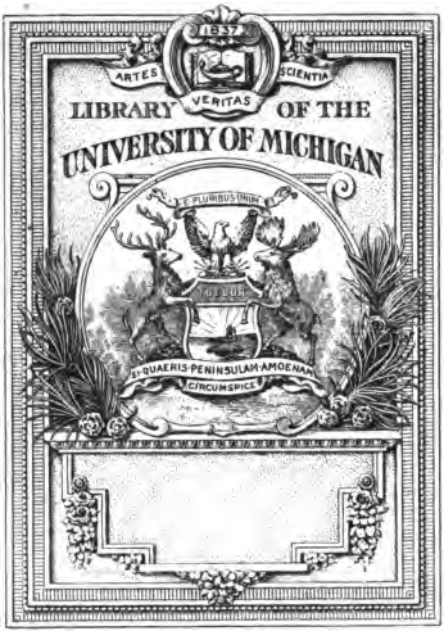
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PRIZE ESSAY

ON

CINCHONA CULTIVATION

WRITTEN FOR THE

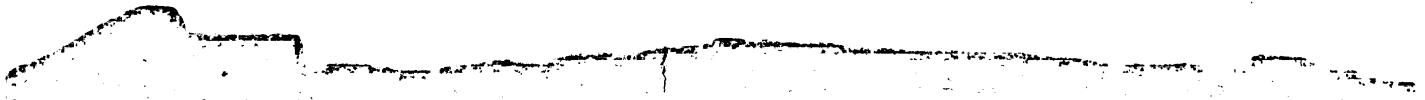
DIKOYA PLANTERS' ASSOCIATION,

BY

THOS. NORTH CHRISTIE.

Colombo:
A. M. & J. FERGUSON.

1883.



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PRIZE ESSAY

ON

CINCHONA CULTIVATION.

THE DIKOYA PLANTERS' ASSOCIATION in calling for an essay on cinchona cultivation particularize the wish for a record of practical personal experience, and not a compilation of the ideas of others; and, although I claim that this paper meets that wish, it must not be supposed that originality is claimed for all or even many of the ideas and modes of cultivation advocated. Much of the advice which the late Mr. McIvor gave me in 1875 has proved to be sound, and many of the devices of my brother-planters have come as great helps during my nine years' experience of cinchona planting, an experience that has been divided equally between such differing districts as dry, windy Nilambe and cold, damp Maskeliya.

It would not be possible, even if it were profitable, within the limits of this paper to enter upon a full history of the numerous varieties of the cinchona plant, and I propose only to treat of the cultivation of the four kinds, which are practically the only ones in which the planter is at present interested, viz. Succirubra, Officinalis, Robusta (hybrid), and Ledgeriana. Under the heading of Officinalis I would, of course, include its sub-varieties, *Condaminea* (the obsolete uritusinga), *Bonplandiana* (the original officinalis), and *Crispa* (the stunted small-leaved variety), and the innumerable forms which link or blend those three together.

The common Calisayas, of which Javanica is the best, may be considered out of date now, for at a low or medium elevation Ledgeriana is incomparably superior, and at a high elevation a hybrid is to be preferred.

Seed is the first thing that claims the attention of the planter, but it is only within the last two years that, generally speaking,

sufficient attention has been given to such an important matter as the selection of reliable seed. I cannot doubt that the indiscriminate importation of half-ripe seed, gathered in many cases from sickly trees, has had a good deal to do with unsuccessful nurseries and clearings. Let us remember that, to a very great extent, like produces like, and eschew all seed that is not gathered ripe from thoroughly healthy trees. The difference in cost between planting a clearing with inferior seed and with the best seed is so out of proportion to the difference between the ultimate values of the clearings that no one should be "penny wise" over the question of seed. At five years of age the one clearing would have cost, say, R410 per acre, and the other R400, when their respective values would be, say, R1,000 and R600 per acre. Not only is the cost of land, cultivating, preparing and transporting just as much whether the bark be rich or poor, but a ton of 8 per cent bark will sell for considerably more than 2 tons of 4 per cent bark. In gathering valuable seed I prefer to dispense with muslin or gauze bags tied round the clusters, as I think they cramp the seed lobes, and often in wet weather tend to produce rot and encourage insects. The signs of ripeness are always sufficiently visible a day or two before the capsule bursts to enable a hand gathering being made. In the case of very old or inaccessible trees, the only way is to shake the seed into a suspended cloth.

Seed gathered before maturity often has just strength to germinate, and then dies off. The difference in weight between different seeds is very great. I have Ledgeriana seeds which take about 75,000, to the ounce, while I have a hybrid, with a very bold seed, that only takes 27,000.

Seed Sheds.—It is impossible to lay down any hard and fast rule as to the construction of seed sheds, for a plan that succeeds admirably in a particular climate or at a particular season utterly fails in another. I advise single sheds about 30 feet long and 3½ feet wide, each of which will hold 2½ or 3 ounces of seed.

The sheds should be at least 3 feet apart: in fact I prefer them with a bedding-out space between each shed, so that the spread of any blight or pest is liable to be confined to one shed only. In very hot or windy climates double *vis-à-vis* sheds are often the best, but at a high elevation, or in a damp climate, nothing beats the single shed, put facing the east, with a coir mat hung in front, when necessary. Jungle poles with a cadjan roof is my favorite style of shed, but bark and thatch are also suitable for

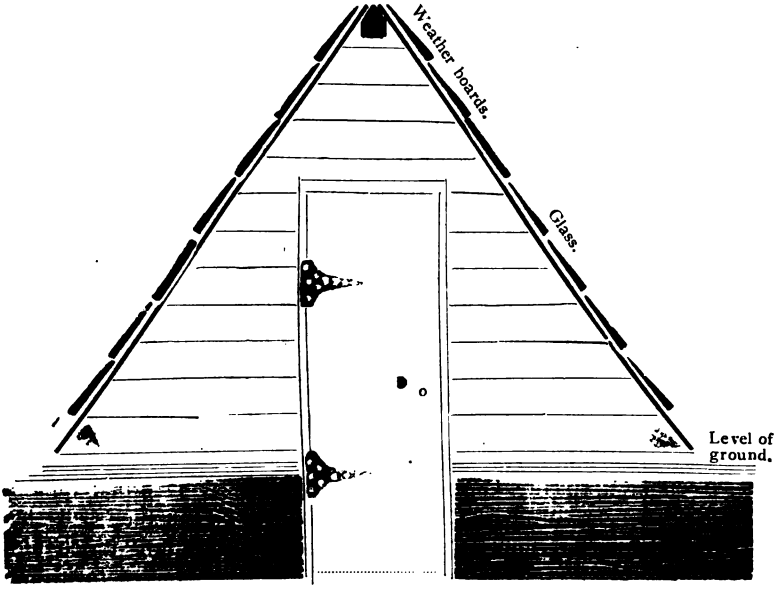
roofing: the latter sometimes harbours injurious insects, however. Whatever style of shed be adopted, the plan of the beds should always be the same, viz., a well raised sloping bed, sufficiently narrow to be watched and watered without an undue amount of stretching. An abundance of new friable jungle soil, not less than 6 inches deep, will do more than anything else towards securing successful seed beds. I only an inch or two of fresh soil be used, the seedlings run a great chance of dying off whenever their roots get beyond it. To get rid of insects and their eggs, I prefer to drench the soil with boiling water, as baking it injures the vegetable humus. The surface soil should be passed through a sieve, and then smoothed off with a stick; and after the seed has been sown broadcast a little fibrous soil or vegetable mould dusted over the surface. For this purpose I find an earth sieve, formed like a large flour dredger, convenient. I have seen many successful seed beds where no earth was put over the seed, but as a rule I think a very light dusting of soil lessens the liability when watering to knock over the freshly germinated seedling. If the earth be put on too thickly the seed will lie dormant. Until the seed has germinated the bed should be kept well moistened—in dry, windy weather water may even be required twice a day—and all rays of the sun excluded. If the seed be Ledgeriana and the nursery above 4000 feet elevation it should never be watered either early in the morning or very late in the evening, and during the dry season, when frosty nights may be expected, the seed beds should never be allowed to get too dry, and the mats should be let down every evening to prevent the chill which invariably strikes severely upon an open dry bed. When once the seed has germinated and the seedling has a hold upon the ground, diffused light and plenty of air should be freely admitted to the shed. More seedlings die from too much water and too little light and air than from the reverse.

