of eight or nine years, and being mainly affected by wars and money panics, chiefly the former. The greatest depression was the result of the American and German wars, which followed one another; it threw plantations out of cultivation by wholesale, and he believed this was the principal cause of letting in the coffee-leaf disease. Some very strong remarks had been made about dishonesty and adulteration, which reminded him of what was once said by a cabinet minister:—"Don't talk to me about adulteration; it is all a question of price." The Government had been appealed to again and again during the last thirty or forty years, but everything they did only made matters worse. By recent legislation they not only allowed chicory but anything else if a twopenny label were put on the pound packet. Government did not care whether people drank potato-spirit for whisky, or saccharine for malt, or chicory for coffee, and it seemed to be hopeless to expect any improvement otherwise; the only sensible thing would eem to be to require the percentage to be stated on everything sold as a mixture. In foreign countries, where the duty on chicory was much lower than on coffee, the mixture of coffee and chicory was not allowed to be sold. The Government were no doubt in fault and so were the traders, but after all, those most in fault were the English people themselves; they were generally very ignorant and negligent in all matters connected with the purchase and preparation of food, but especially so in the case of coffee. No one with any sense would waste money on buying ground coffee; you might as well buy a vintage claret in a quart pot. Chemistry had done very little for coffee; amongst other fallacies, it had been said that the volatile aroma of coffee was an essential oil; if it were, it would be bad enough to grind it up, but from many years' experience in dealing with coffee, he was satisfied that the aroma was something far more subtle than an essential oil; it was an ether, which was difficult enough to retain even in the whole berry, and he would not give much for coffee which had been roasted more than a week, but when it was ground up of course it deteriorated much more rapidly. A one-pound packet of coffee was enough to scent a whole railway carriage, but the scent given off was simply the goodness of the coffee, and by the time it got home it was almost worthless; then it was often put into a tin canister, which made it ten times worse, and the result was, stale coffee for breakfast, which was worse even than chicory. He believed that was why chicory was used to improve the flavour of stale coffee. The practice of mixing was now about fifty years old, and it had got people into the way of buying their coffee ready ground instead of buying a 1*s.* 6*d.* mill and grinding it themselves. If they would only do that they need not appeal to Government, and would soon find grocers who would supply them with coffee freshly roasted every day. If people could be taught this, England would soon become a coffee-drinking nation, which would be an immense blessing to it.

Mr. Tolputt congratulated Mr. Clifford on his very able paper, in which there was only one point on which he would venture to correct him. That was with regard to "cherry" coffee, which he seemed to think was sold for Mocha. The latter, however, was generally the best native Mysore; cherry coffee was simply sold locally, and was prepared in the way described, because it was grown by small cultivators, who could not afford a "pulper" and "peeler." He believed coffee had a grand future before it. They had suffered during the last two or three years from short crops, caused mainly by unfavourable seasons, and to some extent by undue exhaustion of old plantations. If coffee was to pay the planter, it must be treated on the principles of modern scientific agriculture, and as he claimed to have been the pioneer of the modern system of manuring as applied to coffee, he might say that the results were in every way satisfactory. He would point particularly to the Cochin District, not Cochin proper, but a small outlying district to which reference had been made, where there were some estates of which Mr. Lester Arnold had written. He had applied there the manuring system, and had found the result from the commencement to average 5 cwt. an acre, taking good and bad years together. The great difficulty was in dealing with men who had not followed the enormous improvements which had taken place in agriculture all over Europe. It was almost impossible to get the idea into their heads that a small quantity of carefully made manure would have as much effect as a basketful of muck; they had still much the same notion as many British farmers, that nothing could be manure which did not stink. He agreed with everything Mr. Clifford had said about adulteration, and would even go farther. If it were a crime, legally, to put sloe leaves into tea, why should it not be a crime to put chicory roots into coffee? But there were many worse things than chicory used. He was told by an analyst that in one sample he found a large quantity of animal matter and sugar, and he could not imagine where it came from. He said he could tell him; it came from maggoty figs and diseased dates. Some time ago he had occasion to pull up a man who manufactured large quantities of mixed coffee for pirating one of his coffee marks. He took the opportunity of learning a little about the manufacture, and he found that one of the ingredients used was roasted bullock's liver. These things ought to be generally known, for it could hardly be legitimate to poison the British public with roasted cat's meat under the name of coffee mixture. Why should not coffee be sold pure as tea was, and a Government officer be authorised to seize and destroy adulterated coffee just the same as adulterated tea? He feared they owed their last defeat in Parliament to an idea on the part of Mr. Gladstone that coffee was all the better for having chicory mixed with it. It was mainly owing to his opposition and that of Manchester merchants—who believed that Chinamen and Hindoos preferred to buy chalk instead of cotton in their goods—and to the late hour at which Mr. Cavendish Bentinck brought on the motion, that it was lost; but he hoped on the next occasion they would be more fortunate. Coffee growers ought to be grateful to a number of philanthropists who had endeavoured to deal with this question practically, by forming a company to sell pure coffee at the same price as the grocers sold it adulterated. It was no secret that a number of gentlemen put down 1000*l.* a-piece to form the Whole Berry Coffee Company, to see if they could not beat the grocers with their own weapons. He had no interest in it himself, but he knew they supplied pure coffee at a fair price.

Mr. W. Storr remarked that, if coffee planters desired to put down the sale of adulterated coffee, they might find a precedent in the prosecution of a great number of publicans recently for putting water into their beer. Only a year or two ago the Brewers' Association, finding the character of their beer was being damaged by the addition of water to it after it left the breweries, joined together, made an appeal to Parliament, and succeeded in passing a Bill without the publicans knowing anything at all about it, and when the law was put into operation, they were altogether taken by surprise. The public were learning through the heavy penalties which were being inflicted that it was an offence to put even water into beer after the brewer had delivered it. He did not see why the addition of chicory to coffee should not be treated in the same way.

Mr. Hyde Clarke said his business with the coffee planters of India was as honorary agent for the planters of Western India, in 1857–8–9. Those were the early, struggling days of coffee-planting, and the first adventurers suffered much from the difficulties attendant on obtaining land. He brought their case before the Committee on English Settlements in India, which he obtained from the House of Commons, through Mr. William Ewart, and which published reports in 1857–8. The Board of Control affirmed against him that ten acres fit for cultivation by Englishmen could not be found on the higher waste lands, but the agitation resulted in obtaining the requisite facilities, and in promoting the enterprise of the large body of Englishmen, who were doing a great work for the benefit of the Empire, and of the people of India. In supporting the valuable and practical paper of Mr. Clifford, he would point out to him that the imports to Marseilles and Trieste, being mostly in bond, were re-shipped to Constantinople and Turkish ports, in displacement of the former shipments from London. As Mr.

