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MADRAS RECORD OFFICE.

Government of Madras.

Commerce DEPARTMENT.

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No. 83. Read the following Proceedings of the Government of Bengal, Financial Department, (Agriculture,) dated Calcutta, 30th October 1876 :—

RESOLUTION.

READ—

The Annual Report of the Government Cinchona Plantations, British Sikkim, for the year ending 31st March 1876, submitted with Dr. King's letter, No. 30C, dated the 8th August 1870.

The Annual Report of the Government Quinologist for 1875-76, submitted with Mr. Wood's letter, No. 1, dated the 1st August 1876.

A letter No. 12Q, dated the 12th September 1876, from the Superintendent of Cinchona Cultivation, remarking on the foregoing report.

THE results of the working of the Cinchona Plantation during 1875-76 differ materially from those obtained in any previous year. Hitherto the establishment has been employed first in experimental cultivation, and afterwards in systematic planting, while the yield of bark has been comparatively small. In the past season no addition has been made to the permanent plantation, and the main work of the year has consisted in gathering a crop of 211,931 lbs. of red bark, the produce of *Cinchona Succirubra*. This outturn exceeds by 62,000 lbs. the amount estimated by the Government of India in their letter, No. 208, of 21st June 1873, as the probable yield of the plantation in 1877. The following statement of the quantities of bark collected yearly since the establishment of the plantation shows that the yield of 1875-76 is more than five times as great as that of the previous year :—

					Lbs.
Dry bark collected by pruning and thinning during			1869-70	...	2,400
Ditto	ditto	ditto	1870-71	...	12,500
Ditto	ditto	ditto	1871-72	...	39,000
Ditto	ditto	ditto	1872-73	...	Nil.
Ditto	ditto	ditto	1873-74	...	16,000
Ditto	ditto	ditto	1874-75	...	39,105
Ditto	ditto	ditto	....	...	211,931
Crop of 1875-76 ...	...	...	Total	...	321,236

The Lieutenant-Governor considers these results to indicate a very marked degree of success.

2. It is observed that in gathering the bark attention has been paid to the important objects of assisting future cultivation, and of adding as much as possible to the practical knowledge of the best methods of harvesting. Thus on three plots of land, where the trees had become luxuriant and required space for growth, thinning and pruning have been largely resorted to; while in eight other places the plants were either coppiced or uprooted in such proportions, and with such arrangements for filling the vacant spaces as seemed likely to furnish the most ample facilities for comparing the merits of these two modes of gathering bark. At the same time, much valuable experience has already been gained. The practice of uprooting the entire tree was adopted in order to save the loss of bark which arises from the fact that after coppicing a certain proportion of the stools fail to shoot. Mr. Wood's analysis further shows that the root-bark thus made available for manufacture contains about eight per cent. of alkaloids, or one per cent. more than the finest stem bark. The cost of uprooting slightly exceeds that of coppicing, but as the process thoroughly

turns up the soil, it is hoped that it will answer to replant the same ground immediately with Cinchona, and "thus to secure gratuitously the advantage of a very complete kind of digging." Further experience will show whether the soil has been too much exhausted by its former crop to admit of immediate replanting; but attempts are being made to guard against this by allowing the leaves, branches, and wood of the uprooted trees to decay upon and manure the ground, and also by avoiding as far as possible the exact spots occupied by the uprooted trees.

3. The practice of stripping bark from living trees was not resorted to during the past year, as it was found that the renewal of bark under moss was rendered impossible in Sikkim by the attacks of ants. A few trees which had been stripped in 1874 have partially renewed their bark without mossing, but although eighteen months old it is only about half as thick as the original bark. Three hundred healthy trees will be stripped during the current year; but Dr. King does not anticipate very favorable results from the experiment, and it is probable, on the whole, that this method of harvesting bark, so successful on the Nilgiri plantations, will be entirely abandoned in Sikkim. The comparative advantages of coppicing and uprooting will be fully inquired into during the next two or three seasons, but at present it is uncertain which process will turn out to be the best.

4. Owing to the unusual drought of last cold weather no additions have been made to the permanent plantation. But the nursery stock of *Cinchona Succirubra* has been largely increased, and 125,000 young plants have been provided for the new plantations at Sittong. The 116,000 seedlings of yellow bark (*Cinchona Calisaya*) returned in last year's report have been written off as worthless, "experience having shown that *Calisaya* seed, however carefully it may have been collected from the varieties yielding only good bark, produces an uncertain and mongrel offspring." The stock plants of the variety described in last year's report as a hybrid have been increased from 1,000 to 5,000, but as yet none have been planted out, and the seedlings have been rejected as showing the same tendencies to variation which are observed in *Calisaya*. Further experiments will be made with the object of ascertaining whether manure can be profitably used in Cinchona cultivation. Dr. King observes that the manured plants reported on last year cannot now be distinguished in appearance from their neighbours, and points out that vegetable manure is supplied to a considerable extent to all the trees on the plantation by the practice of leaving the cut and uprooted weeds to decay on the ground between the trees.

5. Excluding an item of Rs. 794, transferred to the debit of the quinology account, the total expenditure on the plantation during 1875-76 amounts to Rs. 52,714. Out of this, Rs. 42,937 represent the actual working expenses, while Rs. 9,777 are debitable to the capital account recently opened under the orders of Government. The latter sum includes Rs. 2,134 laid out on the new Sittong plantation, the accounts of which are kept separately. The Quinologist's pay has also been added to capital, as this charge cannot fairly be debited against the crop until the plantation is in full working. It has been noted above that the total yield of bark amounted to 211,931 lbs. After deducting 16,640 lbs. destroyed by an accidental fire, there remain 195,291 lbs. to set against the working expenses of the year. Dr. King calculates that the cost of production of each pound of dry bark may be stated at a fraction above three Annas and a half, or a fraction below four Annas and nine Pies if

interest on capital at the rate of 4 per cent. be taken into account. During the year 92,400 lbs. of dry bark were made over to the Quinologist for conversion into Cinchona febrifuge, and 2,000 lbs. were supplied to the Presidency Medical Depôt. The remainder of the crop is stored at Mungpoo, and is made over to the factory from time to time as it is required for manufacture.

6. Turning to the Quinologist's report, it appears that the actual quantity of dry bark used in manufacture during the year was 107,130 lbs., which yielded only 1,989 lbs. of Cinchona febrifuge, or rather less than two per cent. More than one-half of the bark, however, was branch bark, which is always poor in alkaloids, from the worst part of the plantation, and the amount shown above includes all the bark consumed in experimental manufacture. The actual working expenses of the Quinologist's Department for 1875-76 are given by Mr. Wood as Rs. 30,355, against which are to be set Rs. 31,824, the value of the febrifuge at Rs. 16 per pound. It is observed that in this statement the prime cost of the dried bark is shown as three and a half Annas per pound. If interest at 4 per cent. on the capital invested in the Cinchona plantation is to be charged against the bark produced, the prime cost of the bark will amount to four Annas nine Pies per pound, and that of the alkiloid to Rs. 20-8-0. But as it is estimated that if the full working outturn of the plantation were taken into account, the cost of the dry bark would not exceed three and a half Annas per pound, the Lieutenant-Governor considers that the figures given by the Quinologist may be allowed to stand, and that Rs. 8,370, being the amount of interest chargeable, should be debited to the capital account which it is proposed to open for the Quinologist's Department. This account will also include the cost of manufacturing plant, of the preliminary experiments made in Calcutta, of the analytical laboratory, and of the Quinologist's salary for the past year. The latter item will be transferred from the capital account of the Cinchona Plantation.

7. In Dr. King's opinion 366,000 lbs. of dry bark may advantageously be collected from the plantations at Rungbee, Rishap, and Mungpoo during 1876-77; but the Quinologist submits an estimate for working up only 240,000 lbs. Under recent orders the alkaloid factory will be transferred from Rungbee to Calcutta, and will be worked upon a large scale either in the Presidency or the Alipore Jail. It is hoped that there will be no difficulty in manufacturing the larger amount of bark shown in Dr. King's estimate into Cinchona febrifuge, and supplying it to the public at a cost of less than one Rupee per ounce. The Lieutenant-Governor, therefore, accepts Dr. King's estimate of the amount of bark to be collected during the current year, and the Government Quinologist will be instructed to amend his estimate so as to provide for the conversion into febrifuge of 366,000 lbs. of Cinchona bark. It is observed that Mr. Wood's estimate contains an item of Rs. 10,000 for the Quinologist's pay. This has already been included in the cost of the dried bark, which is estimated at three and a half Annas per pound, provided that 366,000 lbs. are collected from the plantation. But as the pay of the Quinologist does not properly form an element in the cost of production of Cinchona bark, it appears desirable to enter it as a separate item and to reduce the charge for dried bark proportionately. It will thus be possible to define with accuracy the separate cost both of the raw material and of the manufactured alkaloids.

8. During the autumn and winter of 1875 experiments were conducted by medical officers in various parts of India with the Cinchonidine and Cinchona febrifuge

prepared by Mr. Wood. The experiments resulted in a considerable divergence of opinion, and the Surgeon-General expressed his view that, while there could be no doubt of the efficacy of both remedies against the ordinary intermittent fever of Bengal, the question of their general adoption must be considered as still *sub judice*. The intermittent fevers of last year had been of an exceptionally mild type, and the medicines had not been sufficiently tested for any final judgment in the matter to be possible. It is understood that further investigations are now being conducted, and that their results will be communicated to this Government in February 1877. Meanwhile, the Lieutenant-Governor, in his Minute of the 10th September, has already recorded his opinion that any decision on the precise febrifugal power of these alkaloids must be a work of some little time, depending on medical testimony, on actual experience, and on popular acceptance.

