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Revenue **DEPARTMENT.**

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467
26.2.1867

Proceedings of the Madras Government, Revenue Department, 26th February 1867.

Read the following letters:—

No. 363. From the Superintendent of the Government Chinchona Plantations, to the Chief Secretary to Government, dated Ootacamund, 6th September 1866, No. 50.

1. I have the honor to enclose the manuscript and illustrations of a new edition of "Notes on the Propagation and Cultivation of the Medicinal Chinchonas," for the approval of Government.

2. Should the manuscript be approved, and ordered to be printed, I would respectfully solicit the favor of being furnished with two proofs for revision prior to the pamphlet being finally struck off, and that 300 copies may be supplied to me for distribution.

No. 364. From the Superintendent of the Government Chinchona Plantations, to the Secretary to Government, Revenue Department, Fort Saint George, dated Ootacamund, 4th December 1866, No. 87.

1. I have the honor to enclose copy of a letter submitted on the 6th September 1866, together with the manuscript and illustrations of a new edition of "Notes on the Propagation and Cultivation of the Medicinal Chinchonas," to the Honorable A. J. Arbuthnot, Secretary to the Right Honorable the Governor, Ootacamund.

2. I have numerous applications for the pamphlet, and it would be conferring a benefit to the public its being published as early as possible.

No. 365. From the Superintendent of the Government Chinchona Plantations, to the Secretary to Government, Revenue Department, Fort Saint George, dated Ootacamund, 17th December 1866, No. 90.

With reference to my letter No. 86 of the 3rd instant, I have the honor to inform you that, in consequence of the Notification of the Governor General in Council, published in the "Fort Saint George Gazette" of the 14th December 1866, to the effect that the mossing patent is "generally prejudicial to the public," I beg to withdraw the paragraphs in my pamphlet describing the invention and its application.

No. 366. ORDER THEREON, 26th February 1867, No. 467.

Miscellaneous.

Ordered that the report be printed as it stands, with a note to the effect that the patent alluded to in paragraph 42 has been cancelled by the Governor General of India in Council.

(True Extract.)

(Signed) W. HUDLESTON,

Secretary to Government.

To the Superintendent Government Chinchona Plantations, Ootacamund.

Exd. S. T. Augustin.

Notes
on the
Propagation and Cultivation
of the
Medicinal Cinchonas
or
Peruvian Bark Trees

Printed & Published by Order of the Government of Madras

By

William Graham Mc.Ivor F.R.G.S., C.M.R.I.B. & C.E.&

Superintendent Government Cinchona Plantations and

Botanical Gardens Nilgherries

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Notes
on the
Propagation and Cultivation of the Medicinal Cinchonas or Peruvian Bark Trees.

1. In submitting to the public a brief outline of our experience in the cultivation of these valuable plants, I would observe that we do not presume to furnish a complete guide to their management, as before this can be done much has yet to be ascertained of the requirements of the plants under cultivation. My object in this pamphlet is merely to place in the hands of all who are interested in the extension and increase of this valuable product, a knowledge of the management of the plants in their earlier stages, or up to the period to which our experience in their cultivation extends.

2. An almost unlimited number of seeds being now produced by our plants on the Nilgherries, and the Government of Madras having placed the Cinchonas within the reach of the general public, by authorising their distribution at the low rate of 1 Anna each. The time has therefore arrived for the rapid increase of Cinchona cultivation, it however has been felt that the distribution of the plants and seeds might in many instances lead to disappointment and failure if unaccompanied

by

5 Sites. Aspect. Referring to the Nilgherries in
particular, the aspect of the plantations should be
North, or North-West, a North-East exposure will
also be found suitable where the winds accompanying
this monsoon are not severe. The reason why a
Northern exposure in these latitudes is beneficial,
is from the fact that it is much more moist during
the dry season, than a Southern aspect, because
the sun's declination is Southerly during our dry and
cloudless season of the year. Even on the Northern
slope, the rays of the sun do not penetrate, and
parch the soil. A Northern aspect has also the
advantage of preserving a much more uniform
temperature than a Southern, because the excessive
radiation and evaporation on the Southern slopes
greatly reduces the temperature at night, while
in the day they are heated to excess by the action
of the sun's rays striking the surface as they
do at nearly right angles. The practical effects
of aspect on the plants are so great, that they
cannot be overlooked with impunity, and in order
to impress this upon the minds of all who may
have the selection of localities for Cinchona
cultivation, I may mention that the difference of
temperature is almost incredible; for example, at
this elevation (7,500 feat), a thermometer laid on the
surface

surface of the Southern face of a hill exposed to the
sun at 3 P. M. will frequently indicate from 130° to 140°
Fahr: the same thermometer if left in its position
and examined at 6 A. M. will generally be observed
to indicate from 30° to 40° Fahr: while on a similar
slope if selected with a Northern aspect, the thermometer
under the same circumstances at 3 P. M. will indicate
70° to 80° Fahr: and at 6 A. M. from 40° to 50° Fahr.
All authors agree that Cinchona delight in an equable
temperature, and this has been unmistakably established
by the plants under cultivation. The vital im-
portance of aspect is therefore fully explained.
While on this subject, it may be observed that a
hollow or land-locked valley is also unsuitable to
the cultivation of Cinchonas, because the cold air
generated at night on the sides of the neighbouring
hills, being of greater specific gravity than the
warm air, rolls down and fills the valley, thereby
reducing the temperature of the valley to a degree
injurious to the plants, especially in the clear winter
nights.

6 Sites, Rainfall or Irrigation. Local circumstances such
as aspect, and position of the plantation, drainage &c.
in a great degree compensate for a deficiency or
excess of moisture. Attention paid to these conditions
will enable Cinchona to be grown with like success
in a climate where the rainfall may not exceed
30 inches, as in one where the rainfall may reach

and

as high as 200 inches, and even in localities where a shower of rain may not fall for nine months in the year, as in one where the showers may extend throughout the year. A moderate amount of rain however, from 60 to 100 inches in the year, falling uniformly in showers, is as a rule most beneficial for the growth of Cinchona; they delight above all things "in showers and sunshine", this has been fully established by the rapid growth and fine healthy appearance of the plants during the showery months of October and November. Long continued rain is decidedly injurious to the health of the plants, as also continued drough but of the two, the latter is less so, as the plants can be made to thrive well under artificial irrigation. When it is necessary to irrigate, the streams should only run in the centre of the rows of trees, allowing the water to reach the roots by percolation, because if the water is allowed to flow near the stems of the plants, it frequently causes them to rot.

Elevations. The elevation best suited for the growth of Cinchona Succirubra or 'Red Bark' is about 6,000 feet. The plant, however, will grow at considerably greater elevations, and also down to

to 4,000 feet, but they have been found to thrive best at elevations averageing from 5,000 to 6,200 feet on slopes facing the North, and well sheltered from the North East and South West monsoons. The 'Crown Barks', Cinchona Officinalis and its varieties Condaminea, Uritusinga; and Crespilla, at elevations from 6,000 to 8,350 feet, the latter being the highest elevation at which the plants are grown on these Hills. The 'Yellow Bark' or (Cinchona Calisaya) grow from 5,000 to 6,000 feet. The 'Pitayo Bark' (Cinchona Lancifolia) has been planted out at an elevation of 7,600 feet. The 'Grey Barks', C. Peruviana, Nitida, and Micrantha, have grown well in the localities in which they were originally planted, at elevations varying from 4,500 to 6,000 feet, flourishing best at the highest elevation and in sheltered positions facing the North. The C. Pahudiana continues to flourish at elevations of 5,000 and 7,400 feet. These elevations are named from our observations on the Neilgherries, where, an altitude of 4,500 fe. in a sheltered locality, gives a mean temperature of about 66° Fahr: 6,000 feet about 59°; and 7,500 feet of about 53°, the minimum temperature never falling under 32° Fahr:. It may be mentioned that the temperature of any given locality is a more certain

guide

guide to the selection of a site from elevation.