Clifford had stated, there was very little genuine Mocha coffee in Turkey, and that so-called was chiefly Indian coffee passing through the Red Sea. The direct supply to the northern parts of Turkey was formerly "English" coffee. The coffee was roasted daily, and powdered more frequently than ground, so as to produce a coarse fracture instead of the fine powder sought for here. The goodness of the coffee in Turkey consisted in its freshness and preparation; there was no chicory or any adulteration. He concurred with Mr. Clifford that it was desirable for India to keep the Turkish markets, and for that purpose they should look after them. They could send through the Suez Canal, and then tranship, which they could afford, as coffee was transhipped at Marseilles and Trieste. The Constantinople market was worth looking after, as the highest qualities could be sold there. It would be well to have the packages made up with Turkish or Persian wrappers or descriptions. The main remedy against the maistri was, as Mr. Clifford said, a knowledge of the native languages, and Englishmen who could not learn in two years should be got rid of. The maistri would make deductions from the coolies under the manager's eyes. The worst part of the system of frauds was that the coolie did not always get the full wages paid by the employer, and the stimulus of which should bring in recruits. The manager must learn all about feasts, fairs, native superstitions, and lucky and unlucky days. The unlucky days were known all over India, and were to be found in the almanac, and they affected the whole community. European tools were often unsuitable, as hafts were unsuited for small hands, or stout shoes were required which should be supplied with the tools. Combinations of the planters in labour arrangements are essential for the protection of the individual. Mr. Clifford had stated the case well with regard to depressed prices and exchange. The depression of prices is in no degree owing to short supply of gold, but to the effective reduction of the cost of production. So, in the case of Brazil, the rich natural coffee lands were reached by steel railways, made cheaply by the labour-saving inventions of Heath, Bessemer, and Siemens. Thus abundant crops were brought down at a cheaper rate, and in less time than by mules. On reaching the port, the coffee was brought to London at a low freight by the same cheap steel made into the hulls and machinery of the ships. Therefore, the effective cost of producing Brazilian coffee was reduced, and whatever the speculative movements which may from time to time influence the market, he agreed with Mr. Branson that Brazilian crops will govern the market, as constituting the main supply. He considered that Mr. Clifford had well stated the case of the Indian planter under the low price of silver, but he would observe that this recent depression had arrested the rise of wages and commodities, which railway transport had for many years set in operation. Further, the coffee producer was benefited by the lower freights, and thereby he obtained a larger proportion of the market price, which had been reduced, for the freight had to be reckoned off the old price. As to silver, he (Mr. Clarke) had shown that a great reduction had taken place in the cost of producing silver, and that there was no reason the rupee should not go to one shilling or lower. The proposition to rehabilitate silver at a standard was a fallacy; gold was being taken for ornaments now. He (Mr. Clarke) remembered when coffee was consumed in this country, in France, and elsewhere on the Continent. There was no chicory here, and Orater Hunt's roasted corn was sold as roasted corn. Every respectable house had its coffee mill, a higher standard for coffee prevailed, and there were West Indians enough who knew what good coffee was. There was no difficulty in working a trade in genuine coffee. Chicory was grown on the Continent, and was introduced during the great Continental war as a substitute for coffee, and an adulterant. It did not seem to strike his friends that their statistics of the importation of coffee did not touch the real state of affairs, nor did they show what was the amount paid by the population for coffee. The statistics need be carried a step further, and it need be calculated out what the people pay on a full coffee price, receiving in return only half coffee, for the average adulteration need be taken at 50 per cent. If the people were supplied with coffee, as they have paid for it, then double the actual amount of coffee would be consumed. When coffee was sold here, the wealthier or working classes never thought of buying bullocks' liver, olive kernels, or any other kind of refuse to mix with it. There was no doctrine of political science, of economics, or political economy, or of free trade, which authorised, or justified, the frauds now committed, or the supply of the population with insufficient, noxious, and deleterious food. The precepts of political science justified and required the punishment of the evil-doers concerned in such nefarious practices. Great light was thrown on the coffee frauds by the recent action of the brewers in promoting the punishment of their fraudulent publicans. The brewers, it may be, cared little for the people, but they cared for themselves; they might not have cared for the consumer being defrauded, but they cared much for the brewer being defrauded. If in a public-house belonging to a brewer 20,000 gallons of beer were sold, out of which 5000 gallons represented water, then the publican would get money for 20,000 gallons, and only pay his brewer for 15,000 gallons. It might be that the more beer was sold (i.e. beer and water), the less beer was brewed by the brewers. A true state may be that the grocers are selling more coffee, i.e. coffee and bullocks' liver, and yet the importation of coffee appears to decline. This must be so, because the decrease in the quantity of coffee imported is not equal to the progress of adulteration. The grocer who adulterates to 30 per cent. displaces that percentage of coffee, the adulterator of 60 per cent. displaces 60, and the bold operator who supplies 90 per cent. of bullocks' liver, chicory, &c., displaces 90 per cent. of coffee. The lesson from Mr. Clifford's paper was for the grocer and the trade to take firm action, and to try back.

Mr. Martin Wood had been much interested in the paper, and was particularly pleased with the way in which Mr. Clifford dealt with two questions, first, the coolies, whose peculiar habits and failings were no doubt prominent enough, but, as pointed out, if these were duly considered they made good labourers; second, that of the land tenures granted to the planters, which, it was admitted, are fairly liberal. He should like to know what was the kind of coffee chiefly grown in India. He had been told that Jamaica coffee was used as seed in Ceylon, and from that the so-called plantation coffee was taken, though various names were given to it in India. Perhaps Mr. Clifford could say whence these names were derived, and which kind proved most satisfactory. It had been said that coffee would not thrive under 2000 ft. above the sea-level, and perhaps that might account for the failure of some attempts which had been made. He remembered on one occasion that efforts were made in the Goa territory to cultivate coffee, but believed they failed. Most people would agree with the remarks which had been made about adulteration, but it must be remembered that chicory was no more harmful than water in beer. There were ample provisions in law for dealing with the admixture of noxious or deleterious substances even in coffee; it only required a little more attention to ferret out such abominable nuisances.