9. The Lieutenant-Governor acknowledges with thanks the good services rendered by Dr. King, by Mr. Gammie, the resident Manager of the Cinchona plantations, and by Mr. Wood. The latter gentleman has added to his official report a minute and clear account of the process followed in manufacturing the Cinchona febrifuge. Dr. King's labors in compiling a manual of Cinchona cultivation have already been acknowledged in a separate Resolution on the Botanical Garden.

Ordered that copies of this Resolution and of the Reports and letter referred to be submitted to the Government of India in the Revenue, Agriculture, and Commerce Department; also that copy, with 100 copies of the papers referred to, be forwarded to the Superintendent, Botanical Gardens, in charge of Cinchona Cultivation, for information and distribution as usual.

Ordered, also, that copies of the Resolution and of the papers referred to be forwarded to the Surgeon-General, Indian Medical Department, and to the Judicial (Medical) Department of this Office for information, and to the Government of Madras for information, in continuation of this Office No. 378, dated the 7th February 1876.

(By order of the Lieutenant-Governor of Bengal.)

(Signed) H. J. REYNOLDS,
Offg. Secy. to the Govt. of Bengal.

No. 3,425.

Copy forwarded to the Secretary to the Government of *Madras* for information in continuation of this Office, No. 378, dated 7th February 1876.

(By order of the Lieutenant-Governor of Bengal,)

(Signed) H. J. REYNOLDS,
Offg. Secy. to the Govt. of Bengal.

CALCUTTA,
30th October 1876.

From GEORGE KING, Esq., M.B., Superintendent, Royal Botanical Garden, Calcutta, and in charge of Cinchona Cultivation in Bengal, to the Secretary to the Government of Bengal, Revenue Department, dated Rungbee, 8th August 1876, No. 306.

I have the honor herewith to submit the annual report on the Government Cinchona Plantation in British Sikkim for the year ending 31st March 1876.

Fourteenth Annual Report of the Government Cinchona Plantation in British Sikkim, by GEORGE KING, Esq., M.B., F.L.S., *Superintendent of the Royal Botanical Garden, Calcutta and of Cinchona Cultivation in Bengal.*

THE record of work done on the Cinchona plantation during the year 1875-76 is, unlike that of any former year, more one of harvest than of planting. After thirteen years of expenditure, at first on experiments and latterly on *bona fide* planting, during which period but little return was received, the scale has now begun to turn, and, for the first time in its history, the plantation has yielded a tangible result in the way of crop, 211,931 pounds of dry bark having been collected since last annual report. This amount considerably exceeds the forecast made by the Government of India in the seventh paragraph of Mr. Hume's letter reviewing the plantation report for 1873-74, in which it is estimated that, by the year 1877, the plantation should begin to yield at the rate of 150,000 pounds of dry bark per annum. The collection, within a year short of the date fixed by the Government of India, of a quantity of bark exceeding the estimate by nearly 62,000 pounds, may therefore, I hope, be regarded as satisfactory.

2. *Details of the year's Crop.*—The bark collected during the past year was taken from different parts of the plantation, and in a variety of ways. The taking of the crop divided itself into eight operations, which I shall now proceed to sketch briefly, premising that the first three of these were cultural, having been undertaken primarily in the interest of the piece of plantation worked on, while the remaining five were undertaken with the double object of getting bark and of adding as much as possible to that practical experience of the various modes of harvesting it which is the only sure basis on which a regular working plan for the plantation can be founded. The crop consists entirely of red-bark (the produce of *Cinchona succirubra*), and the eight operations by which it was harvested were as follow:—

(1st.) The whole of the plantation of 1867 (with the exception of eight acres, to be subsequently accounted for), extending to about 180 acres and situated on Rungbee, was carefully gone over and thinned where necessary. From this there were obtained 8,017 pounds of dry stem and 12,383 pounds of dry branch-bark.

(2nd.) The upper part of the Rishap spur, planted in 1869 at 6×6 feet, was thinned and pruned,—an operation which yielded about 74,000 pounds of dry bark, of which about one-fifth was stem-bark and four-fifths were branch-bark.

(3rd.) In like manner the whole *Succirubra* plantation of 1872 (with the exception of eleven acres, to be afterwards mentioned,) was subjected to a moderate thinning and pruning. The year 1872 was the first in which close planting was adopted. The trees in this piece of plantation stand only four feet apart, giving 2,722 trees to the acre, against 1,210 trees to the acre in the older planting at 6×6 feet apart. As these trees stand in very good soil, and as their growth has all along been luxuriant, a certain amount of thinning had become absolutely necessary for their general welfare. About 16,153 pounds of dry bark were thus obtained which was composed in round numbers of one-fourth root-bark, and rather less than a fourth of stem-bark, the remainder being branch-bark.

(4th.) About eight acres of trees on Rungbee, planted in 1867, were cut down close to the ground, only a small proportion of trees being left standing. This operation will give further experience as to the result of nearly complete coppicing of nine-year old red-barks. I say *nearly* complete coppicing, because a few trees are left standing, but not enough to afford any material amount of shade to the shoots that will rise from the stools of the felled trees. The trees cut on these eight acres yielded 6,400 pounds dry stem-bark, and 3,781 pounds of dry branch-bark, or a total equal to 1,272·5 pounds of dry bark per acre. These figures do not, however, by any means show all the bark which has been collected from these trees since they were planted, for they have from time to time been thinned and pruned in years past; but of the bark thus obtained, unfortunately no separate record has been kept. This patch of eight

acres lies contiguous to a one-acre patch (also planted in 1867), which, on being coppiced in a like fashion in December 1874, yielded about 2,000 pounds of dry bark; but from this patch also bark had been, previously to 1874, taken by thinning. The young shoots that have risen from the stools on the one-acre piece now promise very fairly indeed, as also do those which are beginning to spring from the stools on the eight-acre piece. The future history of the coppice on these nine acres will be of much value and interest, therefore have I entered into so much detail regarding it.

(*5th.*) A patch of thirty-five acres of trees near the site of the old Rishap hut, planted in 1866 and 1867, and therefore about nine years old, was entirely uprooted. The yield of bark was as follows:—

	Lbs.
Dry root-bark	41,374·28
,, stem-bark	19,677·48
,, branch-bark	21,576·00
Total ...	82,627·76

This is equal to 2,360·8 pounds of dry bark per acre, of which about half is root-bark containing 3 per cent. of alkaloids, and nearly a fourth is stem-bark containing at least 6 per cent. of alkaloids. The present is not the first occasion on which this thirty-five acre plot has formed the subject of report; it will therefore, I think, be instructive to trace briefly its past history. Originally planted at distances of 6×6 feet apart, the trees, when two and a-half years old, were thinned, and 1,000 pounds of dry bark were thus obtained. Shortly before the sitting of the Commission appointed to consider the subject of a disease which then (in the opinion of some) threatened the plantation with destruction, and when the plants were about three and a-half years old, each alternate row of them was cut down, and dry bark was thus obtained to the extent of 8,200 pounds. One of the witnesses who appeared before the Commission was the late Mr. W. G. Mclvor, Superintendent of the Government Cinchona Plantation on the Nilgiris, and in April 1872, or shortly after his examination by the Commission, Mr. Mclvor put on record his opinion that, if put down then (i.e., in April 1872), these thirty-five acres might (including the 4,800 pounds already taken from them) yield a total of about 278 pounds of dry bark per acre, but that, if allowed to remain uncut, a large proportion of the trees would be dead before a year should elapse. Mr. Mclvor even went so far as to say that in his opinion more good bark would be got by cutting the trees then than could ever again be taken, bark from dead and dying trees being worthless. Some time after this opinion had been given, a further thinning (the third) of these trees was undertaken, which yielded 8,000 pounds of dry bark. Prior to uprooting, these thirty-five acres had, therefore, yielded 12,800 pounds of dry bark, or at the rate of about 365½ pounds per acre; at uprooting, as we have just seen, they yielded at the rate of 2,360¾ pounds, bringing their total yield per acre up to 2,726 pounds of dry bark, or about ten times the quantity estimated by Mr. Mclvor. Mr. Mclvor was the most experienced Cinchona cultivator of his day, and his opinion carried much weight. These thirty-five acres were about as much affected by the disease of which Mr. Mclvor took so gloomy a view as any part of the plantation; it is, therefore, satisfactory to find that the ravages of any disease that has hitherto appeared amongst Cinchonas need affect us but little dreaded.

(*6th and 7th.*) With the view of testing at once the results of a shorter rotation than one of eight or nine years, and of the respective merits of coppicing and uprooting as modes of harvesting bark, a six-acre patch of three and a-half years old *Succirubra* trees, standing four feet apart, was selected on Mungoo ridge. On three acres of this the whole of the trees were cut over close to the ground (*i.e.*, were entirely coppiced), and on the other three acres all the trees were dug out by their roots. For the sake of comparison I shall consider the results of these two experiments in the present paragraph.

The yield of dry bark from these two pieces was as follows:—

	Root.	Stem.	Branch.	Total Bark.	Total per Acre.
Three acres uprooted ..	1,155·53	1,565·80	1,565·10	4,086·43	1,362·14
Do. coppiced...	.....	1,550·07	1,568·65	3,118·72	1,039·60

For plants standing 4×4 feet apart and three and a-half years old, these figures show a yield at the rate of 389 pounds of dry bark per annum as against a yield of 302 pounds per annum in the case of the thirty-five acres of nine-year old plants standing 6×6 feet apart, and which had undergone three thinnings and prunings prior to uprootal. This evidences, therefore, is, so far as it goes, in favor of close planting and early cropping. The three-acre uprooted piece has been replanted with red-bark seedlings equal in number to the plants removed, and the new plants have been put down in the spaces between the sites occupied by their predecessors. The three-acre coppiced piece has yielded at the rate of 294 pounds of dry bark per acre per annum. All death vacancies in the latter piece have been filled up by young plants; the stools of the cut trees will receive careful treatment, and both the uprooted and coppiced patches will get an equal amount of care and cultivation. At the end of a given time both patches will be again harvested, and definite comparative results will thus be obtained.