8 Soils. The C. Succirubra or 'Red Barks' thrive in a dark brown deep vegetable mould, resting upon an open sub-soil. The C. Crispilla in dry peaty land, the C. Officinalis also grows freely in this soil, but prefers a deep brown mould; this species also grows well in the laterite soils so common on the plateau of the Neilgherries. The 'Yellow' and 'Grey Barks', prefer the same soil as the C. Succirubra, while the Pahudiana indicates a preference for a dry and gravelly soil.

9 Propagation. It is of the utmost importance that a correct knowledge should be disseminated as to the principles of propagation, as the increase and multiplication of every valuable or newly imported plant form an object of the utmost importance, and by such means only can they be produced in quantities sufficient to test their utility and commercial value. The Cinchonas are propagated by seeds, layers, cuttings, and buds.

10 Propagation by Seeds. To produce germination in all seeds, moisture, heat, and air are necessary. Moisture must be supplied, but not in an unlimited quantity for the seeds will rot, as is the case with seeds when sown in too damp a soil, when the power of respiration in the seed is impeded by excess of water, and it is unable to decompose the quantity of water it absorbs, which collects in the seed and becomes putrid. There must, therefore, be some water, but not too much, and it is generally considered that a mixture of sand and loam is the best soil in which to raise seeds, because the sand keeps the loam from gathering together when watered, and thus allows the excess of water to pass through (or drain off), while the loam, retains as much water among the cavities of the soil as is required for the purposes of germination. Clay or clay-loam retains too much moisture, and seeds sown in such soils are sure to decay. Again the quantity of moisture must not be too great, it should be uniform also, that is, the seed-beds not soaked with water one day and the next day allowed to become dry, because the changes the seeds undergo in germination must take place without interruption, or the seeds will die. To preserve uniformity in this respect, great care is required, especially with Cinchona seeds, which require to be grown either in a glass-house or under thatched pandalls, (hurdles) placed in a sloping direction over the seed-beds, so as to throw off the rain, the beds being of course open on the sheltered side to admit the necessary light and air.

11 Cinchona seeds are very small and light, being smaller and more oblong than the seed

guide to the selection of a site thereof.

Seeds. These, like those of the common birch, and like it, they consist each of the common testa, and like it, they consist each of a wing with a minute embryo in the centre. The seeds when fresh should be steeped for twelve hours in water prior to being sown, but when the seeds have been kept some time, or come from a great distance, they should be steeped for about six hours only. The steeping of the seeds in water facilitates germination, it is however, liable to injure too old seeds, which may be sown without steeping. The most convenient way to steep the seeds is to place them loosely in a bag, and immerse the same in water. When the seeds have been soaked the prescribed time take the bag out and drain off the water; the seeds will be found to have swollen considerably, and in order to separate them, mix them with about twice their bulk of dry sand. In this way the moisture around the seeds is absorbed, and on being stirred gently the seeds separate from each other freely, and intermix with the sand. In this condition they are sown on the surface of the soil in pots (prepared as hereafter described) and lightly covered over with a mere sprinkling of fine sand. After sowing the pots are slightly watered with the syringe, the watering being repeated in dry weather four or five times a day, in order to maintain uniform moisture.

The soil we have used with most

12

advantage

advantage in rearing Cinchona seeds, is composed of leaf mould, or the earth produced by rotten leaves, sifted and mixed with four times its own volume of sand. The leaf mould in the first instance was exposed to the sun for two or three days, and when thoroughly dry, was heated to about 212° Fahr, in order to destroy grubs and larva of insects: after being allowed to cool, watered sufficiently to make it moist, but only to that degree, that the particles of soil would not adhere together when pressed firmly with the hand, that is, the earth on being laid down was sufficiently dry to break and fall into its usual form. The leaf mould and sand in this state of moisture were mixed together, and the pots filled: the surface lightly pressed down, and the seeds sown thereon and covered with a sprinkling of sand as above described. The pots then plunged into beds of moist sand, sufficient water given to damp the surface, but not to penetrate or consolidate the soil in the pots. Under this treatment some of the seeds begin to germinate strongly on the 16th day after sowing, others continuing to come up through the space of two months afterwards. One ounce of clean seeds produces on an average from 20,000 to 25,000 plants. The principal art appears to lie to keep the soil in a uniform state of moisture, but never wet; the least

least excess of which causes the seeds to mould and damp off, while, as a matter of course if kept too dry they become parched up.

13 As soon as the seeds germinate and develope the seed leaves, they are carefully pricked out into pots filled with fresh earth (prepared as above); this operation is a very delicate one, the seedlings being carefully raised out of the original seed-pot by means of a small stick with a ~~rect~~ angular notch at the point to embrace the seed lobes as illustrated at A in Plate I. Fig. I. The plant thus removed to the new pot, a hole is made in the earth by a small round stick, and the root placed in the hole is firmly secured in the soil as at B, with the seed lobes well above the surface. In this way from one to two hundred seedlings are transplanted into a nine-inch pot, and thus treated in every respect the same as the seeds when first sown, that is, they are now watered heavily, the surface being merely sprinkled, and the pots plunged into beds of damp sand to keep the soil in that medium state of moisture as when first placed in the pots. The seedlings should be exposed to free currents of air, especially in moist weather. The necessity for this care is to prevent the seedlings from damping

damping off, to which they are very liable when treated otherwise; it also facilitates their growth, and the formation of roots, as the earth in which they are placed being so open that it is readily affected by the action of the atmosphere, and thus kept in the most favorable condition for promoting vegetation. When thus treated seedlings make an average growth in one year of over thirty inches, while many of those raised and grown on a retentive soil have not attained the height of three inches in the same period. Cinchona seeds germinate best at a temperature varying from 65° to 75° Fahr: they will also germinate, though slowly, at a temperature of 55° Fahr: and will sustain a temperature of 80° Fahr:; seedlings raised in a higher temperature than this, are weak and more or less unhealthy.

14 Propagation by Layers. When it is desirable rapidly to increase the number of original plants, layering in the first instance should be adopted, as it has the effect of causing the plants to throw out large number of branches thus giving a supply of wood well adapted for propagation by cuttings and buds. When the plants have attained a height of from 10 to 15 inches, they may be propagated by

being

being layered as illustrated in Plate I Fig. II, in this way they are found to root readily in about six weeks or two months at the latest, and the plants being bent down, break or throw out shoots from every bud along the whole length of the stem, and not only this, but many latent buds are developed and a fine growth of young wood produced for succeeding layers and cuttings, each leading branch or shoot being also layered as it gains sufficient size. The principle of layering is somewhat different from that usually practised, as when cut the juice of the Cinchonas flows so freely from the wound that if merely placed in the soil, it is apt to cause mildew and rot. To remedy this a piece of perfectly dry brick is placed in the cut as soon as it is made, this absorbs the juice and effectually prevents the ill effects above mentioned. The layers when well rooted are removed from the parent plant, potted off, and kept in a close atmosphere for a few days until they become established. In removing the layers great care must be taken; for if they are cut off before the shoots shown in Fig. II at A and B have attained a good size, and their leaves fairly developed, the stock or parent plant is almost certain to die off. The reason of this is, the sap flows into the plant with equal vigor, but cannot be elaborated because of the removal of the leaves attached to the layer, and consequently it ferments and causes decay in the parent plant.

15 Propagation by Cuttings. Cuttings of from three to five inches in length if planted in beds in the open air, about half an inch of the top of the cutting being kept above the ground, the lower portion firmly secured in the soil, and the top partially shaded. Under these conditions they will form good roots in from three to five months, and when a rapid increase of the plants is not an object, this is perhaps the safest and cheapest plan of propagation; but where the object is to increase the plants rapidly a propagating house as in Plate II is indispensable; the cost of a structure of the description and size given, being from Rupees 800, to Rupees 1000, where labour and material can be procured at a reasonable price. The plate above referred to gives full particulars of the construction and

and application of the buildings. The fuel used being wood, the furnace is however equally well suited for the consumption of peat or coal. With the aid of a propagating house, the youngest wood that can be procured is the best adapted for making cuttings, as young tender shoots, a fortnight or three weeks old, form roots in a very short space of time, the majority of these cuttings being invariably rooted within a month. It is however difficult to deal with this description of wood, and to secure success requires a great amount of care. The earth in which these cuttings are placed is prepared as before described for the seeds, it is however kept a little drier. The cuttings as soon as made are placed all over the surface of the pot in a thin layer of brickdust as at Fig I Plate III or around the sides of the pots the cut end of each being propped firmly on a piece of dry brick as shewn in the illustration in Plate III Fig III. Each pot by the first method contains from 100 to 120 cuttings, and by the second method from 20 to 25 cuttings. As the pots are filled, they are immediately removed to the propagating frames, and plunged into beds of damp sand on a bottom heat which must not exceed

exceed 75° Fahr.