Mr. Clifford, in reply, said there was a theory current in Mysore that good coffee could not be grown at a less altitude than 3000 ft. above sea-level, and that was about the height at which his estates lay; but it was grown at a considerably greater altitude than that in other parts. The peculiarity was that the higher you got, the better was the quality of the coffee, but the smaller the crop. He held it was a mistake to suppose that coffee could not be grown except at that altitude, but whether it could to commercial advantage he could not say. As to the origin of coffee, it was generally conceded that the beans were first brought from Arabia, which was the true home of the shrub; that they were first taken to Ceylon, and thence to Mysore. It was said that coffee was first grown in Ceylon for the sake of the blossoms, which were very beautiful and fragrant, and were used for the decoration of the temples. The plant flourished in Mysore, and some of the finest coffee in the world was now from there; in fact, he could scarcely venture to quote the price of some of the exceptional brands. Those who did not possess these rare kinds did not quite understand it, and looked with some envy on the enormous prices they fetched in Mincing-lane. He thought Mr. Branson was somewhat in error in saying that Brazilian coffee would always rule the price of Indian. So far as Indian, Jamaica, and Ceylon coffee were concerned, he thought they would always fetch a good price in the English market, because it was of a quality which Brazil could not, or at any rate did not, produce. The English consumers would always have the best coffee, and, fortunately, India supplied the best brands. The recent depression had hardly been felt by the best coffee; even at the worst period it maintained its price. He hoped that was an augury for the future, and that Indian coffee would also command the market in England, where people would have the best quality of everything. He agreed with Mr. Branson that a good deal of blame for bad coffee lay at the door of the consumer, who would not even take the trouble to ask for pure coffee. Under the 'Adulteration of Food and Drugs Act,' if a person asked for coffee the grocer was bound to supply it, or if he sold him a mixture, to tell him of it, or to point to the label. Unfortunately, the existing law opened the door to fraud, because in poor neighbourhoods there was no guarantee that pure coffee would be supplied even if it were asked for; they knew that this kind of fraud was habitual, and that not one case in a hundred was ever brought home. The consumption of coffee was appreciably hindered by the adulteration which took place, and the taste for coffee suffered because what was supplied was an inferior article, adulterated to the extent of perhaps 50, 60, or 70 per cent. Under such a system coffee never could have a fair field, which all producers and importers, as well as all true rance, had great cause to complain of.

Mr. Branson said he did not intend to convey the impression that the price of fine East India coffee depended upon that of Brazil, but that the price of Brazil had a considerable effect on the whole market. Thus there was a rise of 20*s.* a ton in East India some time ago simply because Brazil had gone up.

The Chairman said,—It has been a great pleasure to me to preside on this occasion, and we must all feel greatly indebted, I am sure, to Mr. Clifford for the very interesting paper he has just read to us. He has not only given us a mass of information, but has put forward facts which cannot fail to be of great value to persons who have already invested capital, or who are thinking of investing it, in coffee planting. Mr. Clifford's paper has been peculiarly interesting to me, because although I have never had any direct interest in coffee plantations myself, I have watched coffee planting, as I have forestry, in India from its very birth, and have seen a great deal of the growth and development of the industry in Southern India, and have had a wide acquaintance among planters. The only plantations I have ever had to do with personally were teak belonging to the State, and they lay among the coffee tracts. It is just forty years since the Madras Government did me the honour of entrusting me with the organisation of the first scheme of forest conservancy for India, and my avocations then led me through all the districts about which Mr. Clifford has just told us. In those days (I am speaking of about 1848) a few energetic men whose names are well remembered in Southern India—Ouchterlony, Staines, Godfrey, Cannan, Green, and a few others—were struggling with the difficulties which usually beset pioneers, and the whole length of the Western Ghats, from North Canara to Cape Comorin, could only show a few tiny clearings for coffee. Throughout North Mysore, Munzerabad, Coorg, Wynaad, the slopes of the Nilghiris and Annamullays, Cochin, Travancore, Tinnevelly, and Madura, the coffee planter, if heard of at all, was looked on as a speculative man who was risking his money and his health in a very dubious undertaking. Forty years have seen a vast change. All through the provinces I have just named, the planting community has grown into a large and recognised body. They have their beautiful estates, comfortable houses, churches, dispensaries, clubs, social gatherings, race and polo meetings, &c., and are, in most instances, not only making a living, but turning their forest land into valuable property. They have brought an immense amount of capital and European energy into India, and have effected great changes for the better among the people around them. The presence of such men in the country cannot but be a material strength to the State. The Government on their part have not been slow to recognise the importance and value of the planting community. Much has been done for them, although naturally they ask for more. They now work with secure land tenures and good police protection. Many hundreds of miles of roads and passes have been made by which their crops go to the seacoast or to the railways. Laws have been enacted in their interests, and under certain wholesome restrictions forest land is made easily available for planting, wherever the Government can spare it. Under such circumstances the coffee industry has, as you have just heard, made great progress—it has its ups and downs of course—but I think we all heartily wish it increased success, and this will certainly be aided by publicity, and the circulation of such valuable papers as that which we have just heard read.

Java.—Java is the second largest coffee-producing country, nine-tenths of the culture being in the hands of the Government, and effected by forced labour. Around the estates a fence is planted, about 12 ft. from the outer row of the plants, generally of the *jarak*, or castor-oil plant (*Palma Christi*), intermixed with the *dadap*, or the silk-cotton tree; and, in low situations, outside of this a ditch is dug, to carry off the water. These operations commence in August or September, and by the time the ground is in perfect readiness for planting, the heavy rains are nearly over. The plants are either raised from seed in nurseries, or the estates are supplied with "stumps" from wild or casual seedlings. Nursery plants are generally removed at six months, when they are about 12 in. high; their after growth is so rapid, that in nine months they attain to 2 to 3 ft. in height, and at twenty months are 6 to 8 ft. high, and capable of bearing $\frac{3}{4}$ lb. prepared coffee per tree. The trouble and expense of nurseries in so hot a climate are, however, very great, and the second plan is often adopted. In this case, the plants grow more slowly: but they become more lasting and hardy trees. The plantations are generally laid out in squares. The distance between the plants varies according to the fertility of the soil; in a soil not considered fertile, a distance of 6 ft. is preserved; but in a rich soil, where the plant grows more luxuriantly, 8 ft. by 4 ft. is the scale hitherto commonly used. Now, these distances are deemed too small, and new estates are being laid out at 10 ft. by 9 ft., and 9 ft. by 9 ft. At all altitudes below 2500 ft., shade seems necessary, especially during the early growth of the coffee-bushes. The tree almost universally employed for this purpose is the *dadap* (*Erythrina*), of which several varieties are abundant throughout the island, the *serap*, the *dori*, and the *waru*; the first is preferred as affording the greatest shade. It is propagated by cuttings; and in selecting them for the coffee plantations, care is had that they are taken from trees at least two or three years old, and that they are 3 to 4 ft. long, of which 1 ft. at least must be buried in the ground. After the *dadaps* are planted, holes are dug, $1\frac{1}{2}$ to 2 ft. deep, for the reception of the coffee plants. It is a common saying that where the *dadap* flourishes, there also will coffee grow; but they are not always constant or necessary companions, for many gardens in high lands contain few *dadaps*. It is probable that in future these trees will be largely replaced by *Acacia Julibrissin* (*Albizzia Moluccana*), which grows very fast, and is superior for several reasons. Indigo is frequently planted among the young coffee, chiefly in order to keep down the weeds, but also to be used as manure. As the tree waxes, no attempt is made to train it, and it grows up with several stems as a native tree. It is pruned only when branches show signs of decay, or when the borer, which is very destructive, compels the planter to cut down the attacked stems. The weeds are dug up with mammoties, to a depth of 6 in., and piled in rows between the shade trees parallel to the lines of coffee. These weeds, among which is the alang-alang, and other fodder grasses, furnish valuable cattle food. When an estate shows signs of decay, the coffee trees are all cut down, the *dadap* trees being either felled or ringed near the roots, so that they may decay gradually and fall piecemeal to the ground; the process of replanting is then repeated in the same manner as before. Thus the land may be replanted several times, and so rich is it that the last garden will be better than the first. On the other hand, the climate is as a rule far too forcing for permanent culture. The average crop is very light; and after 12 to 14 years, the yield is so small as not to repay the cost of harvesting. On estates below 1000 ft., the trees bear earlier and produce more, but do not last beyond ten years; at altitudes of 3000 to 4000 ft., they may last 30 to 40 years. On many of the elevated plantations, the trees grow to a height of 30 to 40 ft., necessitating the use of ladders to gather the crop. Such trees are grown 25 ft. by 25 ft. apart, on terraces 25 ft. wide, planted with grass at the edge, or all over, to prevent wash. These trees yield 6 to 7 lb. prepared coffee. The average produce of the Government plantations is reckoned, by Jagor, at only $\frac{1}{2}$ lb. a tree; that of the few private estates at 1 lb. a tree; the difference is attributed to the ill effect of forced labour. The methods of cultivation adopted by the private planters vary considerably; in some instances, the trees are topped at 4 to 5 ft., and pruning is attempted, but the results are not satisfactory. The condition of the Government culture has remained stationary during the last forty years. The season affords what are termed three crops; the first is but small, the second is most abundant, and the third is rather a gleaning. Owing to the scarcity of water, the labourers convey the cherry coffee to their own homes, where they pulp and wash it with wooden pestles.