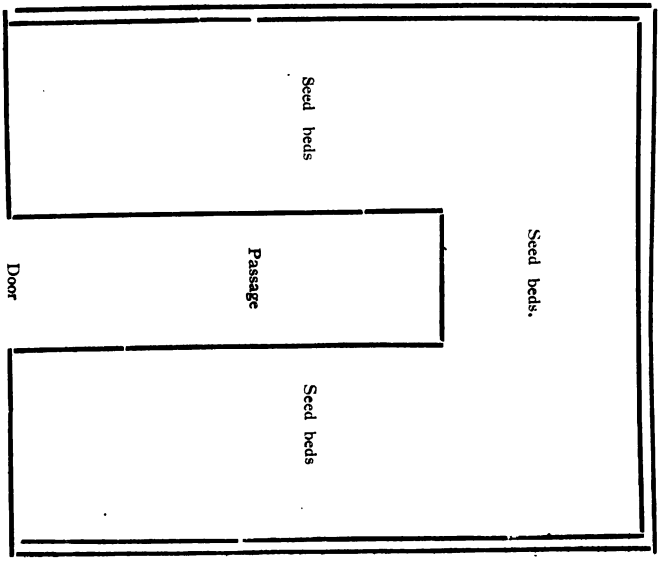
Very valuable seed can often in certain seasons and climates be raised with great advantage under glass, accelerated growth and few failures being the result.

The annexed plan of a small seed house is one that I have been successful with, and its cost was only R160. It is hardly necessary to say that it is essential to have seasoned wood for the glass frames, and well arranged tats or blinds with large ventilators, so that the temperature will never rise above 80° F., and as nearly as possible an average of 70° should be kept. Artificial heat is never required.

Section and Ground Plan of Seed House 10″ × 20″.

The passage is sunk 2½ feet and seed beds are a few inches above the surface of the surrounding ground.





When about 4 months old (or if grown under glass 3 months) the seedlings should be ready to be pricked out, and the nature of the climate and the season of the year must be considered in determining how this is to be best done. In the lower and warmer districts open beds, with the patana fern stuck in as shade, are most satisfactory, and plants so raised are very hardy. In the damper districts, similar beds may be used between the monsoons, and jungle twigs used where fern is unobtainable. The twigs from "beru" ("tyrannie" of the Tamils) tree are best: they retain their leaves for many months. Blue gum twigs can also be used. During the monsoons a light shed with a grass or cadjan roof will be found necessary to prevent young plants rotting off from the excessive damp. For valuable plants small bamboo baskets should be used (about 3 inches wide by 5 deep) of which a woman can make from 60 to 100 per day. In using such baskets great care must be observed on two points: firstly in filling the basket with earth, and, secondly, sinking the basket in earth after the seedling has been put in. As a rule coolies either "jam" the earth in too much, or do not press it down sufficiently. My plan is to have the earth moderately well pressed down, and then to expose the baskets in the rain, or water them well, for 2 or 3 days: treated thus the earth settles down to a natural consistency. After the seedling has been put in, the baskets should be placed side by side and the interstices between them thoroughly filled with sandy soil. If this is not done the earth in the baskets not only runs a great risk of being dried up, but may be removed almost entirely by worms. Carefully used, I consider baskets, particularly in districts free from white ants, the best means of treating any valuable seedling. Cow-dung pots are in practice a failure. Laurie's (and other) transplanters are often useful for small plants in doubtful weather, but for extensive plantings of the ordinary varieties, good large, hardy plants, pulled and planted by the hand with moderate care, are cheaper and better than anything else. A small plant does very well in fresh soil, but a good large plant is necessary for old land. Good hardy plants can be raised from seed sown broadcast in the open, care being taken to select a mossy or fibrous bit of land, but the outturn in proportion to the quantity of seed is very small. In doubtful weather it is often desirable to shade the plant after it has been put out, and for this purpose I prefer fern or "beru" twigs. In new clearings bark must often be used, but it is apt to fall on to the plant, or if sunk at all deeply it prevents the free egress of the roots. Although raising seed is the easiest, and in fact the only way to obtain very large numbers of plants, yet with the rarer varieties, or specially rich trees, every effort should be made to propagate them by cuttings and grafts. I have found all the varieties, including Ledgeriana, equally easy to strike if *suckers* are obtainable. All that is necessary is to prepare a covered bed with abundance of fresh, sandy soil into which the cutting is placed, with its lower eye about 2 inches from the

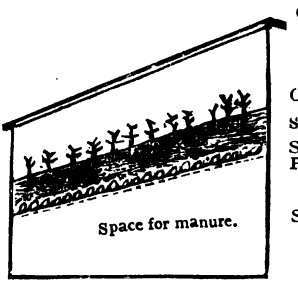
surface, and gently pressed down. Admit plenty of light and air, but exclude direct rays of the sun, and water, as for seedlings, according to weather. Within 3 months most of the cuttings should have struck, and at the end of 6 months they should be well rooted and ready to be basketed. Unfortunately from old trees it is generally impossible to obtain suckers, and we have to resort to the tips of branches which do not root at all freely, and require bottom heat. The two means employed by me are to some extent original, and are far more successful than any of the other numerous plans I have tried. The one way is to prepare a single roofed shed, say 4 feet wide by 40 long, the supports being a little taller than those in a seed shed. In this a layer of fresh cattle manure should be laid about 18 inches thick, on the top of that about 8 inches of fresh soil, and on the top of that 2 or 3 inches of fine sifted sand—silver sand if possible. The cuttings should be placed with the eye from which the roots are to spring almost touching the layer of soil, about 4 inches apart, and covered with a bell glass, or what does equally well the upper half of a light colored bottle. Bottles are neatly and easily cut by burning a girdle of kerosene oil round them and then plunging them into cold water. Bottles of light color are difficult to obtain in quantity, and I got bell glasses made which landed in Ceylon cost only £6-17 per 1000. The glasses, which have an orifice in the top, are never removed until the cuttings are supposed to have struck, which with branch cuttings takes from 4 to 6 months. After the glasses have been removed, the cuttings require care in the matter of watering and strong sun for another 2 or 3 months, and can then be transplanted with a ball of earth.