(*8th.*) A five-acre patch, similar in every respect to the two three-acre pieces just mentioned and adjoining them, was severely thinned by coppicing and by uprooting a proportion of the trees on it and by pruning the remainder. Dry bark to the extent of about 270 pounds per acre has been thus obtained from it. This five-acre patch will be cultivated like the two adjoining three-acre patches above mentioned, and its future yield will be duly chronicled. The results of these eight operations will be found in a tabular form as an Appendix to this report.

3. *Various Modes of harvesting compared.*—The past year has thus added considerably to our experience on several matters of importance connected with the bark harvest. Experience has been got for the first time of the results of uprooting the trees,—a mode of working suggested by Mr. Gammie in imitation of the well-known practice of the *Cascarilleros* in the natural Cinchona forests of South America. The root-bark of this plantation contains, according to Mr. Wood's analysis, about 8 per cent. of total alkaloids, and is therefore richer than the finest of our stem-bark, which rarely yields more than 7 per cent. It has, moreover, all along been found that in the operation of coppicing a certain proportion of the stools fail to shoot; in other words, they die, and as the bark of every part of a dead Cinchona tree is perfectly destitute of alkaloid, there is always in coppicing a certain amount of bark lost. It appeared, therefore, well worth while to give a trial to a method which would make sure of the entire bark of every tree touched. From the two experiments in uprooting which have been above recorded, we have learnt that this is by no means a difficult or expensive process, bark so taken having cost for collection about two and a fourth Pice per pound when green, as against one and three-fourths Pice per pound for green bark taken by coppicing. During the process of uprooting, a very thorough upturning cannot fail to be given to the soil, and I am hopeful that it may be found to answer to replant such ground at once with Cinchona, and thus to secure gratuitously the advantage of a very complete kind of digging. With this view a certain proportion of the uprooted area will, during the earliest good planting weather that occurs, be replanted with red barks, care being taken to avoid, as far as possible, the exact spots occupied by the uprooted trees. The great objection to immediate replanting with the same species is, of course, the obvious one that the soil is possibly to some extent exhausted for red bark. But, after all, the only part of the former trees which has been removed is the barks, the leaves, branches, and (as far as the coolies can be prevented from appropriating it as fuel) the wood also, being allowed to decay on the ground. If experience should show that immediate replanting does not answer, a period of rest can be allowed to the soil. As regards the proportion of root to stem and branch-bark, the uprooted three-acre patch gives for healthy Succirubra trees planted 4×4 feet, three and a-half years old, and from which no bark had previously been taken, the following per-centages of

green bark:—root 26·5, stem 30·3, and branch 43·4 per cent. These per-centages are, be it observed, for *green* bark. But in the process of drying these three sorts of bark lose weight in different proportions. The loss of weight in drying varies, moreover, with the season. In wet seasons green bark naturally contains more moisture than in dry seasons. The past cold season having been an exceptionally dry one, the loss of weight by drying was correspondingly small. The actual figures may thus be tabulated:—

	Lbs.
100 pounds green root-bark dried to	42·94
100 ditto stem-bark ditto	39·07
100 ditto branch-bark ditto	37·10

The thirty-five acres of uprooted nine-year old trees at Mungpoo yielded an exceptionally large amount of root-bark (nearly 60 per cent.)—a result which is accounted for by the very large proportion of coppice-bearing stools to standard trees at the time of uprooting. The best history of this patch, which has been already given, explains why there were so many coppice stools.

With regard to coppicing as a mode of harvesting bark, some experience has been gained during the year, and the basis is laid down for a good deal more to be gathered hereafter. The progress during the year of the shoots from the stools of a number of trees coppiced under a variety of circumstances in 1874 confirms me in the belief that an almost complete coppicing, by which a minimum of standard trees is left (just sufficient for the purposes of shade and of drip), is more likely to yield good results than a partial coppicing, by which only a few stems of the whole crop of plants are cut. The shoots which follow a complete or nearly complete coppicing are in every case more healthy and vigorous and in many cases more numerous also, than any which I have seen to rise from stools standing as above. If the precaution of earthing up the stools be taken, the damage done to the young shoots by wind does not appear to be great. The cost of weeding and cultivating coppices, as nearly complete supplies will be found the same as for seedlings planted from the nursery. Experience alone will show whether coppicing or uprooting will pay best, and it would be premature as yet to form an opinion as to their respective merits as modes of harvesting. With regard to the third method of harvesting which has been proposed, viz., decortication of living trees, former experiments having shown that renewal of bark under moss is a failure by reason of the attacks of ants, no further experiments have been made by that method. Some trees which were partially stripped of their bark during the year 1874 have partially renewed it without the application of moss or straw or other covering of any kind. The renewed bark, however, although now more than eighteen months old, is still only about half as thick as the original bark. Though not hopeful of very favorable results from this method, I have given instructions that 200 healthy trees be submitted to it during the rainy season.

4. *Expenditure for the Year.*—The total expenditure on the plantations for the year (including the rent of Rs. 1,681-4-11 for head office charges) was Rs. 52,713-15-10. Of this, the sum of Rs. 7,951-4-8, incurred on account of labor for the factory, has to be transferred to the debit of the cinchona account, leaving a balance of Rs. 50,714-15-10 as plantation expenditure proper. This sum is made up as follows:—

	Rs.	A.	P.	Rs.	A.	P.
European establishment, Mistries, Chuprassies, &c.						
Carpenters, Blacksmiths, &c.	13,097	0	5			
Head office writers, &c.	584	4	11			
Contingencies	3,053	3	9			
				16,734	9	1

* * —The above charges are in the proportion to the cost of the expenditure of 4·93 per cent.

	Rs.	A.	P.
Cultivation of old plantations (Rungbee, Rishap, Mungpoo)	20,466	13	0
Cost of collecting the bark crop	8,840	0	0
Erection of godowns at Mungpoo	3,050	0	0
Extensions of Mungpoo plantation	1,482	11	9
Spent on new plantation at Sittong	2,138	14	0
Total...	52,713	15	10

This divides itself into two portions, viz., the sum of Rs 42,937-6-1, which represents the working expenses of the plantation for the year, and which is, therefore, to be set against the crop, and the sum of Rs. 9,777-9-9, which is debitable to capital account. The composition of the working and capital expenditure is shown in the following table:—

Working Expenses.

	Rs.	A.	P.	Rs.	A.	P.
Cultivation of the old plantations of Rungbee, Rishap, and Mungpoo, during 1875-76	20,466	13	0			
Proportion of European establishment, head office charges, skilled labor, and contingencies, equal to 46·5 per cent. of the above ...	9,518	9	1	29,985	6	1
Cost of collecting bark crop	8,840	0	0			
Add 46·5 per cent.	4,112	0	0	12,952	0	0
Total Working Expenses...				42,937	6	1

Capital Expenditure.

	Rs.	A.	P.	Rs.	A.	P.
Cost of extensions of plantation at Mungpoo...	1,482	11	9			
Add 46·5 per cent....	690	0	0	2,172	11	9
Erection of bark godowns at Mungpoo ...	3,050	0	0			
Add 46·5 per cent.	1,420	0	0	4,470	0	0
Expended on new plantation at Sittong ...	2,138	14	0			
Add 46·5 per cent.	996	0	0	3,134	14	0
Total Capital Expenditure...				9,777	9	9

5. *Working Expenses.*—The charges against capital will be dealt with in the next paragraph, and the working expenses alone concern us in this one. Of the working charges above shown, Rs. 8,840 represent the actual amount spent in labor on the collection of the bark crop from the trees. This charge includes the cost of uprooting, coppicing, thinning, pruning, sawing, peeling, and carriage to the temporary drying sheds, and it amounts, as nearly as may be, to eight Pies (one penny sterling) for each pound of dry bark. The remainder of the working expenses (viz., Rs. 34,097-7-1) was spent on the cultivation of the Rungbee, Rishap, and Rungbee plantations, upkeep of roads and buildings, European establishment, head office charges, skilled labor (Carpenters and Blacksmiths), and on contingencies.

6. *Capital Account.*—In accordance with the wishes of Government, the mode of keeping the plantation accounts was recently recast by the Accountant-General, and they are now kept in the form suggested by that officer. One of the changes made is the opening of a capital account. The sum put to the debit of this account at 1st April 1876 is Rs. 3,50,000. To this has now to be added the expenditure on capital during the year. That expenditure amounts, as has been above shown, to Rs. 9,777-9-9. In their letter reviewing the plantation report for

the year 1872-73, the Government of India expressed their desire to receive an estimate of the cost at which, with our present experience, a new Cinchona plantation could be formed. This estimate was duly furnished, and in accordance with it all extensions which are being made on the slopes of the Sittong spur are being treated as forming a separate plantation, which is called the Sittong plantation. This is under the same European supervision as the older plantations, but separate accounts are kept of all expenditure on it. The sum spent on Sittong during the year, including a proportion of the cost of European establishment, &c., was, as above shown, Rs. 3,134-14-0, and this forms the first charge against the Sittong capital account. It is accordingly not debitable to the capital of the old plantation, which includes only Rangbee, Rishop, and Mungpoo. The capital account of the latter, therefore, stands as follows:—

	Rs.	A.	P.
Capital at 1st April 1875	3,50,000	0	0
Expenditure during 1875-76	6,642	11	9
Quinologist's pay for 1875-76	10,000	0	0
Total Capital at 31st March 1876 ...	3,66,642	11	9

The Quinologist's pay has been added to capital, as the plantation not being yet in full working, the charge can hardly be debited with fairness against the crop.