Attached to every principal village, near which there are coffee plantations of any extent, there is a drying-house, to which the pulped coffee is brought; it is there placed on hurdles, about 4 ft. from the floor, under which a slow wood fire is kept up during the night. The roof of the drying-house is opened at morning and evening to admit the air, and the berries are frequently stirred to prevent fermentation. As the direct heat of the sun is considered prejudicial, the roof of the house is closed during the day. This operation is repeated till the parchment is quite dry. The berries dried in this way are small, of a sea-green or greyish colour, and are supposed to acquire a peculiar flavour from the smoke, although it does not appear that any particular kind of wood is used for fuel. When dried in the sun, the bean becomes of a pale bleached colour, is larger, specifically lighter, and more insipid to the taste than the former. According to Jagor, a period of five to six weeks is required. The most common mode of freeing the bean from the parchment is to pound the berries, when dry, in a bag of buffalo-hide, great care being taken not to bruise the beans. A mill of simple construction is sometimes used, but is not found to answer so well. The coffee beans are then put into bags or baskets, kept on raised platforms till the season of delivery, when they are carried down to the store-house, sometimes by men, but generally on the backs of buffaloes and mares, in strings of 1500 to 2000 at a time. In some instances, however, improved machinery has been erected for pulping and curing the coffee on the West Indian plan. The crop of 1878 was estimated to be 20 per cent. below the average, chiefly owing to the drought of 1877. The finer descriptions of Samarang (West Indian preparation), Buitenzorg (ordinary preparation), Government Preanger, and Government Padang, commanded high figures: nearly the whole of the two latter brands was bought up for the United States at very advanced figures. Further large importations of Liberian coffee seeds and plants took place during the year; but from the short period of its trial, no reliable opinion can yet be formed as to its suitability. These importations were effected from or through English houses, Ceylon growths being prohibited on account of the leaf disease. The exports of Java coffee, from 1st July, 1877, to 30th June, 1878, stated in *piculs* of 122 lb., were, to Holland, 1,096,372; France, 14,767; Port Said, for orders, 6943; Italy, 5775; Singapore, 5079; America, 3993; Australia, 1107; Channel, for orders, 102.

Liberia.—The Guinea Coast of Africa, and more especially the republic of Liberia, is remarkable among coffee-producing countries as the home of a peculiar species of coffee, formerly known as *C. microcarpa*, but now finally designated *C. Liberica*. It is distinguished from *C. Arabica* by much more robust habit; it attains a greater height, and both leaves and fruit are larger and less delicate; it also prefers low elevations. In its native country, this species grows as well near the sea (100 yds., or less distant), as thirty miles inland, and the wild plant is found even yet further towards the interior. The general temperature of the coast districts ranges between 22° and 31° (72° and 88° F.) in the shade, the maximum being 33° (91° F.) and the minimum 17° (62° F.); away from the sea, the temperatures decline 1° to 2° F., principally owing to the rise of the land. The limits of elevation are from sea-level on the coast to 550 ft. inland. It is as much at home on flat land as on hill slopes, provided always that the land is drained.

Though the cultivation of this plant in its native soil was started by the late President Roberts, and is extending every year, attention has principally been paid to its acclimatisation in other countries. In Ceylon and Southern India, some hundreds of acres are already planted with it, and the movement is still extending. A point greatly in favour of the plant is the low altitude at which it flourishes, thus permitting the utilisation of land otherwise unproductive.

At the elevations where *C. Arabica* is best cultivated, this species refuses to grow, and perhaps the highest successful plantation is at about 1500 ft., at which height it was found beneficial to leave some of the forest trees as shade; probably the planting of coco-nut trees would be better. The young plants require careful protection from wind and extreme heat; but soon become hardy. The size of the trees is such that an acre will not conveniently contain more than 450. At a greater elevation than 800 ft., difficulty is experienced in ripening the fruit. Planters are sanguine that a hybrid between the Arabian and Liberian species would flourish in the zone of 1000 to 3000 ft. The hope that the new species would be proof against leaf-disease has been somewhat disappointed; nevertheless, the trees are very much less affected than the common shrub. The trees appear also to demand less rain and to withstand greater heat. On the score of longevity, there appears to be little difference between the two kinds. They mature early, and bear heavily; one estate in Ceylon had trees yielding a ton an acre at 4 years old; and 7 cwt. an acre is said to be an average crop. The idea of its entirely replacing the longer known variety is fanciful, yet by cultivation and preparation much may be done to improve the inferior flavour and coarseness of the berry, which now prevent its being used alone.

The plant has been largely introduced into other of our Colonies, into Brazil, and by the Dutch into Java. In the West Indies it grows exceedingly well, and bids defiance to the blight (*Cemiostoma coffeellum*); it has a further advantage in this case that the ripened berries remain so long on the trees as to enable the crop to be gathered by few hands. It flourishes best on the "heavy bottom" lands, and in poor moist lands, and is recommended as particularly valuable for planting on cocoa estates. By grafting or inarching the Arabian species on stems of *Liberica*, an increased growth is obtained.

A writer in the 'Journal of the Society of Arts' gives the following information.