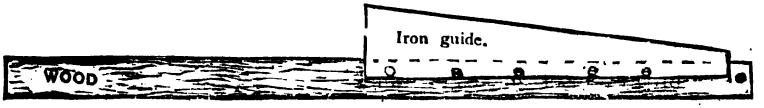
Branch cuttings can also be struck in a hotbed, but, as such expensive houses as the one on "Ythanside" are beyond the purses and skill of most of us, I adopted a cheap and simple substitute in a small way. It is a frame made like an ordinary English cucumber frame, only much deeper, with what I may call a false bottom of perforated metal (similar to that used for drainers in coffee cisterns) half-way down. Under this perforated metal, cattle manure is inserted, by means of two stoke-hole doors at the back of the frame, and this manure is renewed at intervals so that the bottom heat may be kept up, without in any way disturbing the cuttings, which rest on layers of sand, earth and small stones above the iron.

The annexed sketch conveys the idea better than words can. The frame must have sliding glasses to admit of ventilation, and be well protected by a roof from the sun's rays. All cuttings, either suckers or branches, should be of soft wood, and cut, close to the eye, with a sharp knife. The cutting may be of almost any size, but I prefer those from 4 to 6 inches long. The leaves should be cut off, and the opening bud topped.

Cuttings from suckers grow as well and are as long-lived as seedlings. I can notice no difference between them. Cuttings (and also grafts) from tips of branches do not grow so quickly, and unless pruned

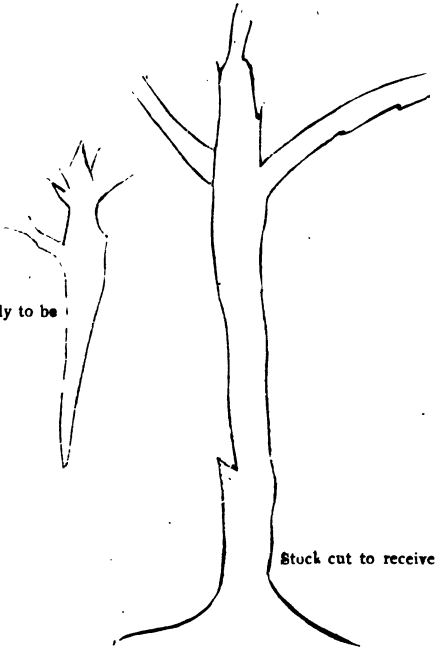
Section of box hotbed for striking cuttings.





Side view of grafting tool half natural size.

Section shewing bed in which the graft is laid.



Scion cut ready to be bound to stock.

Stock cut to receive scion.

are inclined to get bushy. More care is required in transplanting a young cutting than a seedling.

Grafting cinchonas is an operation that I do not think practicable on a very large scale, although the success of Mr. Wm. Smith's efforts to graft in the open brings the expedient within the reach of every planter. I myself have been more successful with outdoor grafting than with indoor, and I think that every planter should try to obtain good Ledgeriana grafts for roadsides, as a very few hundreds of such grafts, growing in the position where cinchonas are most permanent, would yield quite an income. For seed-bearing purposes grafts from the best analysed trees are much to be desired, and if the graft be taken from the branch of a mature tree it will yield seed in a couple of years. A Succirubra or Robusta 18 months old makes the best stock, and a sucker makes the best scion, but as a rule branches only are obtainable.

A broad chisel makes a much truer cut than a knife, and I adopted a simple little instrument whereby a long straight cut was easily given to the scion. It consists of a bit of wood 8 inches long and abont half an inch thick, with a small sloping plate of iron on either side; the graft, *i.e.*, the scion, is laid between the iron guides, and the sharp chisel used to make the cut is guided by them, thus making a wedge of the scion: the annexed sketch shows the instrument, and also the application of the scion to the stock. The connecting surfaces should be at least 3 inches long, so as to afford a strong hold. Of course the nearer the size of the stock agrees with that of the graft the better, but contact between the lips of the cambium on one edge only is sufficient. The scion should be firmly lashed on with bass—plantain or jungle fibre does well—and then clayed up. The stock can either be pegged down or topped, so as to send the sap into the graft, and subsequently cut or sawn across, for which latter purpose I use a fret-work saw. In very wet weather the clay often produces rot or canker, and sunny showery weather should be selected for carrying out the work.

Budding is not, I find, so satisfactory as grafting, the growth being very slow. It is easily and best done by the use of a small bore, say ·500, wad punch, with which the bud is nicely punched out of the parent tree, and then a piece of bark is similarly punched out of the tree that is to act as stock, and into the orifice the bud fits and is bound with bass.

Transport of plants and seedlings is a subject to which I would like to draw attention. Where the carriage is that of a few hours, only little need be done except to put the plants into large baskets—tied bundles being I think very objectionable—but when plants have to be carried 2 or 3 days' journey much greater care is necessary. The great danger is that the plants will heat *en route*, and any heating near the roots is fatal. To prevent this as much as possible, the plants should be placed between large oyster-shell plant baskets,

and not, as is too often the case, tightly packed with grass or ferns. If the weather be very dry and hot, one thin layer of fern may be put round the inside of the baskets, but in ordinary planting weather this is not necessary, and the free circulation of air through the baskets will keep the plants in perfect condition. With seedlings I have adopted a plan whereby they can travel almost any distance, certainly 3 or 4 days' journey, without any injury. It is this:—the seedlings are placed in small supply baskets, say 200 in each, and these (with a fern leaf tied round to prevent the seedlings tumbling out) are in turn, to, say, the number of twenty, placed between 2 good-sized manure baskets without any packing: thus all crushing of the seedlings is avoided, and the air circulates freely through the baskets, which are sufficient to keep out all sun. If theft be feared the strings which tie the baskets together can be sealed. This plan, too, may be adopted with valuable plants, substituting large oyster-shell baskets for the manure baskets. Many plants and seedlings are greatly injured, and sometimes killed, by the carrying coolies resorting at night to hot pent-up bazaars or cooly lines, into which for fear of theft the plants are taken, and in fact often used as pillows!

As a rule it is always possible to give plant-carrying coolies a note to some friend which would ensure the plants being put in the store or stable, and not exposed to theft and the atmosphere of cooly lines at night.

So far all I have written applies equally to cinchonas that are to be planted amongst coffee or in distinct clearings, but in considering the best way to drain, plant and lop much depends on whether we have the cinchona only to think of, or whether the coffee has also to be considered. There is little doubt that cinchona is more suited to be a companion to coffee or tea than a seperate cultivation, and in most instances a good coffee soil is also a good cinchona soil. A *deep* friable and rather gritty or quartzy soil, on a fairly steep hillside, is what cinchona delights in, and at high elevations, *cæteris paribus*, an eastern aspect is much to be preferred. I find depth of soil far more important than richness, but often the two conditions go together. In new soil the growth of the individual trees is very much better than in coffee soil, but the death-rate is so much greater that I rather think the yield per acre on fairly good coffee soil would equal that of a clearing. For quality of bark I would give the preference to the clearing, for in a series of analyses taken from trees on different sides of a ravine I found that the trees growing on the one side, where the soil was very good, averaged 1 % alkaloids more than the trees on the other side, where the soil was thin and poor.