16. The cuttings are now carefully watched, the surface and the leaves being moistened by a fine syringe when the atmosphere in the frames appears dry; they are however never heavily watered, it being very necessary to ensure success to avoid this, as we have invariably found that when the earth is so watered it causes the cuttings to damp off, it also retards their rooting. The cause of this appears to be that the cuttings not only suffer from excess of damp; but when the soil is watered in the usual way after the cuttings are placed in the pots, by its expansion and adhesion from the action of the water, its particles are forced far too close together to be beneficial for the development of roots. With young wood, our losses with cuttings have not averaged 3 per cent. In removing the cuttings from the stock plants, one or two pairs of leaves and buds should if possible, be left between the plant and the part cut; this is done in order not to decrease the succeeding supplies of young wood, which would be the case if the cut was made close to the parent stem. Another circumstance very necessary to be

attended

attended to in order to ensure success is to be careful to place each cutting as it is made into the pot with the cut end in brick dust or on a piece of dry brick; this must be attended to, because where the cut is made, the juice begins to flow, and this juice if not immediately absorbed causes mildew and rot. When the cuttings are placed in the frames, they are exposed to as much light and air as they can bear without flagging, when they begin to flag the cases are of course shut, and the action of the external air cut off.

17 When a large number of plants is produced, and consequently much labour employed in this operation, we have found it necessary in order to economize and lessen the cost of propagation, to abandon the system of placing the cuttings on a piece of brick as described above. The method then adopted is to fill the pots as formerly with prepared soil, but only to within an inch or three fourths of an inch of the surface. This space is then filled up with pounded brick dust, into which the cuttings are inserted as at A in Fig IV, B representing the stratum of brick dust, C the ordinary soil, D moss to facilitate drainage, E the pot sherd or draining material. Under this treatment the cuttings are found to root freely, while a man can pot off in a day from four to five times the number he could under the former method. This simple expedient is of great importance in extensive propagating operations, as it reduces the cost to nearly one fifth of that incurred by placing the end of the cutting on a piece of brick, and at the same time economizes space in the propagating cases. By this system more than three times the number of cuttings can be placed in a four inch pot.

18 Propagation by Buds. The plants can also be successfully propagated by buds with the leaf attached, and as this method has the advantage of producing a large number of plants, it was extensively and most satisfactorily adopted in the beginning of our experiment. Plate III Fig II illustrates the method by which this is accomplished, the whole secret of success depends entirely on the amount of moisture given; if this is supplied in excess, they rot immediately, even in a day; but if sufficient care is exercised, the loss will not exceed 3 or 4 per cent, and this percentage has not been exceeded in many thousands thus propagated. By this method, fine plants are obtained in every respect resembling strong healthy seedlings. The period required to form roots is nearly the same in all the species, varying from three to six weeks. In the figure above mentioned, the pot on the left represents six Cinchona Calisaya buds

buds put in on the 30th January 1862, which were all rooted in 41 days the date on which the drawing was made by Mr Batcock. The drawing on the right represents a rooted bud of the red bark, put in at the same time. It may be observed, that it is not indispensable that a leaf be attached to the bud; this is no doubt a great advantage although we have struck many buds without any leaf.

19 The usual way in which we prepare the buds is to remove the point of the shoot for a cutting, the stem is then divided near the middle of each internode, split down the centre, and immediately placed upon the brick or in the brick dust in the pot, the bud itself being covered with about ¼ inch of soil, while the leaf of course projects above the surface. The pots are then plunged in damp sand and treated in every respect as cuttings.

20 Hardening When the cuttings are rooted they are removed to the hardening cases and there exposed to light and currents of air, at first gradually, but more and more daily until they are sufficiently hardy to bear the open air and full exposure to sunshine. This operation occupies about three weeks when the plants are transplanted direct to the nurseries. when it is desired to take particular care from scarcity or other cause

of

to bear the effects of light and sunshine, the side hurdles being retained where the nurseries are liable to be affected by high winds.

23 The terraces are now again dug over their entire width, with the exception of the pathway at the back, and formed into beds 6 feet 6 inches in length, and 5 feet wide, with a pathway of 1 foot between each bed. These beds when raked smooth are ready for the reception of the young plants, which are planted 4 inches apart in rows across the bed, the plants being 3 inches apart in the row, which gives 300 plants to each bed, or 15 rows with 20 plants in each; this allows for the spaces lost at the ends of the beds. Of course, the plants in the nurseries require watering, when the weather is dry, and even if showery, so long as they are covered with the grape hurdles. In mild showers, it will be found beneficial to the young plants, even if not well established, to remove the grape hurdles while the rain is falling, but they should again be covered immediately the rain ceases.

24 When the plants are transplanted direct from the cutting pots into the nursery, it is desirable in order to enable the plants to be transplanted without damage to their roots, that a layer of moss be introduced under each line of plants. Fig. II, Plate V A represents a transverse section of the nursery bed with moss as at B; C being the longitudinal section. The manner in which the plants are planted being the same as described

in

Nurseries, formation of, in the shade. Nurseries are formed of horizontal terraces having sufficient fall in one side to carry off surface water. The terraces are cut along the face of the hill in a succession of steps about seven feet wide, and with a deep drain at the back to be also used as a path, the terraces being thus formed to the extent the nurseries are intended to occupy; the surface of each terrace is marked off into beds, about five feet square, a pathway being left between each bed, and a path and drain along the back of the whole. The beds are now covered with rich vegetable soil from the forest, and dug over to a depth of about 18 inches. This being completed, forked sticks, 3 feet in height & 4 feet apart are placed on the beds or terraces, the same description of sticks, but five feet in height, are placed along the back and outer edge of the pathway or drains above described. Upon these perpendicular forked sticks, horizontal ones are placed for the support of thatched hurdles, which are used in covering the beds, and in protecting the sides in windy weather, while the young plants are being transplanted, and until such time as they have become established; when the hurdles are removed by degrees, by raising them more and more daily according as the plants indicate their ability to

left standing on the borders of the patches to be blown down, and damage the plants within their reach. The system of cultivating the Cinchonas in partially cleared land is liable to the same objection, for the forest trees when deprived of a portion of the support upon which they are accustomed to lean, are also liable to be blown down; and moreover this system has the more serious objection of shading the plants too much from the sun, while they are subjected to the damaging effects of the drip during the rains, and the roots of the forest trees immediately fill up and choke the holes into which the Cinchonas are placed, thus depriving the young plants of nourishment. In forming our Plantations we have planted a considerable extent of land in this way, but with such bad results as now render it necessary to clear away the remaining forest trees. Our principal plantations have been formed on land entirely cleared of forest, and here the growth of the plants has been incomparably more satisfactory than that of those placed under any

degree

degree of living shade. It is therefore certain that the open system of planting will be the only successful one, especially on the Neilgherries; it is true, that while the plants are young, this system has ... disadvantages, which should not be overlooked. I refer to the excessive evaporation and radiation during the bright and cloudless seasons, when our dry and cold weather prevails. We have hitherto combated this difficulty by sheltering the young plants with a temporary shading of bamboo or Jeru. Many thousands of our plants however have passed through successive dry seasons without any protection whatever; and, although their growth has not been so rapid during the cold weather their health is quite equal, if not superior to any of those protected by artificial shade, while during the spring and rainy season the growth is more rapid in the plants without shade, than in those which have been shaded; consequently the system of artificial shading may be abandoned altogether, except in very exposed situations and when the plants are newly transplanted.