"In Liberia the coffee tree is grown in all varieties of soil, and prospers most in those of a loose nature, such as the sandy and loamy soils, especially if these are strengthened by the addition of rocks. There are two species of sandy soil in Liberia; one has been the bed of the sea, and this has not been enriched by decayed vegetable matter, its substratum of clay or other earth is at too great a depth to be of service to it, and hence it is barren, or nearly so. The other sandy soil has been somewhat enriched by decayed vegetable and other matter, and has near the surface a substratum of clay. This serves as a reservoir, to hold the surplus water, which, rising through the sand by capillary attraction, keeps plants growing, even in dry weather. This soil is particularly suited to coffee, which grows rapidly in it. The United States Consul at Monrovia says that the method of cultivation practised in Liberia is similar to that adopted in the East Indies. The forests are cleared in the same manner; the undergrowth is first cut, then the large trees are felled, lopped, and when sufficiently dry, the whole is set on fire. The stumps of the trees are, as a rule, immediately removed. The entire ground is not ploughed, but holes are dug at proper intervals for the reception of the plants. These are generally not less than 12 ft. apart, and are dug in straight parallel lines. Ploughing, by loosening the soil, would, on sloping land, render it liable to be washed away by the heavy rains. The plants are taken from the nursery when from a year to two years old, and in planting, the cherry hull is removed, and the seeds are deposited in rows from two to three feet apart. The seeds are inserted in the ground at a depth of about one inch, if the showers be regular, but at a depth of two inches if the weather is dry. The transplanting is generally done at the beginning of the rainy season, in May or June. The trees are topped at the height of 5 ft., but this rule is not observed by all farmers. After the trees are topped, they shoot out a number of suckers from the trunk; these are generally pulled out by hand, and no secondary shoots are allowed to grow on the branches nearer to the trunk than 18 in. This would give an open space of 3 ft. in diameter, in the centre of the tree, for the penetration of sunshine, and the circulation of air. The Liberian coffee tree does not produce all its flowers at one blooming; the time of blossoming depends upon the occasional showers that fall in the dry season, for although the buds may stand out prominently, they will remain without opening for a space of two months, or until there falls a shower of rain sufficient to saturate the soil; a light shower which does not soak into the ground will not cause them to open. In December, a slight blossom appears, and the fullest blooms occur in January and February. There is only one full crop, and this is gathered during the months of December, January, February, and March. Surface manuring is the best suited to Liberia coffee trees, as these belong to the class of forest trees whose feeders keep near the surface. Even when the manure is placed in trenches, the fibrous roots or feeders penetrate it and seek the surface long before the manure is consumed. Coffee pulp, mixed with other ingredients, guano, ashes, and clay from the hills of the 'Termites' are also extensively used as manures to promote the growth of the coffee tree. Two systems of hulling the coffee are practised in Liberia; one consists in taking off the cherry hull when fresh from the tree, drying the bean, and then denuding it of its parchment hull; the other in drying the entire berry, and taking off both hulls by one manipulation. The former method is the more expeditious, but by the latter there is an improvement in the quality of the coffee, as the beans having been thoroughly dried in both hulls, the aroma is prevented from escaping, and it is also said that there is a gain in the weight of the bean. The Liberian coffee tree is not subject to so many diseases as is that of other countries; there are, however, sometimes observable on the leaves of some trees, small yellow spots, which, in the opinion of many Ceylon planters, was the *Hemileia vastatrix*, that pestilence so destructive to coffee plantations in the East Indies. But these spots were found always of the same colour, and did not turn black, nor did the leaves drop off, as in the case of the above-named disease, and the trees bore their usual quantity of fruit. The borer only occasionally attacks the coffee tree in Liberia; this is the larva of a fly or winged beetle, now identified as the *Xylotrechus quadrupes.* It generally attacks the tree some inches above the ground by boring. There is a disease also which affects the bark of the coffee tree, and this is caused by grubs attacking the roots of the tree. The disease, however, does not always begin at the root; sometimes it appears in one of the branches, at others it is to be found in a long line on one side of the tree, while the bark in all other directions is perfectly sound and healthy. In no case, however, where diseases similar to those in other countries attack the Liberian coffee tree, are the effects so general or so disastrous. Different estimates have been given of the production of the Liberian coffee trees. It has been stated that, if properly cultivated, they ought to average 3 lbs. when ten or twelve years old, but the trees, owing to lack of means to give them the high cultivation which they require, do not produce on an average one-third of the quantity they are capable of producing. Consul Smyth states that a Ceylon coffee planter of thirty years' experience in coffee growing, estimated that the production of an acre of Liberian coffee would, under favourable circumstances, equal that of ten acres of Ceylon coffee. The cost of cultivation per acre may be roughly estimated as follows:—Clearing the land, 2*l.*; cost of plants, 24*s.*; planting, 13*s.* Weeding, the first year, if the ground is thoroughly cleared and burned at first, will be only half the cost of subsequent years. The cost of weeding, after the first year, may be estimated at 22*s.* an acre, when weeding is done after the Liberian method generally, that is two weedings a year. There will be no cost for topping or pruning the first year; about the third year, however, after the trees are planted, there will be an expense of about 6*s.* an acre for topping, and in subsequent years the cost of pruning, amounting to about 6*s.*, must be added to this. The expense of tools, machinery, or superintendence, is not included in the above estimates. Consul Smyth, in conclusion, states that the Liberian coffee industry is attaining very considerable importance, and the quantity exported largely increasing every year."

Madagascar.—Coffee grows well in most parts of Madagascar; in recent years large plantations have been formed along the banks of the rivers on the eastern side of the island. These are chiefly managed by Creole traders, who employ slave labour. Coffee already promises to become a very important article of export.

Mexico.—Though Mexico scarcely figures in the coffee-producing countries, its capacity and adaptability have been tested by successful cultivation. The productive regions are found on the sea slope of the mountains: on the Pacific side, from Guatemala, for more than a thousand miles to the north, till reaching a line of occasional frost in the State of Sinaloa; and on the Gulf coast, from Yucatan into Tamaulipas, for more than a thousand miles. In addition, it flourishes in the valleys of the interior, wherever the table-land is depressed to the level of tropical and semi-tropical vegetation. The elevation above the sea, at which it is cultivated, varies from 4500 ft., and even higher, down to nearly sea-level in many localities on both coasts. The production need only be limited by the extent of land brought under cultivation. Mexico as a coffee-producing country has been tested by more than fifty years of experience. That coffee has not assumed the first place in exportation is to be attributed to the same causes which have retarded all development of the country. Hitherto, the production has been mostly consumed by the home demand, which is quite large, as coffee is in very general use by all classes; but during the past few years, the cultivation has increased, so that a small exportation has commenced. The statistics of the port of Vera Cruz indicate a steady development of the export, which ought in a few years to become considerable:—1871, 672,588 lb.; 1872, 1,912,020; 1873, 3,909,446; 1874, 4,204,446; 1875, 5,375,678.