In planting out, *holing* is the first question that has to be considered. In the fresh soil of a clearing, or in good soil with moderately old coffee, I have never seen any marked benefit derived from holing, and in a clay soil or on flat land, I deem

it a positive evil, as the holes become perfect cisterns during wet weather. A forking of the soil, which in coffee land should be sufficient to break the coffee roots, is cheap and effectual.

In the case of worn out or hard sun-baked soil holing is not only of undoubted benefit, but sometimes absolutely necessary.

Draining is perhaps the most important work on a cinchona clearing, but until lately it has in many cases been much neglected. It should be remembered that what will act as a preventative will not always act as a cure, and I find that if a patch of cinchona is once allowed to die out it is almost hopeless to try and get it to grow again; even if the spot be scored with drains, half of which if put in at first would have saved many of the plants. With cinchona the chief object is to get rid of excessive moisture, while with coffee the object has been almost entirely to stop "wash." This difference should always be kept in view, and close, short, steep drains made the rule. A 12 or 15 chain drain at a gradient of 1 in 15 or 20 winding round the contour of a hill will no doubt stop wash, but it certainly does nothing towards getting rid quickly of the moisture, rather the reverse, it checks the rush away of the water, and gives it time to soak into the soil. The "herring-bone" system of drains 4 or 5 chains long, 20 feet apart, and at a gradient of 1 in 8 or 10, are what I find best; of course many down drains must be cut where there are few ravines.

In coffee land such very close draining is not necessary—partly I think because there are fewer tree roots to retain the water, and partly from the great amount of moisture drawn up by the coffee itself—though the drains on most estates might be doubled with advantage both to coffee and cinchona. No one who sees how well cinchonas grow in the "spoil" from road cuttings, which is generally poor subsoil, can doubt that perfect drainage is one of the most important factors in successful cultivation. I have planted all my road-sides with regular thickets of officinalis, the plants being about 2 feet apart, and the system has been successful, for now at 3 years of age the trees are wonderfully well grown, and the vacancies few. Of course such close planting would be absurd except in the case of roadside hedges where the plants get leaf and root room far out of proportion to the space their stems occupy. I have also one line of plants below each drain.

Staking has, like draining, been neglected, but in many cases the expense and the difficulty in getting stakes prevented its being undertaken by those who were fully alive to the necessity. In dry districts it is not nearly so necessary as in wet ones, where the plant, getting plenty of surface food and moisture, shows little disposition to throw down deep roots, and so too often is unable to hold itself up against the monsoon. I attribute much of the "damping off" to the fact that the plants being shaken by the wind work a kind of socket in the soil, and in this the water lodges. For very young plants the fibre from the "keku gas" in the high dis-

tricts, and from the large jungle ropes in the lower districts, forms a cheap and sufficient tie, but for older trees coir twist must be used, and its use necessitates a bit of sacking or some other wad to prevent cutting and chafing. I use the outside bark of the "keku gas" chopped into bits about 5 inches long. This is the most effectual and the cheapest pad it is possible to have. If the jungle be anywhere near, a dozen coolies will carry down and chop up enough for 50,000 trees in a day. Trees planted in the made earth along roads and drains, and of all the varieties officinalis, require staking most.

Where staking has not been adopted it will be found of great advantage, when the wind is over, to heap a little earth and trample it well down into the socket round all the shaken trees.

Lopping is the next operation that has to be considered. There can be no doubt that the majority of the old cinchona trees in Ceylon have, for the sake of the coffee amongst which they stand, been overlopped, and for the same reason many will continue to be so treated. In many cases, however, where the same necessity does not exist the practise has been carried out, sometimes because a clean pole looks nice, sometimes because the value of the prunings was a consideration. Very young plants should never be pruned, for the development of the plant regulates the feeding power and growth of the roots, and a heavily pruned young plant runs a great chance of growing up spindly and weakly rooted. No doubt stripping the young plant of its branches and leaves lessens the surface exposed to wind, and for a year obviates the necessity for staking, but the following year the plant suffers proportionatefy more; of course what lopping is to be done may advantageously be done just before the monsoon. Another reason why lopping should be sparingly done is that the trees in a heavily foliaged clearing will from their enormous evaporation be forced to send down deep roots in search of moisture and so cause, as it were, a circulation, instead of leaving the sub-soil, as we too often see it, water-logged and sour, with hardly a root visible 12 inches from the surface. If planters would only remember that the amount of moisture taken out of the soil by a dense foliage is far greater than the amount which the sun beating on the surface can extract, they would be more inclined to follow the wholesome rule of never taking off more than one-third of the foliage at a single lopping, and never lopping twice in the same year. I find that the bark on a heavily lopped tree is thinner than on an almost unlopped one, and that the latter renews its bark quicker, and with less signs of injury, after a shaving.

Officinalis hardly ever requires lopping, while the calisayas at first require more than succirubra. I always gather and heap the leaves from loppings, as for nursery purposes they make first rate vegetable mould.

The four varieties treated of in this essay vary in many particulars, and require separate notice.

Succirubra, "the poor but honest succirubra," deserves the first place, not only because it is the variety that, so far, has done most for the planter during the last 4 years of bad coffee crops, but also because it was in the district (Dikoya) which invites this essay that its cultivation was first attempted and proved a success.

Succirubra is second to none either in the quantity of its bark or in its range of elevation and climate. From 2,500 feet up to 5,000 feet elevation it grows well, and often in soils that will not grow officinalis. In good patana soil succirubra grows well, and some which I planted in rather poor patana soil 9 years ago are now very fine trees, and another patana clearing planted in 1878 is one of the most even clearings I know of. There are two types of the tree, one pubescent and the other not, but no difference in quantity or quality of bark has ever been observed between them.

Officinalis.—At one time it was thought that Ceylon would stand first in the cultivation of officinalis, but the wholesale dying out of clearings, in almost every part of the Island, during the last two years, has made officinalis as regards extended cultivation very nearly, I fear, a thing of the past. Although we must admit the general unsuitability of our land for officinalis, I think the failure has been greatly aggravated by want of care.

Everything was done in such a wholesale manner, pounds after pounds of the most inferior seed were shoved into nurseries, without the slightest regard to parentage, and hundreds of thousands of plants were dabbed into undrained, half roaded clearings, and then left to take care of themselves. With the present high price of bark most of these clearings will give a profit, some of them a large profit, even as they are, but how much more would it have been if the money they cost had been carefully spent on half the acreage? I think, myself, that with good plants, raised from the seed of selected large-leaved trees, small officinalis clearings carefully opened would be very profitable. Fifteen or twenty acres of suitable land should be picked out here and there—for one thing is certain that no large block of 150 or 200 acres will grow officinalis, or indeed any cinchona, regularly from end to end. The two soils which seem most fatal to officinalis, and on which I have never seen it reach even semi-maturity, are, a fairly rich, peaty looking, stoneless, surface soil, 6 or 8 inches deep, underlaid by a heavy clay, sometimes gritty, but generally of a soap-like consistency; the other that thin, poor ironstone soil, the surface nearly all fine rubble gravel, with a better looking and fairly free light colored sub-soil. Very rocky land is also treacherous. Ceylon-grown crown bark (root) has sold for 10s. per lb., and Indian renewed stem bark for 12s. 8d.