If interest be calculated at the rate of 4 per cent. on the above capital, an additional item of Rs. 14,664 will be added to the working expenses of the year.

7. *Cost of the Bark produced.*—The bark taken during the year amounted, as has already been stated, to 2,11,931 pounds. From this there have, however, to be deducted 16,640 pounds which were accidentally destroyed by fire, leaving 195,291 pounds against which the working expenses of the year (Rs. 42,957-6-1) are chargeable. The cost of production, therefore, of each pound of dry bark was 3 Annas 6·21 Pies, being a fraction over three Annas and a half, and as near as may be five pence half-penny sterling. If the charge for interest on capital (1 Anna 2·23 Pies) be added, these figures are raised to within a small fraction of 4 Annas and 9 Pies, which is equal to seven pence and one-eighth sterling.

8. *Bark Account.*—During the year 92,400 pounds of dry bark were made over to the Quinologist for conversion into Cinchona febrifuge. The composition of this bark was as follows:—

	Lbs.
Dry *Succirubra* root-bark	4,800
" stem-bark	42,800
" branch-bark	44,800
Total ...	92,400

To the Presidency Medical Depot 2,000 pounds were also supplied.

The remainder of the crop is stored at Mungpoo, and is being made over to the factory as required. It may be useful to put on record a complete statement of the bark yielded by the plantation since its commencement. The following table shows this at a glance:—

		Lbs.
Dry bark collected by pruning and thinning during	1869-70 ...	2,400
" " "	1870-71 ...	12,500
" " "	1871-72 ...	39,000
" " "	1872-73 ...	Nil.
" " "	1873-74 ...	16,000
" " "	1874-75 ...	39,405
Crop of 1875-76		2,11,931
Total ...		3,21,236

	Lbs.	Lbs.
Supplied to Medical Depôt; sent to Her Majesty's Secretary of State, London; used in experiment; made over to Quinologist, &c., &c., prior to 1st April 1875	48,906	
Supplied to Medical Depôt, 1876-77	2,000	
Made over to Quinologist, 1876-77	92,400	
Burnt accidentally	16,640	
		159,946
Balance in store, 31st March 1876 ...		1,61,290

The total yield up to the end of the year has thus been 321,236 pounds of dry bark.

9. *Accidental burning of part of the Crop.*—During the cold season a destructive fire occurred, by which a large shed, containing about 16,640 pounds of dry bark, was burnt to the ground. The fire appears to have originated through the carelessness of the man in charge of the shed. Certain changes were proposed by me in the arrangements to be followed in future in drying and storing bark, by adopting which similar accidents on such a large scale should be averted. Dry bark is, however, a substance which burns readily, and natives are proverbially careless about fire; there will, therefore, under any arrangements whatever, always remain a certain amount of risk of loss by fire.

10. *Present Condition of the Plantation.*—The cold season was characterised by a drought unparallelled in Sikkim since meteorological observations began to be recorded in the district. The excessive dryness made any planting during the cold season an impossibility; but beyond killing entirely a few trees in very rocky ground, and injuring the upper shoots of a good many others, it did but little harm to the plantation. Trees standing in some of the wetter pieces of land, so common on the older parts of the plantation, seem even to have been benefited by the lengthened absence of rain. The present condition of the plantation is on the whole encouraging. The younger parts which occupy the Mungpoo ridge continue to be very luxuriant and healthy. A small part, however, of the lower Rishop plantation, which has for some years been rather sickly, still continues so; and as it does not seem probable that it will improve, I have decided to uproot it during next barking season. During the year no additions were made to the permanent plantations. This is chiefly attributable to the unusual drought of the cold weather. The nursery stock of red barks on the old plantation has, however, been increased by 200,000, and 120,000 young plants have been provided for the new plantation at Sittong. These will be planted out, as far as possible, during the year 1876-77, and ought to add considerably to the area under trees. Of the yellow-bark tree (*C. calisaya*), 2,000 stock plants (kept under glass for purposes of propagation) have been added during the year. The seedlings of this species, of which 116,000 were returned last year, were not planted out, experience having shown that *Calisaya* seed, however carefully it may have been collected from only the varieties yielding good bark, produces an uncertain and mongrel offspring. These 116,000 have therefore been written off. An addition of 35,000 has been made to the stock of young yellow barks raised from cuttings. Of the new variety referred to in the former reports as a hybrid, no plants have been put out during the year, but the stock plants of it have been increased from 1,000 to 5,000. As seedlings of this sort show similar peculiarities to those of *Calisaya*, the seedling stock of 15,000 returned last year was not planted out, and has been written off. *Cinchona platycalyx* is a species allied to *C. officinalis*, which was introduced on this plantation about five years ago. Sixteen plants of it were returned in last report. These all pined away during the year, and none are now left. Regarding the other species in cultivation, I may remark that *officinalis* was long ago discovered to be unsuited to the climate of Sikkim. Of this species, 125,000 appear in the returns, but before another year passes the majority of these will be cut down. The numbers returned of *C. micrantha* and *C. pahudiana* are respectively 50,000 and 5,092, and are the same as last year. Both species yield bark which is comparatively worthless, and no effort has for some years been made to multiply either.

11. *Manuring.*—The results of the application of manure to Cinchona, as noted in my last annual report, were not encouraging. I agree, however, with Mr. Wood in thinking it desirable to make a further trial of manuring, and I have accordingly asked Mr. Gammie to do this as soon as practicable. The manured plants reported on last year are now undistinguishable in appearance from their neighbours. It should not be forgotten that all the Cinchonas in the plantation are to a certain extent regularly manured, for the weeds cut and uprooted in cleaning the plantation are laid in rows between the trees and the vegetable manure yielded by the decay of these is very considerable.

12. *Survey of the Plantation.*—In accordance with the wishes of the Government, the whole plantation was surveyed and mapped last year by an officer of the Revenue Survey Department. Owing, however, to certain official changes which caused, I understand, the breaking up of the party to which this officer belonged, I have, I regret to say, not yet been able to get a copy of the map. The plantation has now arrived at a point in its history when it must begin to be worked on some systematic plan, with reference to the amount of bark to be annually taken from it, and it is high time that an accurate map of it were available. The boundaries of each year's planting should be shown on such a map as well as on the ground. I have impressed on Mr. Gammie the desirability of having as soon as possible, substantial marks put in the ground which may clearly indicate the limits of the planting of each year.

13. *Distribution of Seed.*—During the year twenty-one ounces of seed were given away to two applicants. This shows a great falling off from the former year, when no less than three hundred and fifty-eight ounces were distributed.

14. *Taudavent.*—The sum of Rs. 1,010-12-10, received for land rent and grazing dues from settlers on parts of the reserve unsuitable for Cinchona, was paid into the Darjeeling treasury.

15. *Estimated Crop of 1876-77.*—In his report for last year, the Government Quinologist, Mr. C. H. Wood, estimated the yield of the Rungbee, Rishap, and Mungpoo Plantations, when in full working, at 360,000 pounds of dry bark per annum. These figures were arrived at as the result of Mr. Wood's own calculations, and were accepted by Government. My calculations lead me to believe that this amount of bark can, advantageously to the plantations, be taken during the year 1876-77, and I beg, therefore, to submit 360,000 pounds of dry bark as my estimate for the crop of the year now entered upon. Unless, however, arrangements are made for working the alkaloid factory on a larger scale than at present, I would hesitate to advise the whole of this amount being taken, as there would be a difficulty about storing such a bulky crop. I feel convinced, however, that, in justice to the plantations, this amount should be taken. If taken, I estimate that (including interest on capital, working expenses, and Quinologist's salary) it can be turned out at about the price estimated by Mr. Wood in his report already referred to, viz., three and a half Annas, or five pence farthing per pound. Production of the raw material to this amount and at this price would enable Mr. Wood to supply during the year the "Cinchona febrifuge"—as he has named a preparation of the mixed red-bark alkaloids,—in a quantity vastly exceeding the total Government importations of quinine and the other Cinchona alkaloids for the whole of India for the year 1875, and at a cost of less than one Rupee per ounce.