The young plants are transplanted from the nurseries at twelve to eighteen months, to the fields, which are prepared in open forests, and on mountain sides affording shade. In open fields, a growing shade must be created, usually by planting bananas; but the best cultivators set out cinchona and valuable timber trees, as oak, walnut, &c. The second year after planting gives a very slight yield of coffee; the third year, about a half crop; and the fourth year (or when the plant is five years old), a full crop. The plants are set out usually about three yards apart each way, though often closer. The cultivation consists in keeping the fields clean, and ploughing; in certain localities, irrigation is necessary; the best planters prune carefully, keeping the height at 6 to 8 ft. The first flowering is sometimes as early as December; the second, in February; the third and most abundant, in March and April. The berries are dried by exposure to the sun, when they shrivel, and change to a black colour. They are then put into a mortar, and the beans are hulled or beaten out with a pestle, and are then separated from the parchment by the crude process of winnowing, though sometimes a fan-mill is used. So far, no disease of plant or berry has appeared; and although great drought may diminish the crop, it does not destroy it. The flower, when in full bloom, is sometimes broken off by severe winds; but this seldom diminishes the yield.

The trees continue bearing for twenty to twenty-five years. There are, however, trees sixty to seventy years old, which are yielding a fine crop. The average yield per tree is about 1½ lb., though with intelligent pruning and manuring, it may be increased to 3 lb. a tree. It is not uncommon to find trees yielding 5 to 7 lb., and in very exceptional cases, 25 to 50 lb. each. After the plants begin to bear a full crop, the annual cost of cultivation, up to sale in local market, is 6 to 7 cents a pound. The above remarks refer especially to the region around Cordova, which is at present the greatest producer of the republic, and the most accessible to the American market; but several other localities are assuming some importance. One of these is the district of Soconusco, in the State of Chiapas, immediately upon the borders of the republic of Guatemala. Several foreigners and a number of resident proprietors have embarked in the cultivation. The special advantages presented here are cheapness of land and labour; the chief impediment is the fact that this district is disputed territory, claimed by both Mexico and Guatemala, and the tenure and protection of property are insecure. The valley of Uruapan, in the State of Michoacan, has great celebrity for its superior quality of coffee. But the most noted region is the State of Colima, on the Pacific coast; its product is so highly esteemed that it commands a fabulous price in the City of Mexico, and more distant places in the republic. The favourable report on sample lots sent to Europe in 1873 gave an impetus to the cultivation. Since that year, over one million plants have been set out, and are now beginning to bear; planting continues to increase, and coffee promises to become the principal article of export. The demand is so great that large lots fetch 27½ cents per pound at the plantation, mainly for consumption in the interior, a small portion only being shipped to Germany by resident German merchants, on private orders. Colima, and some other States, have passed liberal laws for the encouragement of coffee cultivation, offering premiums for the largest crop produced, and exempting coffee lands from all taxes.

Natal.—Coffee culture in this colony seems to be struggling against adverse conditions, notably the disastrous spread of the bark disease, for which no cure has been found. This is the more to be regretted as the quality of the beans is very fair, and the demand for the article is always growing. The causes of the disease do not seem to have yet been sufficiently investigated, and without this there is little good in making suggestions as to shade, manuring, pruning, &c., as remedies. The evidence in favour of partial shade in many localities is strong; for this purpose, local varieties of *Erythrina* might be used, as in Java, &c. One planter expresses himself very strongly on the subject of topping: he condemns the adoption of a universal standard of height, and recommends for the coast lands a height of 6 to 8 ft.; and for the higher lands, ranging from Fields' Hill upwards, about 5 ft. Unlike Ceylon, elevation seems but little to affect the value of Natal estates; but river-beds, and low, damp places, being liable to frost, must be avoided. Too little attention, perhaps, has been given to irrigation in the dry season. The best months for making seed-beds are September or February: when the former is chosen, the seedlings should be ready for the nursery at the time of the autumn rains (March); when the latter, the spring rains (September to October). A safeguard against the young plants being scorched is found in large castor-oil leaves; they are cut with about 9 in. of stalk, and are stuck into the ground between each plant and the sun, soon drooping, and forming sun-shades. The plants are said to begin bearing in eighteen months after transplanting, the yield gradually increasing till the 7th or 8th year, when they should give full crops. A fair average crop is put down at 1 lb. a tree all round. Nearly all the crop is used in the colony or neighbouring republics, consequently the Customs returns only show a very small proportion of the annual yield; it is impossible, however, that the entire yield of the colony has ever exceeded 20,000 cwt. The exports were, in 1874, 680 cwt.; 1875, 363; 1876, 179; 1877, 91.

Nicaragua.—A few coffee estates exist; but the export is very trifling—some 400 to 500 lb. annually.

Pacific Islands.—Coffee has been successfully introduced into the Fiji and the Friendly Islands, and in the course of a few years it will probably form an important export. Trees raised from seed bear fruit in the fourth year. In the Sandwich Islands, the cultivation is also progressing, large plantations having been laid out with a view to supplying the markets of Sydney, California, and Chili. Almost the whole of the produce goes at present to the United States, the small remainder being taken by China and Germany. The total export, in 1878, was 127,963 lb.

Peru.—Coffee grows luxuriantly on the mountain slopes, the crops often being so heavy as to necessitate artificial supports for the branches. Nevertheless, the export from Mollendo, the second port of the republic, amounted only to about 140 cwt., in 1878.

Philippines, &c.—Coffee thrives remarkably in the Philippines, and the berry possesses a peculiar flavour which is highly esteemed on the Continent, so that though it is by no means well prepared or nice looking, the worst brands fetch a higher price than Java growth, and the value on the spot far exceeds the current rate of the London markets. There are two kinds of coffee, viz. "Manilla" and "Zamboanga." The former is grown in the islands of Batangas, Indan, Laguna, and Cavite; its price in place, in 1878, varied between 19½ dol. and 22 dol. (dol. = 4*s.* 2*d.*) a *picul* (139½ lb.); the beans are medium-sized, and pale-green in colour. The latter variety comes from Mindanáo, and the southern islands generally. The beans are larger than the "Manilla," but yellowish-white in colour, and flabby in texture; samples also always contain much rubbish; local prices, in 1878, fluctuated from 17½ to 21 dol. a *picul.* The exports of all kinds from Manilla were, in 1877, 3843 tons, value 245,980*l.*; and in 1878, 2306 tons, value 147,560*l.* The proportion sent to Great Britain, in the latter year, was only 160 tons, and to British Colonies, 242 tons; the remainder was taken by Continental Europe. Shipment is effected in bags of 150 lb., or in cases of 200–300 lb. In the islands of Cebu and Bohol, the natives have planted patches of coffee, and small parcels of "parchment" were offered in 1878. The quality is excellent, and the price stood at 14 to 16 dol. a *picul.* Small quantities, of inferior growth, from Yligan in Mindanáo were offered at 12 to 13 dol. a *picul.* In Timor, the Portuguese are extending the cultivation among the natives; the trees mature early, 1¼ cwt. of coffee being obtained from fifty trees in 4 to 5 years. In Amboyna, also, a number of trees have been planted.