Hybrids.—Some people adhere to the names "Pubescens," "Lanosa," or even that ridiculous epithet "Pata-de-Gallinazo," for which Colonel Beddome is responsible, to describe these plants, but I certainly think the name proposed by Dr. Trimen, and now generally accepted, of "C. robusta" is appropriate and comprehenss

ive. Some, though certainly not the most numerous, forms are pubescent, but I see no possible reason why they should be made into a seperate variety, when the pubescent forms of succirubra and Ledgeriana are considered, and I think justly so, as mere types of the same variety. In 1875 Mr. McIvor gave me some of the seed from his original "Pubescens" trees, but not one-fifth of the resulting trees are pubescent, though all are robust.

The origin of these "hybrid" trees has given rise to much controversy, but they are now generally accepted as hybrids, in the sense that they are the result of the cross-fertilization of two varieties. I have no doubt on the matter, for in cases where I have fertilized the stigma of one variety with the pollen of another the resulting plants plainly show their mongrel origin, and what it was easy for me to do with a small hair pencil would, I have no doubt, be done with the antennæ of insects.

I do not think indiscriminate hybridizing is common, for it would only occur when the varieties were in close proximity and blossoming together; bees, too, the chief carriers of pollen, would prefer to continue at one kind of blossom, and if gathering honey from the white blossom of a Ledgeriana they would be disposed to pass the pink blossom of an officinalis. I take the precaution to allow no other cinchonas to blossom within a quarter of a mile of my Ledgerianas, and I have never been able to detect under the microscope foreign pollen on their stigmas. Hardy, quick-growing and rich though hybrids be, I think they are much overrated at present. I do not believe that the *average* hybrid natural bark is richer in quinine than the average officinalis. It must be remembered that most of the published analyses are of bark taken from selected trees, and it is only when the analyses are good that they are published; nothing is said of the many poor ones. So seeing that all the quoted hybrid analyses run from 4 to 7 per cent sulphate quinine, the idea has gained that the average of 6 year old hybrids would be 5 or 6 per cent, while I consider that 3 per cent would be nearer the mark.

At 4½ years of age the average of 4 of my trees, raised from McIvor's seed, shewed 3·30 sulphate. The best, which was of the glabrous type, gave 5·33 sulphate, and just a trace of other alkaloids. There can be no doubt that hybrids are destined to take the place of officinalis, and in the higher districts of succirubra also. They often grow where no other cinchona will live, and they renew easily, with a particularly rich bark. At low elevations I find that it is only the hybrid in which the succirubra strain predominates that grows luxuriantly, those shewing much of the officinalis are far behind. In the future, no doubt, the Ledgeriana-succirubra and the Ledgeriana-officinalis hybrids will become the favorites. I have specimens of both, and they leave nothing to be wished for as regards size, but they are rather young to be analyzed. The only one analyzed gave 4½ per cent sulphate, at a little over 3 years of age, this at an elevation of about 3,000 feet.

Ledgeriana, the *ne plus ultra* of the cinchonas, is still rare in Ceylon, and I may preface my remarks by copying Dr. Trimen's description, from the *Journal of Botany* for November last,

The description though not quite accurate and so technical as to require the aid of a dictionary, is the best that has been published, and Dr. Trimen's illustration of the blossom (but not of the tree itself) is particularly good, a contrast to that given in Howard's great work, where the figured plant is far from being a typical Ledgeriana, if indeed it is one at all. Dr. Trimen says:—

CINCHONA LEDGERIANA, MOENS.

"Leaves when adult varying from pure lanceolate to oval or to "linear-lanceolate, or to oblong-oval, *but always having the broadest* "*part at or near the middle* and especially narrowing towards either "end, apex sub-acute (rarely acute) or sub-obtuse, base much attenuate "into the short petiole, always perfectly glabrous on both surfaces, "sub-coriaceous, often wavy, full deep green, paler beneath, shining "but not polished above, the base of the midrib and petiole more "or less stained with orange-pink, the veins prominent beneath, "scrobicules not conspicuous mostly confined to the upper vein-"angles, stipules enclosing the terminal bud quickly caducous, "lanceolate-oblong, subacute glabrous, heeled, and with numerous "parallel veinlets. *Flowers* small, on short curved pedicels and thus "drooping or divaricate, tufted or crowded at the ends of the branches "of the usually small rather dense pyramidal panicle: *buds* oblong-"ovoid, blunt, when mature *not at all or very slightly widened at* "*the end and never abruptly enlarged there.*

"*Corolla* with a short wide *tube* about ⅛th inch long, somewhat "inflated in the middle, pale green, lobes pure white or somewhat "cream-coloured (very rarely pinkish), the marginal hairs copious and "long.

"*Capsule* short, ovoid-oblong, rarely more than ⅜ inch and never "more than ½ inch in length, capped by the persistent cup-shaped "calyx-limb with erect teeth. As with the other species of cinchona "in cultivation there is in this a great deal of variability in the "form of leaf, even in adult trees. On the flowering branches they "are often narrow and almost strap-shaped, whilst in some plants "they are as broad as C. officinalis, var. Condaminea, from which "it is indeed not always easy to disinguish them. The amount of "red coloration in the veins is variable, and rarely quite absent.

"Though always absolutely glabrous when mature, this is by "no means the case with young plants; seedlings up to a year or "two old are frequently more or less hairy beneath, but as the trees "get older this disappears."

The repeated statement that the leaf of the mature tree is "always perfectly glabrous" is incorrect: one of the best, and as regards blossom most typical specimens, is thoroughly pubescent. A tree of

this pubescent type analyzed by Howard gave 11·2 sulphate quinine at a little over 3 years of age, another 6 months older gave 11·70.

Nor is it quite correct to say that the leaf is never polished above: one of my trees with a leaf polished as much as a coffee leaf gave at 5½ years of age 10·12 sulphate quinine, The seed capsule of several of my best trees exceeds ½ an inch in length, so that the statement that it is never more than ½ an inch must be modified. Having had the advantage of comparing the analyses of over 60 individual trees with the trees themselves, I can say that there is no correlation between the quantity of alkaloids and any particular size, shape or color of the leaves or capsules. In some cases the broad leaf type is the richest, in some cases it is the reverse, but, without exception, every typical Ledgeriana tree gave a very high analysis. As far as my experience goes I think *the* peculiarity of a Ledgeriana is the inflated corolla, without a knob, and the small drooping blossom generally of a lemon-white color. In ninety-nine cases out of a hundred the experienced eye can without any difficulty be sure of a Ledgeriana, and as a rule the Commoner calisayas may at once be detected by their bud (the difference illustrated below) and the texture of their leaf, The difference between the profuse blossoming of common Calisayas, generally one mass of blossom at 2 and 3 years of age, and the reluctant blossoming of a Ledgeriana is very marked. At 6½ years of age I have no tree that can be said to be blossoming profusely, and I have many without a single bud.