16. *General Considerations.*—With regard to the "Cinchona febrifuge" issued by the Quinologist, I may observe that, in most ordinary cases of malarious fever, it appears to be an efficient remedy. Powerful testimony to this effect is borne by the four physicians in and near Calcutta, to whom, about eighteen months ago, a quantity was given for trial and report. Coolies on the plantation often get fever by attending markets in the Terai, and they are invariably cured by a dose or two of this mixed alkaloid. In the neighbourhood of the Botanical Garden at Calcutta fever of a bad type is very prevalent, and I have given the Cinchona febrifuge to garden coolies and to villagers living near the garden, in the same doses as quinine, and with as unvarying good effect. It is probable that for very severe and critical cases of

malarious fever, especially amongst Europeans, sulphate of quinine will long remain in the estimation of the medical profession the best remedy; but every one who has had much experience of India knows that bad cases of fever are more the exception than the rule, and that there is a simply inculculable amount of fever prevalent amongst the natives of the country which rarely takes the form of a violent or fatal attack, but which expends itself in a succession of attacks, each sufficient to incapacitate the sufferer from work for a time, and a repetition of which too often ultimately induces malarious cachexia and disease of the spleen. There appears to be ample medical evidence for believing that, for malarious fever of this ordinary type, the "Cinchona febrifuge" is a most efficient remedy. Everybody who knows much of rural life in this country must also be aware that at present the great majority of such attacks of fever receive no medical treatment whatever, or at least none of an efficient kind, and for the simple reason that no febrifuge is accessible to the sufferers. Quinine is a costly drug, quite beyond the means of a large proportion of the population. Moreover, it is not to be had except at dispensaries and in large bazaars in neighbourhoods where Europeans happen to be settled. It is no exaggeration whatever to say that, to three-fourths of the population of India quinine is simply *unobtainable even by purchase.* Its high price leads, moreover, to its extensive adulteration, and there is too good reason for believing that much of the substance sold in the bazaars as quinine consists partly, and some of it entirely, of other preparations. A febrifuge even less efficient than the Cinchona febrifuge would, if accessible to the vast fever-stricken population (and accessibility depends on cheapness), be an immense boon. It appears to be, therefore, a matter for congratulation that Government is now in possession of the means of throwing into the country next year several tons of an efficient febrifuge, and of year by year increasing the supply, and that too at an annually diminishing cost-price per ounce.

17. A Manual of Cinchona Cultivation in India, which I prepared at the request of the Government of India, has been printed and published since my last annual report.

18. In conclusion, my acknowledgments are due to Messrs. Gammie, Biermann, Parsons, and Jaffray for their services during the year.

19. The usual tabular returns are annexed.

QUINOLOGIST'S REPORT FOR 1875-76.

During the past year the work in the Quinologist's Department has been chiefly confined to the production of febrifuge upon an extended scale. The total quantity of mixed alkaloid that has been produced from the commencement of the manufacture to the end of March 1876 is 1,989 pounds; only 49 pounds, however, had been issued before September 1875, consequently 1,940 pounds have been sent out during the last seven months.

Altogether 107,130 pounds of bark have been used in the factory, consequently the average yield of febrifuge hitherto has been rather under two per cent. This amount, however, includes all the bark consumed in experiments; it also includes much that was of very poor quality. More than one-half was branch bark from the worst portion of the plantation, and containing but a small proportion of alkaloid. All the old store of bark has been now exhausted, and future working will doubtless show a larger yield.

The following statement gives the actual manufacturing expenses up to date:—

	Rs.	A.	P.
Muriatic acid, 8,137 pounds	1,792	3	0
Bottles and packages for ditto	884	10	0
Sulphuric acid, 504 pounds	63	0	0
Bottles and packages for ditto	39	6	0
Carriage of acids from Calcutta	1,510	4	0
Caustic soda, 8,984 pounds	1,110	0	0
Carriage from Calcutta	524	10	0
Charcoal, 510 maunds	211	14	0
Sundries	104	5	6
Factory labour	889	0	0
Bark, 107,130 pounds at 3½ Annas per pound	23,434	11	0
Total ...	30,355	0	3
Febrifuge produced, 1,989 pounds at Rs. 16 per pound	31,824	0	0

It will be seen that the foregoing does not comprise current expenditure, it does not include the cost of erecting the sheds and purchasing tools, &c. The amount thus expended on manufacturing plant is under Rs. 1,000. It also does not include the cost of the Calcutta experiments, or the charges for the analytical laboratory. These sums should be massed together to form a capital account, interest upon which should be a charge against manufacture in future years. Moreover, no charge has been yet made on the manufacture for the Quinologist's salary. During the greater part of the last year the Quinologist has been chiefly employed in another appointment, and previous to this the factory was a very small one, intended simply to test the practicability of the process. Up to date the Quinologist would be a fair charge against capital, his work having been to devise and start the process. It is only within the last two or three months that the manufacture has reached proportions which would bear the full charge for supervision.

During the next year (1876-77) it is intended to work 240,000 pounds of bark, and on this scale the entire charge for the Quinologist can be borne. But even this will be only two-thirds of the estimated producing power of the plantations; as soon as the full scale of 360,000 pounds of bark per annum is attained, the manufacture of febrifuge at a Rupee an ounce, even by this present process, will pay all expenses of plantation and factory, with interest on the whole capital; and it is to be considered that the present process is not the one which professes to make the most economical use of the bark. It has been adopted as a temporary measure to save the cost of erecting a permanent factory.

The following is the estimate for manufacture during the year 1876-77:—

Estimated expenditure—

	Rs.	A.	P.
Acid, 15,600 pounds at 8 Annas per pound (including carriage to plantations)	7,800	0	0
Soda, 15,600 pounds at 3½ Annas per pound (including cost in England, sea and land-carriage to plantations)	3,412	8	0
Charcoal, 416 maunds at 7 Annas per maund... ...	182	0	0
Factory labor, Rs. 130 per month...	1,560	0	0
Quinologist	10,000	0	0
Native Assistant for laboratory	480	0	0
Servants for laboratory	480	0	0
Bark, 240,000 pounds at 3½ Annas per pou ...	52,500	0	0
al ...	76,414	8	0

Estimated produce—

Febrifuge, 4,800 pounds at Rs. 16 per ...	76,800	0	0

It will be seen, therefore, that the febrifuge produced will fully equal in value the total grant for Cinchona for the year. Unfortunately, however, the estimate will be seriously affected by the delay in the arrival of soda from England, and some increased expenditure or reduction in the scale of work may result on this account.

The following statement shows how the febrifuge produced up to date has been disposed of:—

	lbs.	oz.
To Medical Store Department	1,607	14
To India Office, London	9	4
To Dr. King, Botanical Gardens	6	8
In store at factory	365	6
Total ...	1,989	0

A description of the present manufacturing process is appended to this report.

(Signed) C. H. WOOD,
Government Quinologist.

Description of the Process at present used for manufacturing "Cinchona Febrifuge" at the Sirkim Plantations.

BY C. H. WOOD, GOVERNMENT QUINOLOGIST.

General Object of the Process.—The present method of treating Cinchona bark was adopted as a temporary measure to afford the means of ascertaining the medicinal value of the proposed febrifuges. It was considered undesirable to incur any expenditure for factory buildings, machinery, or skilled labor, until the efficacy of the product as a remedial agent had been thoroughly determined by extensive trials. Consequently, it was necessary to so arrange the process that it could be conducted for some time on a considerable scale, and involve no other appliances than such as were already in hand.

General Nature of the Process.—The dry bark is crushed into small pieces (but not powdered), and is put into wooden casks, where it is macerated in the cold, with very dilute hydrochloric

acid. The liquor is then run off into solution of caustic soda; a precipitate forr with water. The precipitate is then dried crude febrifuge, which is next submitted t certain weight of the crude product is diss a solution of sulphur in caustic soda is a liquor is carefully filtered. The filtrate is collected on calico, washed with a small qu for taste, and is sent out under the name

Arrangement of the Factory Sheds.—A godowns, and so situated on the side of the pit a level with the roof of the sheds in wh

These sheds are rough temporal roof. Down the centre an open dec wooden stands are placed, on which square piece of calico to a wooden a row of 21 casks, standing on sod ground. They are empty beer ho Department at Darjeeling, the head remov the side of the cask at a level with the bott row of tubs, formed by cutting beer barrels the liquor will run out into the tubs.

Outside the shed, at one end, are a pair liquid can flow from them along a bamboo capacity of the vats, up to a mark on the in is run into the vat up to the mark, and a q whole well mixed. The diluted acid can t the vat by means of a bamboo trough. T brick building, floored with charcoal, in w which the process of purification is conducted

Method of conducting the Process.—The casks are worked in sets of three, and are marked A, B, C.

In each shed there are 14 sets; seven on each side. Each cask receives one maund of dry bark, which undergoes four successive macerations, the liquor being moved in rotation through the three casks. Each maceration lasts half a week. The liquid used for the fourth and last maceration is pure water drawn from the vat. When this is run off, it is moved into the next cask to form the third liquor. When this is drawn off, it forms the second liquor for another cask, and, when transferred from that, it goes on to new bark, from which it is drawn off, and precipitated. The following table will show the manner in which this rotation is effected. Of course, in starting a new shed every cask contains dry bark, consequently the system of rotation is not brought into full operation until after the first fortnight; and it is only after the shed has been in operation for 3½ weeks (June 7th in table) that the liquor for precipitation has been used for four macerations. The table is drawn for a new shed; after June 7th, it is in regular order.

The liquor that is for precipitation is run into the tubs. The other liquors are drawn into wooden buckets and poured into the proper casks. The new acid is then drawn from the vats. The diluted acid is made in the vat by adding 1 gallon of muriatic acid to every 100 gallons of water (10 fluid-ounces to each cubic foot).

If three sheds are employed, No. 1 is worked on Mondays and Thursdays, No. 2 on Tuesdays and Fridays, and No. 3 on Wednesdays and Saturdays. It will be seen by the table that each set of three casks exhausts one maund of dry bark per week. Three sheds, therefore, containing 42 casks each, would exhaust 42 maunds of bark every week.

The weight of acid used in the exhaustion is 6 per cent. of the weight of dry bark. It is obtained from Mr. Waldie's chemical works, at a cost of 3¼ Annas per pound in Calcutta.

To precipitate the saturated liquor, a solution of caustic soda is added in excess. The caustic soda is obtained from England in 5-cwt. drums, costing from £15 to £20 per ton in London. One part of this is dissolved in three parts of water, and the solution stored in iron vessels. The quantity to be added to the bark liquor must be judged of by the appearance produced. When a sufficient quantity has been introduced, the precipitate assumes a somewhat curdy condition.