Siam.—In the hilly districts of the East Coast of the Gulf of Siam the cultivation is carried on to a limited extent. Some fine samples were shown at the Exhibition of 1862.

Straits Settlements.—After a fair trial, it seems that coffee planting in Penang has not been a success. During the first 12 to 18 months, the plants grow well, and are strong; but the effort of bearing fruit, under the influence of long-continued drought, weakens them so that they lose foliage and fall a prey to disease. Under shade, on the plains, they stand better; but the crop is very light, and often fails altogether. On the Great Hill, the plants bear better; but the plantations are restricted to narrow limits. Liberian plants have been introduced into Singapore and Sarawak, and promise well.

Sumatra.—Among the Eastern Archipelago, this island ranks next after Java in the quantity of its produce, the cultivation having been largely adopted by the natives. The quality of the berry varies much; the dark-yellow or brown are the best, the black are inferior. The annual crop may perhaps reach 20 million lb.

Surinam.—A century ago this colony produced 7½ million kilo. of coffee; this enormous quantity has gradually dwindled down to insignificance:—In 1875 the production was 37,357 kilo.; the export, 644 kilo.; in 1876 the figures were 12,412, and 325; in 1867, 6179, and 159. In this last year there was one estate planted with coffee and cocoa, and four with coffee and plantains.

United States.—The Department of Agriculture, at Washington, has recently issued a circular relative to the possibility of coffee culture in some of the States, and is led to believe that the conditions of climate and soil will be found suitable in Florida, Lower California, and part of Texas. It is stated, indeed, that in the two former is found an abundance of wild coffee. In California, seed obtained from Costa Rica has been planted, and the results hitherto are satisfactory.

Venezuela.—The annual production is about ½ million cwt., the best being grown in the cooler portion of the State. The crop is gathered in October; the cherries are spread on hurdles exposed to the sun, where they ferment for 14 to 20 days, and then dry. Pulping is performed by machinery, and the parchment is winnowed away. The average crop is generally placed at ½ lb. a tree, which in some localities is reduced to ¼ lb.

West Indies.—The decline of coffee culture in the British West Indies since the emancipation of the negroes almost amounts to abandonment. It is commonly attributed in great measure to the ravages of the blight already described; but it is evidently traceable rather to social influences and a faulty system of agriculture. Serious attempts are now being made to restore the industry to some of its former importance, so that a sketch of the principal conditions of successful culture may be opportunely given. The best soil is an open, dark-brown or reddish loam, 1–2 ft. thick, resting on finely disintegrated but undecomposed volcanic rock. Some of the finest ground exists on declivities which can be traversed only by planting the feet at the base of the coffee stems. On some hills of this character are now to be found trees 60 to 70 years old, which have been uprooted and have re-established themselves. In the face of this fact, the renovation of the existing abandoned plantations should be an easy matter. The trees should be relieved of the mass of bush, weeds, and "provisions" which now smothers them, and should undergo a judicious pruning, extended over three years if necessary. In this climate, shade and shelter are undoubtedly beneficial. On old, overgrown plantations, natural shade may be left when clearing, taking care to select trees of small foliage for the purpose. When laying out new estates, greater choice will be possible.

In many instances, cocoa has been planted amongst the coffee, probably with a view of getting crops of both from the same ground. It is quite possible to grow them profitably on the same field; but each must have its own sufficient space, and thus there is no gain; besides, their habits of growth are unsuited to the arrangement.

For the purpose of shelter, there is, perhaps, nothing better than the *pois-doux* tree, especially on inferior soils and in exposed situations; hedges of it planted as a break-weather are to be found on every abandoned estate. The pimento is equally suitable, but is of slower growth. Neither is of any value as a shade-giving tree. Of all indigenous plants, the *Moricypre* (*Byrsonina spicata*) appears to be the most suitable as a protection against both sun and wind; it is a small-leaved, fast-growing, medium-sized tree, and common everywhere. The distance from tree to tree will depend on the variety of coffee grown, and the character of soil and of situation; but it is indicated by the principle of each plant being so far from its neighbour, that when all have grown to their fullest size, they do not touch by about 1 ft. Thus the distance may vary from 4 to 8 ft., or even more. A very important factor in the sum of influences which have brought the culture to its present low ebb is to be found in the greatly diminished moisture of the climate occasioned by the wholesale destruction of the forests. This is especially the case with plantations on steep hillsides; and it remains to be seen what art can do to combat the difficulty.

Cuba.—In 1847 there were over 2000 coffee estates, yielding nearly 50 million lb. annually; in 1851 sugar and tobacco had so far replaced coffee that the production fell to 13 million lb.; and now Cuba imports coffee from Porto Rico.

Dominica.—From an annual production of over 2 million lb., Dominica has fallen to nil. The effects of the negro emancipation and the coffee blight were, perhaps, felt more severely here than in the other islands. The export tariff is 13½*d* a cwt.

Grenada.—At one time, Grenada coffee was one of the only three brands known in the London markets; cocoa has now taken its place.

Guadaloupe.—A century ago, this French colony exported 7½ million lb. of coffee; in 1874 the exports were 625,200 lb. It nearly all goes to France as of Martinique growth. In 1873 there were 3588 *hectares* under coffee, yielding about 1000 lb. a *hectare* (= nearly 2½ acres).

Hayti.—Hayti has fallen from a production of 80 million lb., in 1789, to 54½ million in 1874, chiefly owing to disastrous hurricanes. The exports in 1878 were, to Italy, 83,000 lb.; Spain, 17,000; West Indies, 11,000; France, 3000; United States, 2000; Great Britain, 1400.

Jamaica.—This hilly island used to produce large crops of fine quality. The average annual shipment in 1805–7 was 28½ million lb.; this fell to 4 million in 1864; but increased to over 10 million in 1874. The export, in 1875, was 7,136,327 lb.; 1876, 8,707,552; 1877, 9,532,887. An export duty of 6*s.* a tierce is levied. Renewed efforts are being made to extend the cultivation, and what appear to be rather extravagant hopes are being based upon the introduction of Liberian coffee. Some plants of this variety, introduced in 1874, were placed in cinchona propagating houses, and then distributed to planters at all altitudes; those put out at the lower elevations attained the greatest success. In Jamaica, common coffee is cultivated at all heights, from the sea-level up to 5000 ft. The superior qualities, however, are only produced at heights ranging above 2000 ft., beneath which altitude the quality decreases in value as it approaches the level of the sea. As the peasantry, who are now the largest producers, almost exclusively cultivate their coffee below 2000 ft., the acquisition of a species adapted to the climate of the lowlands is a matter of great importance. A gradual diminution in the area of plantation coffee is taking place. The soil of the Port Royal Mountains, in which the best coffee is grown, is becoming more impoverished from year to year, and all the land adjacent to these plantations has been in a great measure exhausted by coffee cultivation, so that there is very little available land in their immediate proximity. These fields are confined to the southern slopes of the

Blue Mountain range. The northern slopes, except near the sea, are covered with dense primeval forest, no attempts at cultivation having been made here, though these lands are the most valuable in Jamaica for coffee cultivation. It is important, however, to bear in mind that the conditions of humidity differ on the northern and on the southern slopes. On the latter side the destruction of the forest has materially lessened the moisture, thus rendering the climate comparatively dry. The area of unoccupied land favourable for coffee, including forest on the eastern prolongation of the southern slopes, may be roughly estimated at 60,000 to 80,000 acres, nearly all of which belongs to government. The total area in the island now under coffee cultivation, much at unsuitable elevations, is 22,000 acres.