2) Cultivation. Preparation of Sites. The sites being selected, the operations of felling is begun at the lowest

lowest portion of the land, and proceeding with the work upwards, until the whole is completed. Belts of forest may be left upon the ridges to give shelter; but these must be pretty wide, otherwise they will be destroyed by fires when burning the fallen forest. After the forest has lain for a sufficient time 2 to 3 months to become dry and fit for burning, the afternoon of a dry day with a brisk wind is selected for firing, and this operation should be done with care as great saving in expense and labor is secured by its being well done. A row of coolies being placed about twenty or thirty yards apart across the entire length of fallen forest at the west extremity, each provided with a firestick, and a large bundle of dry grass, the grass being carefully placed under the leaves and branches of the fallen trees opposite to each man, at a given signal the whole is set on fire at once, thus immediately generating a force of fire which consumes nearly the whole of the trees, and saves an immense deal of after labor in lopping and burning. By thus firing the forest, a good burn (as planters term it) is almost certain, whereas if the forest is set on fire on one or two places, it travels comparatively

lively weakly through the trees, consuming only the leaves and small branches. The burning being finished, the next operations is to lop and burn such portions as are entangled by the stems of the trees.

28 When the lopping is completed the lines of road are marked in such positions as render the different parts of the plantation easily accessible, all the main roads should be 10 feet wide, and the branch roads 5 to 6 feet. The next operation, is that of lining or marking off the distances at which the plants are to stand apart. For C. Succirubra, C. Calisaya, and the varieties of "Hairy Bark", when the plants are scarce, the lines should be placed 10 feet apart, but when plants are abundant the distance at which the plants may be planted can be much reduced. The plants being thus placed close together causes them to run up with strong stems, and afford each other shelter and support. For the varieties of the "Crown Barks, the lines should be placed 8 feet apart, this being done, the land is trenched over 3 feet wide

8, wide, and 2 feet deep, along the lines, and the plants planted in the trenches at 6 or 10 feet apart. In placing the plants in the trenches, they should stand alternately, that is, the plants of the second row should be in the centre of the vacancies of the first row. When trenching is considered too expensive, pits may be dug for the reception of the plants, 2 feet square, 2 feet deep, and 4-6 or 8 feet from centre to centre, according to the species intended to be planted. When filling in the holes, the best surface soil, mixed with a little charcoal and the burned earth is selected, care being taken not to fill the pits with wood ashes which proves destructive to the plants.

29 Planting. The best season for planting is the early part of the year, or after the ground is well soaked by the first showers of spring; this gives the plants time to become well established before the setting in of the dry winter months. Damp, cloudy or foggy weather without rain, is best for planting, and when the soil is not too wet, that is, in a state that it will not clog and adhere together, which is the case with all soils, when worked during

heavy

heavy rains. In placing the plants in the trenched land or pits, the roots must not be pressed with the hand, as this invariably causes decay. The soil in the trenches or pits being carefully dug over the operation of permanently planting out may be commenced. In order to facilitate this work the plants when removed from the Nurseries are laid in a deal box in nearly a horizontal position between thin layers of moss as at Fig. I Plate V beginning to fill the box at D, and finishing at E; in this way from 1000 to 2000 plants are placed in each box and carried by one or two men from the nursery ground to the planters, where the box is placed in the centre of the line between the planters in order that it may be conveniently moved along as the operation proceeds. The planters remove the plants one at a time beginning at F and continue this operation until the box is emptied.

30 Each plant is lifted from the box by catching the leaves between the fore finger and thumb of the left hand, while with the right hand the roots are freed from any obstruction, the plant is

is then carried to the spot where intended to be planted, the right hand being thrust into the soft prepared soil in a sloping direction, and gently raising the back of the hand to the dotted line shown at E. Fig. I Pl. V the earth is then drawn forward as at G, leaving a straight bank behind the hand at H, the plant is now placed by the left hand against the face of the bank, the collar or top of the root being held on a level with the ground, the roots are now spread out with the right hand and the hole deepened should the length of the roots require it; the earth from G is then brought forward with the right hand against the roots, but not pressed, and thus the operation of planting is completed, in this way a man can plant from 400 to 500 plants daily. In removing the plants which are established in cowdung pots from the nurseries to be permanently planted out, they are raised from the nursery beds and arranged on a light deal wood tray, 2 feet by 3 feet as at Fig. II Pl. V B, this tray being filled, is lifted by the handles and placed in the bottom of a box at C; another tray is filled in like manner, and three round sticks being run through the holes in the sides of the box at

D

D; the second tray E is placed on and supported by three sticks, and the third tray F treated in the same way. The box being now filled and containing about 540 plants, is lifted by the pole G, and carried by two men to the planters where it is deposited, the same men returning with an empty box to be refilled. The planters first draw out the pole G and remove the upper tray F from the box, and proceed to plant out the plants as illustrated at Fig III, filling in the soil in the same manner shown at B, this completed the plants are immediately shaded and the operation of planting is completed.

31 The young plants may be shaded after planting by a cylindrical basket open at both ends, 12 inches in diameter, and 14 inches long as at Fig I Pl VII made out of suitable and plentiful material one man making from 8 to 10 of such baskets daily, this is found to be an efficient as well as an economical way of protecting the plants, as when they are established the baskets can be removed and are available for further use. When timber is plentiful on the spot the plants can be as

effectually

effectually protected with split wood placed around the plants as at Fig II Pl VII This rough split wood, as a protection and shade for the young plants, has been found very suitable, while one man is able to shade from 50 to 60 plants per day. As the plants grow they are protected against chafing by a grass rope being twisted round the top as at H.

32 It may here be observed, that no plant should ever be watered while the sun is shining upon it, as every globule of water forms a lens, which burns up the portion of the leaf on which it rests; neither should any plant be buried deeper in the ground than the collar, or union of the stem and roots. When a portion of the stem is buried in transplanting, the growth of the plant is much retarded, and it does not, as some suppose, give it a firmer hold of the ground, but the reverse. When manure can be obtained, its application will be found to be highly beneficial, as Cinchona plants like the coffee delight in a good soil well enriched by manure. If used too fresh, the application of manure might prove injurious; it is, therefore, always safest to

apply

apply such manure only as is well decomposed.

When the planting is finished, the young plants must be carefully attended to until such time as they become established; should the weather prove wet with high gales of wind, the shading should be drawn out to such a distance as not to touch or rub upon the plant when moved by the action of the wind.

33 The plants when young are shaded and protected as described above, and when they attain the height of 2 to 3 feet, they are staked, and tied with grass ropes as at Fig. III. Pl. I, great care being taken to see that the grass rope does not touch the stem of the plant, as when this is the case, the movement of the plant by the winds cuts the bark through at the point of contact with the rope, and destroys the plant; this can be effectually avoided by drawing the rope up to encircle the leaves and small branches when present, so that the leaves or branches come between the rope and the stem of the plant. This requires particular attention, because, if not attended to a whole plantation might be destroyed in one storm, it being much better that the plants be not tied at all, if not secured effectually. To stake a large number of plants may occasionally prove inconvenient and sometimes impossible, especially where labor is scarce.

On the Neilgherries our plants suffer most from the violence of the winds in June and July, when on exposed situations, they are frequently cut to pieces by the heavy gales, in consequence of the branches lashing one against the other, and the heavy top giving the action of the wind a leverage over the stem, renders the plant liable to be broken off a few inches above the ground. These bad effects can be in a great degree avoided by trimming the plants up i.e. removing the side branches and large leaves in the early part of June, as illustrated at Fig. IV. Pl. VI B. The trimming of the plants and the consequent removal of leaves in some degree retards the development of the stems, but as this pruning does not require to be practised after the second year's growth, the injury is merely temporary, and is more than compensated in the saving of the expense and labor attendant on staking and tying. The plants being once fairly established

established, the plantation like those of coffee will merely require to be occasionally weeded, and the surface turned over from time to time, in order to permit of the action of the atmosphere upon the soil.