Mature bud of C. Ledgeriana.

Mature bud of C. Calisaya.

As a young tree the Ledgeriana is perhaps the handsomest of all the cinchonas, but it gets shabbier looking as it gets old. The Java ones are described as "scraggy looking trees."

I annex a photograph of one of mine, 5 years old, which (though from the age of my chemicals the photograph is not as clear as it should be) gives a good idea of the habit of the tree. This tree gave an analysis of 11·70 per cent of sulphate of quinine.*

Considerable misapprehension exists as to the growth and yield of Ledgeriana trees, and it is often talked of as being a small and delicate variety—a statement that is only true of it when planted at extremely high elevations. My experience of it is that it is no more likely to die off than any other variety, and that it stands wind much better than officinalis, and that its yield *per acre* would be very little if at all behind that of succirubra. In point of size at a moderate elevation it is quite ⅔rds the size of a succirubra, and possessing a much thicker bark its yield is proportionately more.

I have three 6½ year old trees growing side by side on a very windy slope, at 4,000 feet elevation, and the *average* of their

* We regret that we cannot reproduce this photograph.—PUBLISHERS.

three analyses is 13·10 total alkaloids, 12·19 sulphate quinine, while their average girth is 13½ inches, and height 15 feet, and I estimate that they would each give 5 lb. of dry bark.*

Three trees, six years and four months old, cut down this year gave respectively 9 pounds, 8 pounds 6 ounces and 8 pounds of dry bark, exclusive of root and stump, while one tree exactly six and a half years old, analysis 9·61 sulphate of quinine, gave the unprecedented quantity of 33 lb. of wet bark, which dried down to 13½ lb. of dry bark, a yield that will compare in quantity with any succirubra of the same age. These trees were, however, road-side ones, and so above the average; but on the other hand they were grown in very medium soil and in an exposed position at 4,000 feet elevation.

I shaved some Ledgeriana and succirubra trees, 2 years 9 months old, growing under exactly similar conditions, and the average yield was succirubra 7 ounces wet bark per tree, Ledgeriana 6¾ ounces wet bark per tree, but when the bark was dried the averages were succirubra 1¾ ounce per tree, Ledgeriana 2¼ ounces per tree. When setting the spokeshave the difference between the thin papery bark of the succirubra and the thick substantial bark of the Ledgeriana was very marked; both varieties renewed their bark equally well. Java has had the start (and kept the lead by sending out so much spurious seed) in the cultivation of C. Ledgeriana, but I am certain that Ceylon is destined to take a foremost position in the cultivation of this splendid variety.

In point of average richness the results obtained in Ceylon are better than those obtained in Java, so far as I have been able to compare analyses.

In Ceylon we have the "Mattakellie" trees, about 6 years old, giving an average of nearly 9 per cent sulphate quinine; the "Yarrow" trees, a little over 4 years old, an average of 8 per cent, and the "St. Andrews" trees, 5¼ years old, 10¼ per cent sulphate quinine. I have not found in any of the published Java analyses any series with such high averages, and in individual cases their richest trees, though double the age of ours, only in a few instances are better, while they have many far poorer than anything heard of in Ceylon.

There is hardly an estate in the old districts that has not some patch of chena or patana land well suited for the cultivation of Ledgeriana, and there are thousands of acres of patana and forest belt land, not only in Uva but also between Nuwara Eliya and Kandy, admirably adapted for its cultivation. Our experience is as yet too limited to say for certain at how low an elevation it may be successfully planted, but I think 2000 feet is about the minimum. Two trees that I planted in poor chena soil at 2,500 feet analyzed at 4 years of age 4·55 and 4·68 sulphate quinine, The chief advantages of Ledgeriana are that it yields such a rich substantial bark at very early age, that it grows at an elevation where the climate is forcing and where violent windstorms never

* Four months after this was written the smallest of the three was cut down, and it yielded 6½ lb. dry bark, exclusive of root and stump.

occur, and that when planted amongst coffee the drip from its small leaf does but little injury.

Harvesting Bark.—Unless there be great practical difficulties of application, there can be no doubt that any system whereby a tree is deprived only of the product for which it is grown is better than one in which to secure the produce it is necessary to cut down or uproot the tree.

Uprooting is so plainly "killing the goose" that it may be dismissed as a regular means of harvesting. It is only in the case of dying trees or in thinning out an over dense clearing (which latter phenomenon is seldom seen) that such a proceeding would be resorted to. That cinchona cannot be grown twice on the same land may be taken as a fact. I have seen many and large failures, and never one real success.

Coppicing, though in my opinion but a few degrees better than uprooting, has some advocates and offers the temptations of a larger immediate return and fancy prices for fine druggist's quill. Its disadvantages are (leaving aside the question of ultimate yield) the greater exhaustion of soil when called upon to reproduce the whole frame-work of a tree than when only called upon to renew a few pounds of bark, the liability of the stool to rot without sending up suckers, particularly in the case of old trees, the liability to rot even after the suckers have started, and the brittle nature of the connection between the stool and sucker, which renders the latter so liable, for a couple of years, to be blown off.

If the collar of the tree be spokeshaved a few months before the coppice is made, there will hardly be a failure in sending out suckers, and to expedite the healing over of the stool 2 suckers on opposite sides should be allowed to grow, and when sufficiently grown any danger of being broken off by wind can be prevented by putting on a connecting tie of coir. The suckers should be grown near the top of the stool, otherwise all the bark above them rots, and the rotting once established may extend to the suckers. All the trees that I have coppiced have been done with a small cross-cut saw, the cut being at a slight angle, say 20°, a few inches above the ground.

Stripping.—McIvor's plan of taking the bark off in strips, while it fulfils the condition of only taking from the tree what is actually wanted, fails to a great extent in practice.

At certain seasons, and with certain trees, the bark refuses to rise, and at all seasons and with all trees it is impossible, on anything like a large scale, to get coolies to perform the operation without injury to the cambium. When carefully done the bark renews at once, if the cambium be immediately screened from sun and rain.

Shaving.—This method of harvesting, first introduced by Mr. Moens of Java, is beyond doubt the best and most rational, and it is surprising that it was not sooner thought of. Not only does this system leave a protecting layer of bark over the cambium,

and that layer the portion of the bark poorest in alkaloids, but it is of all systems the most practicable with ordinary cooly labor, and by far the cheapest. The renewed bark obtained by this process gains quinine largely at the expense of cinchonidine, &c., and seems just as rich as the renewed bark obtained by stripping.

For shaving young trees I think the small iron spokeshave is the best, for medium-sized trees the American box-shave (with the orifice filed to ¼ inch), but for very old trees a knife—preferably one like a farrier's—is the only tool that can be used. The large curved wooden spokeshave also does well for medium-sized trees. Each shaving cooly should be provided with a bit of sacking about 6 feet square, with a slit to the centre, to put round the tree, and the bigger the shavings are the better,—to avoid loss from chips being dropped and lost at the tree.