Martinique.—Here also coffee culture is declining, in spite of new lands being taken up. The acreage probably amounts to about 1400, the yield being reckoned at 500 to 1000 lb. a *hectare* (2½ acres); the total production in 1873 was 210,000 kilo.; it is mostly consumed in the island, France taking the little that is exported.

Porto Rico.—Coffee cultivation might be extended here on now unproductive land. Considerable quantities are grown in the province of Ponce, and minor quantities in Mayaguez, Arecibo, and Aguadilla. The quality is excellent, and though not well known in England, it is valued in Latin Europe. Shade is provided according to the needs of each plant. The beans are garbled for market, and those intended for the Mediterranean are polished in a mill, with the addition of a little colouring matter when necessary. The exports in *quintals* (of 101½ lb.) were, in 1874, 199,488; 1875, 256,485; 1876, 306,526; 1877, 137,140; 1878, 151,204. The destinations of the export of 1878, were: Spain, 16,771; Italy, 15,406; France, 5908; Great Britain and Provinces, 5472; Germany, 4279; United States, 34; other countries (principally Cuba), 103,334.

Trinidad.—The coffee export reaches about 25,000 lb. yearly. There is said to be scarcely any part of the island where coffee culture may not be profitably undertaken; but the districts of Maracas, Aripo, and North Oroponche are regarded as possessing conditions not to be surpassed. The export duty is 11¼*d.* a cwt. The island possesses a fine Botanic Garden, in which are grown some ten varieties, or sub-varieties, of coffee. Some notes concerning their peculiarities may be of interest:—(1) Liberian coffee seems to be regarded as a means of reviving coffee culture in the Western Tropics. The plants thrive well in the ordinary red gravelly loam of the northern part of the island. From the nature of its growth, it must be planted widely, and topping is recommended at 7 ft. Prestoe advises an interval of 16 ft. between the trees, the space to be temporarily occupied by common creole coffee, which would benefit by the shade, and afford a quicker return; the latter are to be removed as soon as the Liberian plants require room, say at the 6th to 7th year. (2) A narrow-leaved coffee received from Java seems well adapted for poor, rocky soils. It resists drought, is very prolific, and has a large bean; but it is slow of development. Its peculiar foliage enables it to withstand heat and drought, and renders it unliable to attack from insects and fungi. It should be planted at 6 ft.; its sturdy but stunted growth is said to obviate the necessity for topping and pruning. (3) Souffrière coffee has been so named from its occurrence on the Souffrière Hills of Dominica, where the plants remained uniformly fruitful and healthy, while surrounded by creole and Mocha trees all affected by blight and drought. The texture of the foliage makes it proof against insects; the natural habit of growth is trichotomous; and the bean is large. It seems suited for steep and barren hill-sides, and though less hardy than (2), it develops more quickly. (4) The Mocha variety is subdivided into major and minor; the former attains a height of 7 ft.; the latter, formerly cultivated in the Maraval, St. Ann's, and Laventille valleys, does not exceed 4 to 5 ft., yields a smaller bean, and is less prolific. The northern hills and valleys of Trinidad might grow both sub-varieties, major in the low ground, and minor on the hills.

Prestoe says that as a rule they would become most prolific under full exposure (presumably to the sun), after being established by the shade afforded by such crops as pigeon-peas, &c. Even such a scorching as to cause a partial shedding of the leaves he considers beneficial. (5) Bengal coffee differs from the others, in a very compact growth, small and long bean, and a preference for dense shade. Its peculiarly-shaped bean places it among second-class coffees as regards market price; but it is recommended for planting with cocoa, when this system of double cropping is practised.

CHAPTER VIII.

BIBLIOGRAPHY.

J. B. A. Chevalier.
Du Café — Paris: 1862.

W. G. McIvor.
Laborie's 'Coffee-planter of St. Domingo.' — Madras: 1863.

P. L. Simmonds.
Coffee and Chicory. — London: 1864.

A. R. W. Lascelles.
Nature and Cultivation of Coffee. — London: 1865.

C. E. A. Le Comte.
Culture et Production du Café dans les Colonies. — Paris: 1865.

W. H. Middleton.
Manual of Coffee-planting. — Natal: 1866.

W. Sabonadière.
Coffee-planter of Ceylon. — London: 1870.

R. H. Elliott.
Planter in Mysore. — London: 1871.

Moreira.
Breves Considerações sobre a Historia e Cultura do Cafeiro. — Rio de Janeiro: 1873.

P. H. F. B. d'Orli.
Culture du Café, &c. — Paris: 1874.

H. E. Stainbank.
Coffee in Natal. — London: 1874.

H. Prestoe.
Report on Coffee in Dominica. — Trinidad: 1875

A. Riant.
Le Café, &c. — Paris: 1875.

W. P. Hiern.
African Species of Coffea. Jour. Lin. Soc.: 1876.
R. Hanson.
Culture and Commerce of Coffee. London: 1877.
E. C. P. Hull.
Coffee-planting in S. India and Ceylon. London: 1877.
P. L. Simmonds.
Tropical Agriculture. London: 1877.
L. Rice.
Mysore and Coorg. Bangalore: 1877–8.
G. Pennetier.
Le Café. Paris: 1878.
R. B. Tytler.
Prospects of Coffee Production. Aberdeen: 1878.
T. Christy.
New Commercial Plants. London: 1878—.
G. Anderson.
Coffee Culture in Mysore. Bangalore: 1879.
J. Hughes.
Ceylon Coffee Soils and Manures. London: 1879.
H. A. A. Nicholls.
Cultivation of Liberian Coffee in the West Indies. London: 1881.
R. C. Haldane.
Subtropical Cultivations and Climates. London: 1886.
A. M. and J. Ferguson.
Planting Directory. Colombo: at intervals.
Hon. M. Romero.
Cultivo del Cafe en la Costa Meridional de Chiapas.
Neitner.
Enemies of the Coffee-tree. Colombo: Fergusson.
E. L. Arnold.
Coffee: its Cultivation and Profit. London: 1886.
Liberian Coffee: its History, &c.

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