34 It may be expected of me to answer the very natural, and probably the first question which will arise in the mind of every planter, namely, "How will Cinchona cultivation pay?" Although we have not yet practically answered this question, I feel called upon to contradict a very erroneous notion which has been extensively propagated, that "Cinchona trees will not produce bark under forty or fifty years." It is not desirable to be over sanguine as to the produce to be obtained from any new cultivation, but still the advantages which the Cinchonas offer should be taken fairly into consideration. In the early part of this experiment, it occurred to me that a small produce might be obtained in the sixth or seventh year after planting, since then it has been proved, that a small harvest of bark may be procured in the fourth or fifth year, and

and that Cinchonas will not be far behind Coffee or Tea in the period which must elapse between the time of planting and that of reaping the first crop. Another serious objection urged against the profitable cultivation of Cinchonas is the supposed necessity of felling the trees in order to procure the bark, because this has usually been done on the Andes. There can however be no doubt that such a system can never be put into operation with plants under cultivation. The opinion which I first advanced has already been fully confirmed, namely, that constant and uniform yearly supplies of bark can be obtained by lopping and pruning the trees, this operation being necessary in order to give our Cinchona trees straight clear trunks of from 25 to 35 feet in height from the ground to the first branch, the stems yielding at the same time large supplies of bark by the system described in paragraph

35 Judging from the growth the plants have attained here, I estimate as the probable produce of the fifth year ½ lb of bark from each tree or 250 lb per acre.

36 The cultivator of Cinchona should bear in mind that the expenses of the Plantations are heaviest at first, namely from the first to the fifth year, as

after

after this period the cost of maintaining the plantations will be a mere trifle, the trees being once fairly established require neither care and attention, but only time to enable them to gain their full development. After that age, neither would the health of the plants or the annual produce of the plantations be affected by adverse seasons.

37 Value of South American bark compared with that produced on the Neilgherries

We find that Howard in his noble work "Nueva Quinologia" gives as the finest produce of South American bark the following results. "A particular "parcel of fine Calisaya, examined carefully for "comparison, gave me – from the Cuzco (marked cc), "Quinine and a small portion of Cinchonidine, 3.21, "Cinchonine, 0.01. total 3.22. The Charquesillo (marked cc) "gave Quinine and Cinchonidine (as above), 3.41, Cinchonine, "0.03. total 3.44. The Tabla (marked c) gave Quinine "and Cinchonidine (as above), 3.55, Cinchonine, 0.04. total "3.59. And, still further to investigate the relative "contents of the cellular envelope and the liber. I recently "took a remarkably fine piece of Red Bark, one third "of an inch thick, and about 2 feet long by 6 inches "in width (bark of C. Succirubra of the sort called China "rubra dura by the Germans), having a very decidedly "developed (so-called) resinous ring, and capable of being

separated

22

separated by mechanical means into two portions equal by weight; one, the Outer Bark, comprising all the cellular envelope constituting the resinous ring, and also inevitably some of the liber, the other consisting entirely of liber. The difference between these two portions was remarkable. The Outer Bark seemed to be in this case, as in the bark the chief seat of the Quinine, as well as of the greater part of the colouring matter and of the gum, and yielded me by far the largest percentage of alkaloids that I have yet found in any bark viz, nearly eight and a half parts in a hundred. The Inner Bark, though rich in alkaloids to the extent of five parts in a hundred, did not contain nearly so much Quinine in a state capable of crystallization. The produce of the Outer Bark more exactly given in detail, was as follows – Quinine, when in combination as salts, and crystallized, nearly five per cent, – 3.65; Quinine not capable of crystallization, 2.66; and Cinchonidine, 1.34." And the large amount of alkaloid in the bark under examination must not be taken as a standard of the ordinary produce of C. Succirubra, which varies in this respect considerably. I do not find previously any record of a larger produce than 5.50 per cent which is considerably below the average of Outer and Inner Bark, as above stated."

These are the results of the finest barks from South America which probably may have been 20 to 30 years

of

of age or more, and a glance at the following table will show that our young barks grown in the Neilgherries on plants not more than 4 yrs of age are much superior both in the quantity of alkaloids and in their quality.

38 Table showing the yield of unmoped, and moped Neilgherry Bark (both original and renewed) at different periods of growth, as follows:—

C Succirubra

Age of Bark	Moped Bark: Quinine under moss	Moped Bark: Purified Alkaloids	Moped Bark: Crystallized Sulphates	Moped Bark: Cinchonine	Unmoped Bark: Purified Alkaloids	Unmoped Bark: Crystallized Sulphates	Unmoped Bark: Cinchonine	Renewed Bark
Years	Months	Per Cent			Per Cent			
1	6	3·40	2·80	0·60	2·59	-	-	Renewed bark aged 1 year on a tree aged 3 years yielded 9.72 per cent of purified alkaloids, 2·72 of crystallized sulphates.
2/p	12	6	5·20	0·80	5·06	2·43	-	Renewed bark aged 1 year and 5 months on a tree aged 3 years yielded 9.7 per cent of purified alkaloids. 5 of crystallized sulphates.
3/p	11	8	6·94	1.06	"	"	"	Dr de Vry obtained 11 per cent of alkaloids from the same sample.
3/p	18	"	11·34	"	"	"	"	The renewed bark which gave 2·72 per cent of crystallized sulphate when 1 year old, on a tree aged 3 years, gave 5·85 when 18 months old.

39 The unprecedented result of 11.34 per cent of crystallized sulphates was obtained from the bark of a tree of 3½ years old, and of this ⅔ were Quinine and the remainder Cinchonidine, the inferior alkaloids not being taken into account. This is a result greatly superior to anything derived from South America bark both in quantity and quality, the South American "Red Bark" invariably producing from ⅓ to ½ as much Cinchonidine as Quinine as will be seen by the above quotations from Mr Howards work. Cinchona bark may, and frequently does produce five alkaloids, namely, 1st Quinine, 2d Quinidine, 3d Cinchonidine, 4th Cinchonine, and 5th Aricine. The first of these alkaloids is of the greatest value in commerce, the second and third being rather more than one half the value of the first, while the fourth and fifth are almost valueless, it is thus that the price of Cinchona bark depends entirely in the quantity it contains of the three first alkaloids in a state capable of crystallization, therefore to increase the quantity of Quinine to the diminution of other alkaloids; is the first and most important object of the cultivator, especially when it is considered that the presence of inferior alkaloids, though of no value add so much to the cost of manufacture as to render their presence a disadvantage. With

three important considerations in view from the time the Cinchona plants were introduced to this country, my attention has been steadily directed to ascertain by practical observation, how and in what manner the alkaloids are formed, how they increase and pass from one into another. Although the experiments and observations have been limited when compared with the importance of the enquiry, still I feel satisfied that this problem has been so far solved as to place in a great degree under the control of the cultivator, the quantity and quality of the alkaloids produced.

40 Quinine and other alkaloids are first formed or produced in the leaves by the action of light and air on the juices, and while the leaves are performing their usual office of elaborating the sap or juices of the plant. Here the alkaloids are intimately combined with the elements of the sap such as Quinovic acid &c. and in this condition, carried down by the return sap, and deposited in the bark, most impure in the liber or inner bark, but as the liber becomes transformed into cellular tissue, a superior alkaloid (quinine) is produced in a state of great purity and easy of separation.

The inferior quality of the alkaloids in the liber is apparently caused by the rapid circulation in this portion of the bark of sap containing oxygen from recent exposure in the leaves. Quinine being most abundant in the cellular tissue of the bark, where it is deposited at first, also in an impure state, but in consequence of the retarded and horizontal circulation of the sap in this bark, the tendency of the alkaloids is to become and pass into quinine. In the cellular tissue however there is also a process of waste, caused by the action of light and air on the surface of the bark, thus the quinine apparently oxidises, becomes inseparably combined with or passes into red coloring matter and gum. This process of waste is however somewhat less than the deposit or accumulation in the bark, and for this reason the alkaloids increase according to the age of the plant.