The quantity that a cooly can bring in varies very much according to the age, variety and proximity of the trees shaved. From 4 year old trees, at a medium distance apart, I think 80 lb. wet bark per cooly is a good average, and from old trees 100 or even 120 lb. can be brought in. There have been a great many machines introduced for aiding in the barking of twigs and branches, but I cannot say that I believe in them. Any little saving in labor which they may effect is more than counterbalanced by their expense, and difficulty of manipulation by women and children, who are generally put to this work. A couple of alavangas driven into the ground side by side, or a couple of small smooth round sticks tied together at one end—on the nutcracker principle—and then slightly pressed together while the twig is being drawn through, are as simple and effectual devices as one need wish. The quantity that a woman can peel varies from 15 lb. wet, of officinalis twig bark, to 60 lb. of succirubra branch bark. The roots of living trees can be stripped or shaved, and I find that covered with a few leaves and soil they renew their bark well. Of course it is only in the case of old trees that it is worth while touching the roots.

Covering.—Perhaps at present we attach an exaggerated importance to the covering of shaved trees, but if so it is an error on the right side. There can be no doubt that the great richness of renewed bark in quinine is due not to the covering, but to the change of cinchonidine, &c., into quinine by the operation itself; still a covering does do something towards improving the bark, and in dry weather or in hot climates it is often almost necessary, and greatly expedites the renewal. During long-continued wet weather any covering is apt to engender canker and rot, and the trees are better without it. In showery weather in a cool climate trees renew perfectly without covering. At present I know of no better covering, all things considered, than the ubiquitous mâna grass. At elevations where white ants are so destructive it is necessary to leave 6 or 8 inches at the collar of the tree uncovered, and this as a rule will prevent them effecting a lodgment. Guinea and Mauritius

grass and several jungle leaves can also be used as coverings. Common newspaper does well enough, but in wet weather it requires very close tying. I think it probable that some cheap varnish of a gelatinous nature might be made which would be useful at low elevations where white ants are feared. Collodion does well, but its expense is prohibitive.

Gelatine by itself is too easily dissolved, but the addition of a few grains of bichromate of potash renders it insoluble on exposure to light. Until, however, it is seen whether the bichromate has any bad effect on the alkaloids I would hesitate to employ it.

Drying Bark.—Unlike a fruit crop, our bark crop can in a great measure be harvested at whatever season we like, and advantage taken of suitable drying weather.

I have tried artificial heat, but found it very slow work; one day's sun did more than a week's artificial heat. No doubt bark could be rapidly dried in a store fitted with a Clerihew dryer, or in some adaptation of tea or hay drying machines, but I think sun drying will always be the most satisfactory and generally used. Bark should be dried until it is quite crisp; long quill requires a great deal of drying to get the moisture thoroughly out of the centre. The dryage varies very much: very young succirubra dries down to one-fourth while very old bark, or rich ledgeriana, dries but little more than a half. Generally speaking, bark will dry to about one-third of its wet weight.

Season to harvest in.—In considering this question three points have to be considered, viz., at what season the bark is richest in alkaloids, at what season the drying can be best done, and at what season the tree receives least shock from the operation.

Broughton's Indian experiments are the only *data* we have to go upon as regards the season of maximum yield of alkaloids, and we may take it that, out of Uva at least, that occurs just before the burst of the S. W. monsoon. The best season for drying the bark coincides with the season of greatest richness, for March and April are months in which bark could always be sun dried. The third point, as to the season when the tree can stand the operation best, is more doubtful. I have always found that barked trees renew quickest, and show less signs of injury, during showery weather. A couple of weeks' drought is often followed by a reddening of foliage and stoppage of growth. Again I have seen young trees shaved just before the monsoon and left uncovered, with their windward sides dead—the remaining bark and cambium killed back to the wood by the cold wind and rain. On the score of injury to the trees I think it would be better to shave during the showery weather between the end of the S. W. and beginning of the N. E. monsoons, particularly if the trees are not to be covered. But considering all three points I prefer to shave just before the little monsoon: there is then a rich bark, sufficient sun to dry it, and no very long drought or immediate continuous rain.

In wet climates I would advise that trees barked at that season should be covered until the big monsoon sets in, and then the coverings removed to avoid all risk of rot and fungi.

Yield of Shaved Trees.—Opinions differ greatly as to how much bark can be shaved from a tree, and how often the operation can be repeated without material injury to the tree. The Nilgiri trees have been barked 7 and 8 times and are reported to be very healthy, but they are 20 years old.

In Ceylon we are not so easily contented, and if habit be a second nature most of our trees must regard shaving as one of the regular incidents of their lives. It is now a rare thing to see a tree bigger than a walking stick that has not contributed its "mite" towards swelling the exports. While I cannot approve of such early shavings, I must say that healthy young trees do not seem much affected by a *moderate* shaving, even when repeated twice in the year. I carefully selected pairs of trees 3 years old, growing side by side, and shaved one of each pair, and though there was a slight reddening of the foliage I cannot say that the growth or health of the shaved trees has appreciably suffered. With older trees I think the check in growth is more visible.

If trees are expected to be at all permanent I do not think they should be shaved before they have completed their fourth year, and then it should only be carried round a half or at most two-thirds of their circumference once a year.

With trees whose longevity is doubted I think early shaving should be resorted to. I do not mean that unhealthy trees should be shaved: on the contrary to such trees a shaving is generally the "last straw," but if a planter has reason to fear that a large percentage of his clearing will die out at 4 years of age I think he should shave it at 3 years. The trees remain in perfect health until within a few weeks of their death, and a shaving 10 months previously in no way quickens their end. It is better therefore to get a third year's shaving of say 3 ounces per tree and then on their death 4 ounces of renewed bark, in all 7 ounces of stem bark per tree, than to get only 4½ or 5 ounces at their death.

It is wonderful what recuperative powers young cinchonas have. I have taken their bark off, right round the whole circumference, leaving a couple of feet of the stem with nothing but the cambium, and they renewed rapidly under cover, the trees not suffering much. It is a mistake I think to shave right round a tree to get say 8 ounces of bark when the same quantity could be got by shaving only three-fourths of the circumference, and carrying the shaving a little higher and lower. The deaths which occur in a field that has been shaved are generally due to the trees having been sickly, though often healthy trees succumb if the shaving has been too heavy, or the weather very adverse. Old trees require much more careful treatment than comparatively young ones.

The increase of quinine in the renewed bark varies with the variety, but roughly it may be put at 50 per cent, except in the case of Ledgeriana, which contains such a small quantity of inferior alkaloids that its renewed bark would probably not be more than 10 or 15 per cent richer than the original. The increased quantity of bark obtained in successive shavings is also very variable, but I consider from 15 to 30 per cent per annum an average rate. The greatest increase is with young growing trees from 4 to 8 years of age. On the last page of this Essay I give in tabular form what I consider to be *average* yields and values, but I am well aware that such statements are of little use, as the yield in one place is so different from that obtained in another. The difference, too, between the quantity of bark that may be obtained from individual trees, and from the quantity which is *averaged* over a clearing, is very great.