About 6½ pounds of solid soda are used for every 100 pounds of dry bark.

The filtration is not commenced until the following day, when the liquor is transferred to the calico strainers which have been well wetted. The first portions that run through are returned until the liquid passes of a bright ruby color, is then allowed to flow away by the drain. After all the liquor has drained off, water is through the precipitate until it ceases to acquire a red tint. The alkaloids on the filter should be of a uniform cream color. The precipitate is now dried and reduced to a fine powder, is stored in suitable bins. It constitutes the crude febrifuge.

The Process of Purification.—The precipitate not of drying acquires a slightly reddish-brown color. It is, therefore, submitted to of purification. Fourteen gallons of water are mixed with two pints of sulphuric acid and twenty pounds of the dry powder are introduced. The alkaloids dissolve, and a quantity of coloring matter remains insoluble. About half a pint of a solution of sulphur in caustic soda is now stirred in, and the whole allowed to stand for twenty-four hours. It is then filtered through calico into a clean vessel, care being taken to get the liquor perfectly bright. About 6 gallons of water are used to wash the sediment left on the filters. The clear filtrate is thoroughly mixed with solution of soda to precipitate the alkaloids; the precipitate is collected on calico, washed with a small quantity of water, drained, dried, and reduced to fine powder; it is then ready for issue.

Wooden tubs are used for this process, but are not so well suited for the purpose as enamelled iron or earthenware. The purification conducted in a separate shed by a man who is confined to that work.

The Labour employed.—The only workmen employed in the factory are Nepalese coolies. When the process is once brought into full operation, it is found that these men readily master every detail, and conduct the whole thing with all the care and accuracy that is required. But, of course, the factory is under the supervision of Mr. Gammie, the officer in charge of the plantations, who visits it once a-day, and sees that the work is being properly performed.

The Bark used.—Dry *Succirubra* bark only is employed. Moreover, care is taken to mix the root, stem, and branch bark together in as nearly as possible the proportions in which they are yielded by the plantations. This mixture is hewn into small pieces, and a maund of it goes into each cask. This is done to insure uniformity of composition in the product. Green bark is never operated on. It will be seen that the arrangement of the process requires that a certain weight of bark should be put into the casks every week throughout the year. This could not be done with green bark, because bark is only taken from the trees twice per annum. Apart from this, however, it has been found that dry bark yields a much better product, and quite as large a quantity. The small cost of drying the bark is more than counterbalanced by the advantages gained.

Temporary Object of the Process.—It must be remembered that this method has only been adopted to furnish a large supply of febrifuge for trial; it does not profess to make the most economical use possible of the bark. The factory is estimated to turn out during the present financial year 4,800 pounds of febrifuge, which, at a Rupee an ounce, will pay the whole cost of the plantations and manufacture for the year. If the product proves to be of permanent value as a remedial agent, it is probable that the process will be considerably modified to produce greater economy, but involving the use of permanent buildings and machinery.

SIFED No. 1.

Casks marked A, B, C.

Thursday, May 13th ...	Put dilute acid in A.	1st liquor for A. (New bark is in A.)
Monday, „ 17th ...	Run liquor from A. and precipitate.	
	Put dilute acid in A.	2nd liquor for A.
	Move liquor from A to B.	1st liquor for B. (New bark is in B.)
Thursday, „ 20th ...	Put dilute acid in A.	3rd for A.
	Run liquor off B. and precipitate.	
Monday, „ 24th ...	Move liquor from A to B.	2nd liquor for B.
	Put dilute acid in A.	4th for A.
	Move from B to C.	1st liquor for C. (New bark is in C.)
Thursday, „ 27th ...	Move A to B.	3rd for B.
	Clear	
	Run and precipitate.	
Monday, „ 31st ...	Mov E to C.	2nd liquor for C.
	Put B.	4th for B.
	Move liquor from C to A.	1st liquor for A. (New bark is in A.)
Thursday, June 3rd ...	Move liquor from B to C.	3rd for C.
	Clean out B.	
	Run liquor off A. and precipitate.	
Monday, „ 7th ...	Move liquor from C to A.	2nd liquor for A.
	Put dilute acid in C.	4th for C.
	Move liquor from A to B.	1st liquor for B. (New bark is in B.)
Thursday, „ 10th ...	Move liquor from C to A.	3rd for A.
	Clean out C.	
	Run liquor off A and precipitate.	
Monday, „ 14th ...	Move liquor from A to B.	2nd liquor for B.
	Put dilute acid in A.	4th for A.
	Move liquor from B to C.	1st liquor for C. (New bark is in C.)
Thursday, „ 17th ...	Move liquor from A to B.	3rd for B.
	Clean out A.	
	Run liquor off C and precipitate.	
Monday, „ 21st ...	Move liquor from B to C.	2nd liquor for C.
	Put dilute acid in B.	4th for B.
	Move liquor from C to A.	1st liquor for A. (New bark is in A.)
Thursday, „ 24th ...	Move liquor from B to C.	3rd for C.
	Clean out B.	

From Dr. GEORGE KING, M.B., Superintendent, Royal Botanical Garden, Calcutta, and in charge of the Cinchona Cultivation in Bengal, to the Acting Assistant Secretary to the Government of Bengal, dated Kurseong, 12th September 1876, No. 120.

I have the honor to acknowledge your letter marginally noted, forwarding copy of the annual report of Mr. Wood, the Government Quinologist, and calling for any remarks thereon which I may wish to make.

No. 1,915, Financial Department (Agriculture), dated 1st September 1876.

2. I would now, therefore, submit a few comments, not by way of criticising Mr. Wood's report, but of explaining a few points in which his report as Quinologist and my own report as Superintendent of the Plantation might seem to be at variance.

3. I would observe—

(1)—That in paragraph 3 of his report Mr. Wood takes the cost-price of the 107,130 lbs. of bark supplied to him at 3½ Annas per pound, giving a total of Rs. 23,434-11-0. Now 3½ Annas is the prime cost of the bark as calculated in my annual report if no charge for interest on capital be made; but I understand interest on capital is to be charged at the rate of 4 per cent. per annum. With interest at that rate the cost of the bark is raised to 4 Annas and 7 Pies per pound, and the 107,130 lbs. supplied to Mr. Wood represent Rs. [illegible] instead of Rs. 23,434,—a difference of Rs. 8,370, which raises the prime cost of the alkaloid from Rs. 16, as estimated by Mr. Wood, to about Rs. 20-8-0 per pound. Three and a-half Annas per pound is the estimated prime cost, including interest of the bark when the plantation shall be in full working, *i.e.*, when it shall be turning out 366,000 lbs. of dry bark annually. The plantation yielded only 213,000 lbs. of bark during the year under review, and was far from being in full working. I think it would, therefore, be quite justifiable to let 3½ Annas stand as the price of the bark made over to Mr. Wood, and to charge the interest (Rs. 8,370) to capital account. During the current year 1876-77 the plantation should, as estimated in my annual report recently submitted, reach full working power, and should turn out 366,000 lbs. of dry bark, which, including the Quinologist's pay and interest on capital, will, I estimate, cost 3½ Annas per pound. This leads me to observe—

(2)—That in the 5th paragraph of his report Mr. Wood puts down only 240,000 lbs. as the outturn for the present year, and frames his estimate accordingly. His estimate should, I think, be increased so as to provide for the working of all the estimated crop.

(3)—With regard to Mr. Wood's estimate, as it stands in paragraph 6 of his report, I would observe that while accurate as showing the real prime cost of the alkaloid, it is obviously not intended for the Accountant-General as a budget estimate, as it includes an item for soda supplied by the Secretary of State. It also includes Quinologist's pay (Rs. 10,000),—an item which, if 366,000 lbs. of bark be taken, would be included in the sum of 3½ Annas, which in my annual report I have put down as the prime cost of the bark.

No. 84. ORDER THEREON, 5th December 1876, No. 1,915.

Miscellaneous.

COMMUNICATED to the Board of Revenue, the Conservator of Forests, and the Commissioner of the Nilgiris, and the Acting Resident, Travancore.

(True Extract.)

(Signed) D. F. CARMICHAEL,
Secretary to Government.

To the Board of Revenue.
„ the Conservator of Forests.
„ the Commissioner of the Nilgiris.

Exd. F. R. Bantleman.

FINANCIAL DEPARTMENT.

AGRICULTURE.

CALCUTTA, THE 30TH OCTOBER 1876.

RESOLUTION.

READ—

The Annual Report of the Government Cinchona Plantations, British Sikkim, for the year ending 31st March 1876, submitted with Dr. King's letter No. 30C, dated the 8th August 1876.

The Annual Report of the Government Quinologist for 1875-76, submitted with Mr. Wood's letter No. 1, dated the 1st August 1876.

A letter No. 120, dated the 12th September 1876, from the Superintendent of Cinchona Cultivation, remarking on the foregoing report.

The results of the working of the Cinchona Plantation during 1875-76 differ materially from those obtained in any previous year. Hitherto the establishment has been employed first in experimental cultivation, and afterwards in systematic planting, while the yield of bark has been comparatively small. In the past season no addition has been made to the permanent plantation, and the main work of the year has consisted in gathering a crop of 211,931lb. of red bark, the produce of *Cinchona Succirubra*. This outturn exceeds by 62,000lb. the amount estimated by the Government of India in their letter No. 208 of 21st June 1873 as the probable yield of the plantation in 1877. The following statement of the quantities of bark collected yearly since the establishment of the plantation shows that the yield of 1875-76 is more than five-times as great as that of the previous year:—

					lb.
Dry bark collected by pruning and thinning during			1869-70	...	2,400
Ditto	ditto	ditto	1870-71	...	12,500
Ditto	ditto	ditto	1871-72	...	39,000
Ditto	ditto	ditto	1872-73	...	Nil.
Ditto	ditto	ditto	1873-74	...	16,000
Ditto	ditto	ditto	1874-75	...	39,405
Crop of 1875-76 ...	...	...	...	...	211,931
			Total	...	321,236

The Lieutenant-Governor considers these results to indicate a very marked degree of success.