41 From the above it will be understood that if this process of radiation or waste from the surface is effectually prevented, Quinine will be deposited and increased in the cellular tissue of the bark to a large extent, because the leaves form the Quinine (laboratory), while the bark is merely the Storehouse and double the leaves daily elaborate, and deposit a certain proportion of Quinine, and will continue to

do

do so till the last day that a healthy leaf exists upon the tree. There is therefore a continual and never failing alkaloid producing power in action, and the alkaloid thus formed and deposited can be cheaply and most effectually preserved by covering the surface of the growing bark with any material so as to exclude light and the action of the air. There will of course be a limit to the quantity of alkaloid that the cellular tissue will contain which probably will be from 18 to 25 per cent the bulk of the bark, and making an allowance for the less pure alkaloids of the liber, from 14 to 17 per cent of pure Quinine may be obtained from "Red Bark" thus managed. In addition to protecting the alkaloids from waste, it is desirable to increase the cellular tissue, and to effect both these objects, moss has been selected to cover the surface of the bark, as this material effectually excludes the light and at the same time greatly increases the cellular tissue. By this process the yield of Quinine can be trebled, quadrupled or even more, according to the time the bark is subjected to the process which to develope its full advantages should be applied for a period not less than 18 months, a longer time than this being [process] also gives the bark of the stems and branches removed and renewed, produce from an as much as that which can be obtained by the usual method of cultivation. The application of moss or other material to effect the above purpose having been secured by Letters Patent, the following extract from the specification, will explain the modus operandi.

"The finest green moss, (or other suitable material) is selected for protecting the bark from the exclusion of light and air, and also to increase the cellular tissue of the bark, as this portion forms the principal receptacle of the Quinine. To effect both these purposes moss has been found a cheap, convenient and very suitable material as it preserves on the exterior of the bark greatly increased moisture and consequently the capacity for the production of the alkaloids.

With these observations I proceed to detail the particulars of the application of moss only, submitting

submitting it to be understood that when other material is used, variations will be necessary, according to the comparative density or otherwise of the material employed, but ordinary moss should have the preference, as this as a rule, can be procured in abundance in all localities suited to the growth of Cinchonas.

43 To be effectual, the covering of moss should be from 3 to 3½ inches thick, laid on uniformly, as at Fig I Plate VIII. with the surface or green side of the inner layer, (freed from all extraneous matter), next to the bark of the tree, while the outer layer should have the surface exposed to the atmosphere. By covering the bark in this manner, the plant is secured against injury from fermentation, as this may take place if the inner layer of moss is much mixed with decayed leaves, grass, lichens &c. when this put on the moss immediately begins to grow, especially when used in wet or damp weather, and this is of great importance, because the natural growth of the moss increases its own bulk and thickness around the tree, ~~while~~ the root fibres, and young shoots, ramifying through the moss, effectually secures the whole around the stem

it reaches the ground, the knife being held, and worked, by the right hand, the bark as separated is secured by the left hand.

47 The operator now turns round and inserts the knife at the point from whence he took the downward stroke, and keeping the knife in a direct line upwards, in this way proceeds to remove a strip of bark the whole length of the stem, dividing it in lengths of 3 or 3½ feet, so as to be convenient for drying. The space thus denuded is immediately re-covered by the moss. A like width of bark to that removed is now left untouched, and another strip of bark taken off in the manner above described, and so on until one half the bark is removed from the tree. This done the moss is again re-secured and the tree allowed to remain covered for about four months, when the trunk is again uncovered, and the other half of the bark (that is the alternate strip originally left,) removed in the same manner as the first, the tree is now again covered with moss, and not disturbed for 18 months or 2 years, when the renewed coat of bark can be removed in like manner to the first. This operation may be repeated every 18 months, or 2 years because

after this period each new bark, will have attained considerable thickness, and give a large yield of alkaloid.

48 From the above description it will be readily understood that by the application of this invention the produce of Quinine, from an acre of land will be fully thirty times as much as can be obtained by the usual method of production.

49 The following brief notice of the different species of Cinchonas at present cultivated on the Neilgherries, will enable intending purchasers to select such as may be best suited to their localities.

50 Cinchonas yielding Quinine and Cinchonidine

Cinchona Succirubra, the "Cascarilla colorada" or "Genuine Red Bark" of commerce. This species grows to a lofty tree, and is rich in alkaloids, which generally amount to as much as 3 to 4 per cent, and thus fair average samples are valued in the market at 1s 6d to 8s per pound of dry bark. This sort is also hardy, its range of growth extending from 3100 to 8,000 feet; the plant according to the Spruce, prefers open ground with plenty of air, light and room, wherein to develope its proportions, the Bark is thin in proportion to the diameter of the tree

stems and branches to which it is applied. The moss when laid on is secured by pliable bands of split cane, fibrous bark, creepers, or any other convenient and suitable material, wound round the outer layer in a spiral manner, this being further secured, here and there, by cross ties, until the covering of the whole of the bark be completed.

44 The bark when subjected to this process of protection from light, and air, for 18 months or two years, (more or less at the option of the cultivator) is opened out by the moss being divided in a straight line down the stem, or branch, and turned back until about one half of the stem or branch is laid bare, as at Fig II. Plate VIII. The other half of moss is then secured in this position, by thin pieces of semicircular hoop iron A, when the strips of bark are removed from this portion as at B the stem is again recovered by the moss, and the other half laid bare, and treated in like manner to the first. In this way at each operation one half of the bark is removed from the stem, in alternate strips of from 1 to 3 inches in width, according to the size of the tree.

45 In performing these operations the aid

aid of a knife such as at Fig. I is necessary in order to enable the operator to perform the work safely and expeditiously.

46 This knife has a perpendicular cutting blade on each side, to cut through the thickness of the outer bark and a portion of the liber, behind the cutting face of these two blades and joining them together is a very thin horizontal steel blade for separating the bark from the trunk or branch, this blade is constructed to curve at pleasure to any radius, by an adjusting screw, so that in a few seconds the blade can be made to fit any stem, or branch. This blade being adjusted to fit the stem, and the roller to the depth the slice of bark is to be cut, which should be so arranged as to leave a small portion of the liber and the whole of the cambium undisturbed; the cutting knife is now ready for use, and is first brought into operation on the bark near the roll of moss, at a height of about 3 ft. feet from the ground, where it is forced into the bark, then downwards, in a straight line until it

trees when growing at low elevations, and thick in proportion when growing at high elevations".

"The amount of alkaloids is also much affected by elevation. Mr Spruce informs us that Senor Cordovez (who has analysed the Red Bark, collected at various altitudes) found that the greater the height at which the tree grows, the larger is the proportion of alkaloids contained in the Bark".

57 Cinchona Calisaya, or "Yellow Bark of Bolivia". This species grows to the height of a large forest tree, and is considered the most valuable of all the medicinal Barks. The present price of Calisaya or "Yellow Bark, varies from 2s to 4s 6 per pound. Of this species we have now on the Nailgherries four varieties very distinctly marked. Our Calisaya considered to be a valuable kind till this year, is now ascertained to have been the Josephiana a comparatively worthless variety, first in December 1865 Mr C. Markham and Mr J. Ph. B. Money brought to the Nailgherries two separate parcels of Calisaya seed which have germinated largely. Among these there are numerous plants of the Calisaya Vera, and of the Calisaya Verde, and the remainder are of a different variety not yet ascertained. According to Mr Markham and Dr. Weddell, "the true

Calisaya

Calisaya grows on declivities and steep rugged places of the mountains 5,000 to 6,000 feet above the sea, in the hottest forests of Caravaya and Bolivia". Subsequently Mr Markham in writing of this species states, "There can be no doubt "that the correct method of cultivating the Cinchona "is planting them out, in the open ground, with "plenty of light and air. They may require shade "from the direct rays of the sun at first. The only "really fine well grown plant of Cinchona Calisaya "that I saw in Caravaya was one that had been "planted in a small clearing entirely exposed; those "in the forest were poor straggling things in "comparison".

52 Cinchona Officinalis a Uritusinga, the "Cascarilla fina" or "Original Lima Bark" introduced by Chs. Howard Esq. This species, which in the days of La Condamine was a noble and lofty forest tree, is now almost extinct, the trees of a large size having entirely disappeared from the Andes, it is rich in Alkaloids, good specimens giving a total of 3. 8 per cent, and in this respect it equals the Calisaya Bark of Bolivia; it was common in the mountains of Uritusinga, and grows at elevations from 6000 to 8000 feet. A general opinion

opinion prevails among the Cascarilleros that the Bark of this species "differs in quality according as it is exposed to the morning or evening sun".