In a clearing of officinalis 4½ years old, shaved round ⅘ths of the circumference, from many trees I got 6 ounces of dry bark, but when summing up at the end, the average was 2½ ounces. The average of 1,300 four-year old succirubra, similarly shaved, was barely 5 ounces dry bark.

Diseases and Enemies.—While most of us are too familiarly acquainted with diseased cinchonas, we are very ignorant as to the nature of these diseases, and particularly of the one called by some "canker"; by others "damping off": while some say it is infectious, others say it is not. It is one of the questions the solving of which is beyond the planter, whose practical experience can only enable him to pronounce empirically what conditions of soil, climate, aspect and drainage will favor the disease or the reverse. Government, who have received such large sums by the sale of cinchona land, and to whom the railway traffic in bark is of such importance, might well spend a few thousands of rupees in clearing up some of the mysteries of cinchona. The dying-off which is immediately caused by the bark, just at the collar of the tree, drying up, is certainly not canker as that disease was known in India. In a lot of officinalis trees, then 6 years old, planted through coffee I had never even noticed canker until it was pointed out to me by Mr. McIvor, and then, of course, I wondered how the disease could have escaped my observation so long. This, the true canker, generally attacked the branches, sometimes the stem, but it never actually killed any of the trees in question. At the point of attack the bark swelled, got corky and broke up, and the branch died off, but, unless a fresh attack set in lower down, there was no other injury done to the tree. This canker is often to be seen in old trees, but it does little harm. The inert suberous coating which old trees, and particularly Ledgerianas and a variety of officinalis known in Ceylon as "alligator," often assume must not be mistaken for canker; it is a natural effect and common in South American forests, where the bark gatherers beat it off with a stick before

taking the living bark. The wholesale dying-off from which our clearings suffer is a very different disease from true canker, and is I believe intimately connected with excess of moisture, but whether it is the simple effect of damp itself or whether it is caused by a fungus is still doubtful. I believe it to be the direct effect of damp, and that the fungi which are to be found on the bark are also an effect, and not the cause. I have not found that either close or wide planting have much influence on the death-rate. Cinchonas planted closely or widely on a free dry soil live, while if planted either way on heavy retentive soil they die. Cinchona planted in land that has been opened some years—either in coffee, tea or grass—suffers much less than that planted in freshly felled forest land. Patana land, unless it be clayey, is also more exempt—close draining is the only palliative I know of.

The oleander caterpillar often does great damage to young plants; their voracity is almost incredible, and a one-year old plant in the course of a night is reduced to bare poles. Their attacks are very intermittent, and gathering them by the hand is the only means that can be adopted.

The cockchafer beetle preys on cinchona leaves, but the damage it does is insignificant compared to that done by its grub which eats cinchona roots freely, although it prefers coffee. In Java grub is reported to have actually killed out patches of cinchona, but I have never seen it do so in Ceylon, and I know several fine fields of cinchona growing on badly grubbed coffee land. Elk do considerable damage to high clearings adjoining their haunts. A bar fence of jungle poles will keep them out. Nurseries are subject to many pests. Seed beds are killed out by a small ant-like spider and by fungi. Unless the seedlings be very valuable, my plan is, the moment I see any patch suffering from any insect pest, to apply a strong mixture of kerosine oil and water which kills out the insects at a sacrifice of the adjacent plants. I have tried all sorts of insecticides, and have never found one that could be trusted to kill the insects unless it was applied so strongly that the seedlings too were killed or injured.

A very small slug often cuts young seedlings across; it will be found on the beds in the mornings, and a hand gathering is the only remedy.

Worms sometimes undermine seed beds, particularly in old nurseries; the seedlings cease to grow and assume a yellow-red tint, and the surface of the bed becomes a mere crust which breaks through when touched. Lime water will keep the worms away, but if they have once undermined the beds the best thing is to take out the seedlings without delay.

Bedded out plants "damp off" like those in clearings, but they often die out from what, though it looks like damping off, is really exhaustion of the soil. I find it is more likely to occur in soil that has been used before, or when the plants have been bedded in too closely. The dying-off generally takes place soon after the commencement of the monsoon, and is therefore often attributed to damp, but I think the fact is that that is their season of growth, and it is then the exhaustion takes effect and the plant dwindles away.

White ants in low districts often attack the patana fern used in nurseries, called I think "memuna" by the Sinhalese, but the other equally common and good creeping fern, the "kekela" of the Sinhalese, is as a rule quite ant-proof; they never attack it if they can get anything else.

Manuring cinchonas has hardly been tried to a sufficient extent to judge of its merits. I manured four sets of 200 succirubras with cattle manure, pulp, Grinlinton's compost, and bones and poonac mixed. They all shewed in the deeper green, and improved growth, but the cattle manure and pulp were slowest. I cannot say yet how the richness of the bark has been affected.

Where fresh soil cannot be obtained it is sometimes necessary to manure nurseries. A mixture of well-rotted pulp and lime is the best and safest.

Trees that are to be shaved again and again will require manuring beyond doubt, and more attention will have to be given to this subject.

It may be thought that such an essay as this should not end without giving estimates of the financial returns to be expected from cinchona cultivation, but I consider all estimates based on the so-many-trees-to-the-acre and so-many-ounces-per-tree principle to be worse them useless for general purposes. Those who actually have the trees can count them, find their average yield, and make such estimates for themselves, and those who have not got the trees had better wait until they have. To bring 100 acres of cinchona to a self-supporting age will cost about R35,000 exclusive of interest, and I do not think any one entering on cinchona cultivation should reckon on an average return of more than from R75 to R100 per acre per annum profit lasting from 10 to 12 years. I am aware that particular fields or even exceptional estates may double or treble this return, but they are far above the average. Ceylon has no doubt many advantages, and would, I think, produce bark at a lower cost than any other country. Those who are now only opening cinchona estates have, I think, as good a prospect before them as the earlier cultivators had. They will have the benefit of the experience of others, and any fall in the price of bark will be counterbalanced by cultivating the choicest varieties. It must also be remembered that a dozen years hence there will be very few of the cinchonas which now exist in the country alive, and that unless fresh clearings are opened the Ceylon production of bark, having reached the maximum, say 3 years hence, will begin to fall.

Table of what may be considered fair average yields in quantity of bark and sulphate of quinine.

	Yield in shavings per tree.				Yield shavings per acre.	
	at 4 years.	Percentage of S. Quinine.	at 7 years.	Percentage of S. Quinine.	at 4 years.	at 7 years.
Succirubra ...	5 ounces	1·25	14 ounces	2·25	250 lb.	650 lb.
Officinalis ...	3 ,,	2·25	8 ,,	3·50	180 ,,	450 ,,
Robusta ...	5½ ,,	2·00	14 ,,	3·50	250 ,,	700 ,,
Ledgeriana ...	5 ,,	6·00	12 ,,	8·00	250 ,,	600 ,,

It is understood that with officinalis and ledgeriana more plants are put into an acre than with the others, and in all cases it is assumed that fairly good land has been selected and carefully opened.

THOS. NORTH CHRISTIE.

St. Andrew's,

Maskeliya, Ceylon,

5th October, 1882.