2. It is observed that in gathering the bark attention has been paid to the important objects of assisting future cultivation, and of adding as much as possible to the practical knowledge of the best methods of harvesting. Thus on three plots of land, where the trees had become luxuriant and required space for growth, thinning and pruning have been largely resorted to; while in eight other places the plants were either coppiced or uprooted in such proportions, and with such arrangements for filling the vacant spaces, as seemed likely to furnish the most ample facilities for comparing the merits of these two modes of gathering bark. At the same time, much valuable experience has already been gained. The practice of uprooting the entire tree was adopted in order to save the loss of bark which arises from the fact that after coppicing a certain proportion of the stools fail to shoot. Mr. Wood's analysis further shows that the root bark thus made available for manufacture

contains about eight per cent. of alkaloids, or one per cent. more than the finest stem bark. The cost of uprooting slightly exceeds that of coppicing; but as the process thoroughly turns up the soil, it is hoped that it will answer to replant the same ground immediately with cinchona, and "thus to secure gratuitously the advantage of a very complete kind of digging." Further experience will show whether the soil has been too much exhausted by its former crop to admit of immediate replanting; but attempts are being made to guard against this by allowing the leaves, branches, and wood of the uprooted trees to decay upon and manure the ground, and also by avoiding as far as possible the exact spots occupied by the uprooted trees.

3. The practice of stripping bark from living trees was not resorted to during the past year, as it was found that the renewal of bark under moss was rendered impossible in Sikkim by the attacks of ants. A few trees which had been stripped in 1874 have partially renewed their bark without mossing, but although eighteen months old, it is only about half as thick as the original bark. Three hundred healthy trees will be stripped during the current year; but Dr. King does not anticipate very favourable results from the experiment, and it is probable on the whole that this method of harvesting bark, so successful on the Nilgiri plantations, will be entirely abandoned in Sikkim. The comparative advantages of coppicing and uprooting will be fully inquired into during the next two or three seasons, but at present it is uncertain which process will turn out to be the best.

4. Owing to the unusual drought of last cold weather no additions have been made to the permanent plantation. But the nursery stock of *Cinchona Succirubra* has been largely increased, and 125,000 young plants have been provided for the new plantation at Sittong. The 116,000 seedlings of yellow bark (*Cinchona Calisaya*) returned in last year's report have been written off as worthless, "experience having shown that *Calisaya* seed, however carefully it may have been collected from the varieties yielding only good bark, produces an uncertain and mongrel offspring." The stock plants of the variety described in last year's report as a hybrid have been increased from 1,000 to 5,000, but as yet none have been planted out, and the seedlings have been rejected as showing the same tendencies to variation which are observed in *Calisaya*. Further experiments will be made with the object of ascertaining whether manure can be profitably used in cinchona cultivation. Dr King observes that the manured plants reported on last year cannot now be distinguished in appearance from their neighbours, and points out that vegetable manure is supplied to a considerable extent to all the trees on the plantation by the practice of leaving the cut and uprooted weeds to decay on the ground between the trees.

5. Excluding an item of Rs. 754, transferred to the debit of the quinology account, the total expenditure on the plantation during 1875-76 amounts to Rs. 52,714. Out of this, Rs. 42,937 represent the actual working expenses, while Rs. 9,777 are debitable to the capital account recently opened under the orders of Government. The latter sum includes Rs. 2,134 laid out on the new Sittong plantation, the accounts of which are kept separately. The Quinologist's pay has also been added to capital, as this charge cannot fairly be debited against the crop until the plantation is in full working. It has been noted above that the total yield of bark amounted to 211,931lb. After deducting 16,640lb destroyed by an accidental fire, there remain 195,291lb to set against the working expenses of the year. Dr. King calculates that the cost of production of each pound of dry bark may be stated at a fraction above three annas and a half, or a fraction below four annas and nine pie if interest on capital at the rate of 4 per cent. be taken into account. During the year 92,400lb. of dry bark were made over to the Quinologist for conversion into cinchona febrifuge, and 2,000lb. were supplied to the Presidency Medical Depôt. The remainder of the crop is stored at Mungpoo, and is made over to the factory from time to time as it is required for manufacture.

6. Turning to the Quinologist's report, it appears that the actual quantity of dry bark used in manufacture during the year was 107,130lb, which

yielded only 1,980lb of cinchona febrifuge, or rather less than two per cent. More than one-half of the bark, however, was branch bark, which is always poor in alkaloids, from the worst part of the plantation, and the amount shown above includes all the bark consumed in experimental manufacture. The actual working expenses of the Quinologist's Department for 1875-76 are given by Mr. Wood as Rs. 30,355, against which are to be set Rs. 31,824, the value of the febrifuge at Rs. 16 per pound. It is observed that in this statement the prime cost of the dried bark is shown as three and a half annas per pound. If interest at 4 per cent. on the capital invested in the cinchona plantation is to be charged against the bark produced, the prime cost of the bark will amount to four annas nine pie per pound, and that of the alkaloid to Rs. 20-8. But as it is estimated that if the full working outturn of the plantation were taken into account, the cost of the dry bark would not exceed three and a half annas per pound, the Lieutenant-Governor considers that the figures given by the Quinologist may be allowed to stand, and that Rs. 8,870, being the amount of interest chargeable, should be debited to the capital account which it is proposed to open for the Quinologist's Department. This account will also include the cost of manufacturing plant, of the preliminary experiments made in Calcutta, of the analytical laboratory, and of the Quinologist's salary for the past year. The latter item will be transferred from the capital account of the Cinchona Plantation.

7. In Dr. King's opinion 366,000lb of dry bark may advantageously be collected from the plantations at Rungbee, Rishap, and Mungpoo during 1876-77; but the Quinologist submits an estimate for working up only 240,000lb. Under recent orders the alkaloid factory will be transferred from Rungbee to Calcutta, and will be worked upon a large scale either in the Presidency or the Alipore Jail. It is hoped that there will be no difficulty in manufacturing the larger amount of bark shown in Dr. King's estimate into cinchona febrifuge, and supplying it to the public at a cost of less than one rupee per ounce. The Lieutenant-Governor therefore accepts Dr. King's estimate of the amount of bark to be collected during the current year, and the Government Quinologist will be instructed to amend his estimate so as to provide for the conversion into febrifuge of 366,000lb of cinchona bark. It is observed that Mr. Wood's estimate contains an item of Rs. 10,000 for the Quinologist's pay. This has already been included in the cost of the dried bark, which is estimated at three and a half annas per pound, provided that 366,000lb are collected from the plantation. But as the pay of the Quinologist does not properly form an element in the cost of production of cinchona bark, it appears desirable to enter it as a separate item and to reduce the charge for dried bark proportionately. It will thus be possible to define with accuracy the separate cost both of the raw material and of the manufactured alkaloids.

8. During the autumn and winter of 1875 experiments were conducted by medical officers in various parts of India with the cinchonidine and cinchona febrifuge prepared by Mr. Wood. The experiments resulted in a considerable divergence of opinion, and the Surgeon-General expressed his view that, while there could be no doubt of the efficacy of both remedies against the ordinary intermittent fever of Bengal, the question of their general adoption must be considered as still *sub judice*. The intermittent fevers of last year had been of an exceptionally mild type, and the medicines had not been sufficiently tested for any final judgment in the matter to be possible. It is understood that further investigations are now being conducted, and that their results will be communicated to this Government in February 1877. Meanwhile the Lieutenant-Governor, in his Minute of the 10th September, has already recorded his opinion that any decision on the precise febrifugal power of these alkaloids must be a work of some little time, depending on medical testimony, on actual experience, and on popular acceptance.

9. The Lieutenant-Governor acknowledges with thanks the good services rendered by Dr. King, by Mr Gammie, the resident manager of the cinchona plantations, and by Mr. Wood. The latter gentleman has added to his

official report a minute and clear account of the process followed in manufacturing the cinchona febrifuge. Dr. King's labours in compiling a manual of cinchona cultivation have already been acknowledged in a separate Resolution on the Botanical Garden.

Ordered that copies of this Resolution, and of the Reports and letter referred to, be submitted to the Government of India in the Revenue, Agriculture, and Commerce Department; also that copy, with 100 copies of the papers referred to, be forwarded to the Superintendent, Botanical Gardens, in charge of Cinchona Cultivation, for information and distribution as usual.

Ordered also that copies of the Resolution, and of the papers referred to, be forwarded to the Surgeon-General, Indian Medical Department, and to the Judicial (Medical) Department of this office for information, and to the Government of Madras for information, in continuation of this office No. 378, dated the 7th February 1876.

By order of the Lieutenant-Governor of Bengal,

H. J. REYNOLDS,

Offg. Secy. to the Govt. of Bengal.

No. 3425

Copy forwarded to the Secy. to the Government of Bengal Revenue Department for information and in continuation of this office No. 378 dated 7th February 1876.

By order of the Lieutenant-Governor of Bengal,

H. J. REYNOLDS,

Offg. Secy. to the Govt. of Bengal.

Calcutta,
The 30th October 1876.

C. H. G.—Rev. No. 4210—4-11-76.

No. 30C., dated Rungbee, the 8th August 1876.