53 Cinchona Officinalis β Condaminea, the "Cascarilla Colorada del Rey" or "Cascarilla Amarilla" the "Newly Crown Bark" of English commerce and of equal value to the preceding species, to which it is nearly allied, inhabiting the same localities, but perhaps growing at greater elevations. In the days of Pavon, this was a slender tree of little more than 25 feet in height, and is considered to be the species that produced the bark which cured the Countess of Cinchon. At the present time, Mr Crop informs us, "but few trees are "to be seen of these dimensions. The plants from "which the bark of commerce is now taken are "in general not more than eight to ten feet in "height. When the plants are cut down, three "or four young shoots, or suckers in general "spring up, but this does not always happen, as "some of the more industrious Cascarilleros "frequently pull up the roots, and bark them "also. The bark is taken from the smallest "twigs, thus the annual growths are sometimes "taken, especially if they are strong. Mr Crop "also observes that the alluvial deposit in the "ravines where this species is found growing is "shallow and in many places not more than

six

six inches in depth.

54 Cinchona Officinalis δ. Crispa (C. Crispilla), or "The Crown Bark". This species is a small shrub and contains a smaller quantity of alkaloids than the preceding, still it brings a high price in the market, being a "very fragrant and pretty looking Bark". It grows at great elevations (from 7,000 to 10,000 feet) in a deposit of peat, and where the temperature sometimes falls to 27° Fahr.

55 Cinchona Lancifolia from Java or "Pitayo Bark". This is a valuable species, it is also hardy and easily cultivated, inhabiting the high and cold regions of the Andes. Dr Karsten observes, that "it descends only to a height of 2000 metres (6,170 feet) above the sea, from the cold summits of the mostly snow-capped mountains, where it sometimes reaches the upper limits of the growths of trees, that is 3500 metres, (10,797 feet). Mr Howard observes that this species produces a Bark which rivals in their rich product of Quinine, the Barks of Bolivia, and consequently commands a very high price".

Cinchonas yielding Quinidine & Cinchonine.

56 Cinchona Nitida, "Quina cana legitima", or "Genuine Grey Bark". This is a lofty tree, abounding in the higher regions of Huanuco; its predominant alkaloid is Quinidine, and is consequently of less value than the preceding species, which belong to the class yielding Quinine. The analysis of the Bark from which our seeds were gathered gave 2·22 per cent of alkaloids, consisting chiefly of Cinchonine; Mr Howard has however found Quinine in samples of the fine Grey Barks of commerce.

This species grows in exposed places at elevations from 6,000 to 8,000 feet, and is said to delight in "free air, cold, water, and sunshine".

57 Cinchona Species without name, allied to the above, and raised from seeds gathered by Mr Pritchett near Huanuco. Mr Howard is of opinion that this species may prove to be identical with Cinchona Obovata of Pavon. It is said to be a "good Bark", and extensively imported with the Grey Bark of commerce.

58 Cinchona Micrantha, the "Cascarilla Provinciana" or "Grey Bark". This is a lofty tree, inhabiting warm and damp forests, where it attains a great circumference, one tree frequently yielding from 200 to 250 lbs of dry Bark. The Bark is generally rich in Alkaloids, yielding as much as 2·70 per cent, principally consisting of Cinchonine In the cultivated plant this product has greatly improved. Ashy grey bark of this species yielding 5·82 per cent of crystallized sulphate of Quinidine according to the analysis of Mr Howard.

59 Cinchona Peruviana, the "Cascarilla Para de Gallinaza

Gallinaza" or "finest Grey Bark". This species attains the height of an ordinary sized tree in the forest of Cocheros, where it is still abundant, growing at a lower elevation than Cinchona Nitida, and yields a Bark of considerable value.
The Bark of the trees our seeds were collected from when analysed by Mr Howard yielded 3 per cent of alkaloids, comprising chiefly of "Cinchonidine and Cinchonine." It thus ranks among the most valuable of the Grey Barks.

60 Arrangement of Labor, and direction of operations
It may not be out of place here to say a few words on this subject as the profit or loss on Cinchona, and indeed on all other cultivation depend in a great degree on the talent and resource shewn in the management of the work. If the operations are skilfully arranged and the labor well directed, from five to six times more work will be performed by the same number of men, thereby effecting a saving of from 500 to 600 per cent on the outlay. The capacity to superintend and direct large bodies of men in diversified operations, to turn every favorable circumstance to advantage, and to provide for unforseen obstacles is a talent possessed by few.

It is the art of foreseeing possible reverses and of arranging to avoid them, and to readily turn previously unknown measures to account in accomplishing the end in view. Much that is useful however may be acquired by an intelligent observer particularly in the arrangement and distribution of routine work. To secure success in the formation and establishment of a Plantation the Superintendent should possess a thorough knowledge of the leading principles of Vegetable Physiology. He must be also acquainted with the climate, and this can only be acquired by local experience, but is indispensable in order that he may be able to foresee and avoid reverses likely to arise from floods, storms, drought &c, and to perform the various operations at the proper seasons. These acquired and natural capacities, and sufficient resource to remove and overcome any difficulty as it presents itself, together with probity, energy, untiring perseverance, temper tact in the management of workmen, and the ability to detect the true cause of every failure form the essential qualifications of a successful Superintendent.

61 Let us take a brief view of an Estate under a Superintendent, possibly a trustworthy and hardworking man, but wanting in ability to mange workmen properly. We look at the work done by a jobbing

party

party, and find the pits much under the prescribed size, and not more than half the number shewn in the returns. On bringing this to the notice of the Superintendent, he says, he has had so much to do here, there, and elsewhere, that in his absence the Maistry, and the Overseer and these coolies will persist in doing wrong, and how can he help it. On enquiring what particular works has engaged his attention, we find it to have been a party of weeders, and a number of men staking plants. We examine the work performed by the weeders, and find it done in the most slovenly manner, the roots of the weeds for the most part being left in the ground, and many of them merely trampled down. On referring to the Superintendent he says he gave the strictest instructions how the work should be done, but the Maistry, and these coolies will do so and so, and what can he do? We now proceed to the party employed in staking, and find that the ties instead of supporting the plant, are so placed as to cut their stems through on the first high winds or storm. It is pointed out to the Superintendent that he is not merely wasting his labor, but employing it in such a manner as to cause serious injury to the plants. Here again we are met by the unanswerable argument, what can he do? The coolies will tie them in that way.

We look at the plants recently put out and find them densly shaded and rotting off if the weather be damp, or it may be all shade removed and the plants parched up by the sun. In this way the Estate suffers first by one disaster then another, until the loss becomes unsupportable, and the damage irreparable. We now look into the tool room, and find that the tools, instead of being arranged on their racks and pegs, are thrown over the floor in a map of confusion and being destroyed by rust. If we now examine an Estate under efficient management, we find that, though here things may be occasionally out of order, yet the Superintendent, so far from exonerating himself by attaching the blame to Overseers, Writers, Maistries and Coolies, admits the oversight which led to the neglect and forthwith puts it right, fully comprehending that his duty is to do all things necessary to secure success. If either the Writers, Coolies, or any one else on the Estate neglect their duty or perform their work badly the Superintendent enforces attention mildly but firmly, and shows with his own hands to the unskilful laborer the way in which the work should be performed. He keeps that steady pressure on the whole of the establishment necessary to check negligence and imposition. On examining the work we

find the pits of the prescribed size, and the numbers agree with the returns. The roots of the weeds have been carefully taken out of the ground and the whole buried. The plants are tied in the manner best calculated to give them support; the tools are kept in excellent working order, and the labor has been concentrated and well arranged. It is the manner of doing these and other duties connected with the well being of an Estate, that distinguishes the qualified from the unprofitable Superintendent; that makes the whole difference between profit and loss.

62 The main object in the distribution of labor is so to arrange the men, that the responsibility of neglect, can be instantly fixed upon the delinquent.

63 In order to secure this it is necessary that there be no confusion in the manner in which the men are placed to work and that the men be not removed from one work to another. The work directed must be begun at a given point and each individual should be restricted to a given space or row (or two rows in some cases) in pitting, planting, shading, weeding, staking &c. Over each 25 or 30 men there is one Maistry or head man, whose only duty is to inspect the work of his gang. Should any individual in the gang perform the work in a careless, negligent, or insufficient manner, it is the Maistrys duty to call the man back and to cause the work to be properly done, and to report the same to the Superintendent or Overseer, who should inflict a fine on the individual laborer, proportionate to the injury or loss sustained by his neglect. But if the Maistry has failed to report the neglect or is unable to fix it clearly on any individual, the Maistry is then held responsible and punished accordingly, in proportion to the loss sustained by the neglect of his gang. Where order is to be maintained, a fine inflicted on a Maistry should never be remitted, because the necessity for each can only arise by the grossest negligence on his part and the loss cannot be redeemed. With the laborer it is different, as by subsequent good work, the punishment for one neglect may be occasionally remitted with advantage. When these punishments are inflicted, it is the duty of the Superintendent to explain in a temperate and kindly manner to the delinquent laborers, the reason for inflicting the fine, and its necessity to obtain attention & care in the performance of the work. With native laborers it requires both temper and tact to maintain any system as they have

have hitherto been accustomed to perform the smallest possible work for their wages with the men mixed up in a mass of confusion, and this is most congenial to the native mind since it renders it hopeless any attempt to bring home individual responsibility, and they are perfectly indifferent to blame attached to them as a body.

64 The above arrangement of labor can therefore only be carried out successfully by moderation on the part of the Superintendent, by gaining the confidence of the Maistries and bringing their influence to bear on the men, by giving to each man only a moderate task to perform, and by inflicting punishment with moderation, and only when gross neglect is clearly brought home to the individual. Otherwise discontent, murmuring, and strikes will be the result, especially at first, but when the system is once fairly introduced all good men much prefer it to any other, because their individual merits become at once apparent, and these merits should at all times be fairly appreciated and rewarded.

65 Next in importance to the arrangement of the individual laborer is that of concentrating the whole of the labor on the estate in the performance of operations in a given space on the plantation. This renders the supervision of the labor easy and effective; whereas when men are allowed to work in straggling parties supervision is difficult and inefficient, and of this the men immediately take advantage. All the operations necessary to be done on the plantation, should be performed at one time, and by the same gang of laborers, beginning at one end of the plantation and progressing steadily to the other until the whole is completed. For example with the operation of planting, the shifters should immediately follow up the planters. In weeding an Estate, the weeds should be carefully taken up by the roots and buried in deep pits. As this operation progresses the weeders should draw round and remove accumulations of earth from the stems of the plants, should clean out the catch drains, and repair all roads and pathways which lie in their immediate line. Immediately succeeding these a certain number of men follow whose business it is to inspect and secure the stakes and ties. Thus the plantation, behind the weeders and

ties

tiers shows the whole of the work completed.
This saves the waste of labor caused by sending small parties to perform operations in detail. Such works as road-making, fitting, and trenching, may with advantage be performed separately and best by contract. but these works should be completed as the fang progresses, and on no account should portions be left in an unfinished state.

66 Every Superintendent should arrange before hand the future work for his laborers. He should never pay his men without examining the quantity and quality of the work performed. He should show them with his own hands and instruct them in the performance of this work. He should never allow any work to be ineffectually performed and never attempt to do any thing in a hurry." This in other words is merely to throw away the time of the men employed and waste the wages for such time, because all work ineffectually performed must be either immediately done over again, or will become either worthless or positively injurious.

67 In propagating, in Nurseries, in fitting, in trenching, in planting out, and in subsequent attention to the plants, work ineffectually performed or the omission of work for a few days may lead to increasing or irretrieveable injury for years.

68 Transmission of Plants. By the usual way of packing plants in Wardian cases, their transmission to a distance is most expensive and uncertain. To obviate this risk, and reduce the cost of transit has formed a subject of recent experiments. The results of these, justify us in recommending to the public, the following method of packing Wardian cases, by which the cost of transit is reduced to less than one sixth, with greater safety in transport, inasmuch as the plants are less liable to damp off from an excess of moisture, while it secures the advantage of reducing the weight of the cases to about one fifth, thus rendering them more easily handled and less liable to damage in being removed.

69. Wardian cases can be procured here at a cost of Rs 15 each, one case will contain from 170 to 220 plants according to the species, instead of 28 or 30 plants as formerly. In the system of packing which is now recommended the Wardian cases are filled with moss instead of earth, to a depth of about 3 inches, and the Cinchona plants in the pots in which they were grown, are firmly packed in the moss, and secured with cross battens, in order to prevent them being displaced should the cases be upset in transit. When the plants are thus secured, they receive a moderate amount of water, the sashes are then

secured

screwed on, the glass being protected by battens, and secured from the direct rays of the sun by a covering of thin cloth, so as to admit a portion of light. In this way, the plants can safely be conveyed to Calcutta or Ceylon without the cases being opened; but where the journey is likely to be prolonged over a month, the cases should be opened mornings and evenings, so as to admit of the plants receiving light and air, water being added only when the surface of the earth in the pots is dry. Upon the receipt of plants in Wardian cases, it is desirable to place them in the first instance under the protection of glass. If this be not available, the cases should be placed in a shady position, and opened only so much at a time as the plants will bear without flagging. So soon as the leaves of the plants are observed to flag or droop, the cases should be immediately closed, and great care taken not to give the plants too much water at the roots, as this is apt to cause them to rot; in fact, the soil at the roots should always be kept rather dry than otherwise. The supply of moisture being kept up in the plant by frequently sprinkling the leaves. This treatment is only necessary until the roots assume a healthy and vigorous action, which will take place in from eight to twenty days, according to the length of time the plants have been confined in the Wardian cases.

Government Gardens
Ootacamund 5th Sept. 1863.

Pres. No 3091/66.

Pres 26th Sept. 1867 Ld Ds 363.—

For Orders

This was of necessity, left back owing Mrs McLean meeting my dressing system as a patented process. The Patent has been cancelled & he must wish her Solicitor describing it the Counter. As however first time all along Remained that he had no right to attempt the Patent by claim, this request shd. not I think, be complied with but the memo. be printed with a note stating that the Patent is not in force. The Knife is an ingenious thing and may, I think, be fairly acknowledged, although the Law of State denies the right of a first & true Patent. I do

Revenue 1866 Depart
Pro Govt for Febry
No 309.

From,

The Superintendent
Govt Cinchona Plantns
Ootacamund

To,

The Chief Secretary to the
Right Honble the Governor
Ootacamund

No 50
Dated 6th Sept. 66
Recd. 12th

V/ Rui
No 467 - 26 Feby 67

Encloses the manuscript and
and illustrations of a new
edition of "notes on the Propa-
gation & cultivation of the
Medicinal Cinchonas" for
the approval of Govt.

Cinc

Reported to England
by 25th March No 220 of 1867 Mis

Rui

No 363

Cinchona

Revenue Depart

No. 467.

Proceedings of the Madras Govt
under date the 26th. July 1867.

Read the following
letters from the Supt of
the Govt Cinchona Plan
=ations.

Enclosing the Mss &
illustrations of a new
Edition of "Notes on the Propa
-gation & cultivation of the
Medicinal Cinchonas for
the Neilgherries" (Here enter 6th Sept 1866 No 501.

Enclosing copy of a
letter addressed to the
Hon'ble A. J. Arbuthnot
on the 6th Sept 1866, with ref-
-erence to the publication
of a new Edition on the Pro-
-pagation & cultivation of
Cinchonas & soliciting early
attention to the subject. (Here enter 4th Dec
No 67 /-

for distributing Cards
in his pamphlet describing
the inoculation & application
of the Moss in Patent, in
consequence of a notification
of the Govt Gl.

Work

(Here enter 17th do do
No 907.

Orders

orders that the
report be printed as
it stands with a note
to the effect that the
patent alluded to in
para 42 has been
cancelled by the Govr
General of India in
Council -

1 Copy to Supt Govt Chin. Plantations Depts 27

2018 Jdg 07 N° 220 221

Revenue 1867 Departt
Pro of Govt for February

Reported to England
D/ 25th March N°420 of 1867
Mis.

N°467

Pro: of the Madras Govt
D/ 26th February 1867

From M.G. McIvor Esqr Inventor
Patentee of the Construction
Working process &c &c March 67
Col N° 618 –

The printing of
Notes on the Propagation
and cultivation of Chinchona
Plants sanctioned –

N 363 to 366