From—George King, Esq., M.B., Superintendent, Royal Botanical Garden, Calcutta, and in charge of Cinchona Cultivation in Bengal,

To—The Secretary to the Government of Bengal, Revenue Department.

I have the honor herewith to submit the annual report on the Government Cinchona Plantation in British Sikhim for the year ending 31st March 1876.

Fourteenth Annual Report of the Government Cinchona Plantation in British Sikhim. By George King, Esq., M.B., F.L.S., *Superintendent of the Royal Botanical Garden, Calcutta, and of Cinchona Cultivation in Bengal.*

The record of work done on the cinchona plantation during the year 1875-76 is, unlike that of any former year, more one of harvest than of planting. After thirteen years of expenditure, at first on experiments and latterly on *bond fide* planting, during which period but little return was received, the scale has now begun to turn, and for the first time in its history the plantation has yielded a tangible result in the way of crop, 211,931 pounds of dry bark having been collected since last annual report. This amount considerably exceeds the forecast made by the Government of India in the seventh paragraph of Mr. Hume's letter reviewing the plantation report for 1873-74, in which it is estimated that, by the year 1877, the plantation should begin to yield at the rate of 150,000 pounds of dry bark per annum. The collection, within a year short of the date fixed by the Government of India, of a quantity of bark exceeding the estimate by nearly 62,000 pounds, may therefore, I hope, be regarded as satisfactory.

2. *Details of the year's crop.*—The bark collected during the past year was taken from different parts of the plantation, and in a variety of ways. The taking of the crop divided itself into eight operations, which I shall now proceed to sketch briefly, premising that the first three of these were cultural, having been undertaken primarily in the interest of the piece of plantation worked on, while the remaining five were undertaken with the double object of getting bark and of adding as much as possible to that practical experience of the various modes of harvesting it which is the only sure basis on which a regular working plan for the plantation can be founded. The crop consists entirely of red-bark (the produce of *cinchona succirubra*), and the eight operations by which it was harvested were as follows:—

1*st*.—The whole of the plantation of 1867 (with the exception of eight acres, to be subsequently accounted for), extending to about 180 acres and situated on Rungbee, was carefully gone over and thinned where necessary. From this there were obtained 8,017 pounds of dry stem and 12,388 pounds of dry branch-bark.

2*nd*.—The upper part of the Bishop spur, planted in 1869 at 6 × 6 feet, was thinned and pruned,—an operationwhich yielded about 71,000 pounds of dry bark, of which about one-fifth was stem-bark and four-fifths were branch-bark.

3*rd*.—In like manner the whole *succirubra* plantation of 1872 (with the exception of eleven acres, to be afterwards mentioned,) was subjected to a moderate thinning and pruning. The year 1872 was the first in which close planting was adopted. The trees in this piece of plantation stand only four feet apart, giving 2,722 trees to the acre, against 1,210 trees to the acre in the older planting at 6 × 6 feet apart. As these trees stand in very good soil and as their growth has all along been luxuriant, a certain amount of thinning had become absolutely necessary for their general welfare. About 10,153 pounds of dry bark were thus obtained, which was composed in round numbers of one-fourth root-bark, and rather less than a fourth of stem-bark, the remainder being branch-bark.

4*th*.—About eight acres of trees on Rungbee, planted in 1867, were cut down close to the ground, only a small proportion of trees being left standing. This operation will give further experience as to the result of nearly complete coppicing of nine-year old red-barks. I say *nearly* complete coppicing, because a few trees are left standing, but not enough to afford any material amount of shade to the shoots that will rise from the stools of the felled trees. The trees cut on these eight acres yielded 6,400 pounds dry stem-bark and 3,781 pounds of dry branch-bark, or a total equal to 1,272·5 pounds of dry bark per acre. These figures do not, however, by any means show all the bark which has been collected from these trees since they were planted, for they have from time to time been thinned and pruned in years past; but of the bark thus obtained, unfortunately no separate record has been kept. This patch of eight acres lies contiguous to a one-acre patch (also planted in 1867), which, on being coppiced in a like fashion in December 1874, yielded about 2,000 pounds of dry bark; but from this patch also bark had been, previously to 1874, taken by thinning. The young shoots that

have risen from the stools on the one-acre piece now promise very fairly indeed, as also do those which are beginning to spring from the stools on the eight-acre piece. The future history of the coppice on these nine acres will be of much value and interest, therefore have I entered into so much detail regarding it.

5th.—A patch of thirty-five acres of trees near the site of the old Bishop hut, planted in 1866 and 1867, and therefore about nine years old, was entirely uprooted. The yield of bark was as follows:—

	Pounds.
Dry root-bark	41,374·28
,, stem-bark	19,677·48
,, branch-bark	21,576·00
Total ...	82,627·76

This is equal to 2,360·8 pounds of dry bark per acre, of which about half is root-bark containing 8 per cent. of alkaloids, and nearly a fourth is stem-bark containing at least 6 per cent. of alkaloids. The present is not the first occasion on which this thirty-five-acre plot has formed the subject of report: it will therefore, I think, be instructive to trace briefly its past history. Originally planted at distances of 6×6 feet apart, the trees, when two and a half years old, were thinned, and 1,600 pounds of dry bark were thus obtained. Shortly before the sitting of the Commission appointed to consider the subject of a disease which then (in the opinion of some) threatened the plantation with destruction, and when the plants were about three and a half years old, each alternate row of them was cut down, and dry bark was thus obtained to the extent of 9,200 pounds. One of the witnesses who appeared before the Commission was the late Mr. W. G. McIver, Superintendent of the Government Cinchona Plantation on the Nilgiris, and in April 1872, or shortly after his examination by the Commission, Mr. McIver put on record his opinion that, if cut down then (*i.e.* in April 1872), these thirty-five acres might (including the 4,800 pounds already taken from them) yield a total of about 273 pounds of dry bark per acre, but that, if allowed to remain uncut, a large proportion of the trees would be dead before a year should elapse. Mr. McIver even went so far as to say that in his opinion more good bark would be got by cutting the trees then than could ever again be taken, bark from dead and dying trees being worthless. Some time after this opinion had been given, a further thinning (the third) of these trees was undertaken, which yielded 8,000 pounds of dry bark. Prior to uprooting, these thirty-five acres had therefore yielded 12,800 pounds of dry bark, or at the rate of about 366 pounds per acre: at uprooting, as we have just seen, they yielded at the rate of 2,360·8 pounds, bringing their total yield per acre up to 2,726 pounds of dry bark, or about ten times the quantity estimated by Mr. McIver. Mr. McIver was the most experienced cinchona cultivator of his day, and his opinion carried much weight. These thirty-five acres were about as much affected by the disease of which Mr. McIver took so gloomy a view as any part of the plantation; it is therefore satisfactory to find that the ravages of any disease that has hitherto appeared amongst cinchonas need after all be but little dreaded.

6th and 7th.—With the view of testing at once the results of a shorter rotation than one of eight or nine years, and of the respective merits of coppicing and uprooting as modes of harvesting bark, a six-acre patch of three and a half years old *succirubra* trees, standing four feet apart, was selected on Mungpoo ridge. On three acres of this the whole of the trees were cut over close to the ground (*i.e.*, were entirely coppiced), and on the other three acres all the trees were dug out by their roots. For the sake of comparison I shall consider the results of these two experiments in the present paragraph.

The yield of dry bark from these two pieces was as follows:—

	Roots.	Stems.	Branches.	Total bark.	Yield per acre.
Three acres uprooted	1,155·33	1,396·80	1,565·10	4,056·49	1,352·14
Ditto coppiced		1,350·07	1,368·65	3,118·72	1,039·60

For plants standing 4×4 feet apart, and three and a half years old, these figures show a yield at the rate of 989 pounds of dry bark per annum, as against a yield of 302 pounds per annum in the case of the thirty-five acres of nine-year old plants standing 6×6 feet apart, and which had undergone three thinnings and prunings prior to uprooting. This evidence therefore is, so far as it goes, in favour of close planting and early cropping. The three-acre uprooted piece has been replanted with red-bark seedlings equal in number to the plants removed, and the new plants have been put down in the spaces between the sites occupied by their predecessors. The three-acre coppiced piece has yielded at the rate of 294 pounds of dry bark per acre per annum. All death vacancies in the latter piece have been filled up by young plants; the stools of the cut trees will receive careful treatment, and both the uprooted and coppiced patches will get one and the same amount of care and cultivation. At the end of a given time both patches will be again harvested, and definite comparative results will thus be obtained.

8th.—A five-acre patch, similar in every respect to the two three-acre pieces just mentioned and adjoining them, was severely thinned by coppicing and by uprooting a

proportion of the trees on it and by pruning the remainder. Dry bark to the extent of about 270 pounds per acre has been thus obtained from it. This five-acre patch will be cultivated like the two adjoining three-acre patches above mentioned, and its future yield will be duly chronicled. The results of these eight operations will be found in a tabular form as an appendix to this report.

3. *Various modes of harvesting compared.*—The past year has thus added considerably to our experience on several matters of importance connected with the bark harvest. Experience has been got for the first time of the results of uprooting the trees—a mode of working suggested by Mr. Gammie in imitation of the well-known practice of the *cascarillados* in the natural cinchona forests of South America. The root-bark of this plantation contains, according to Mr. Wood's analysis, about 8 per cent. of total alkaloids, and is therefore richer than the finest of our stem bark, which rarely yields more than 7 per cent. It has, moreover, all along been found that in the operation of coppicing a certain proportion of the stools fail to shoot—in other words, they die, and as the bark of every part of a dead cinchona tree is perfectly destitute of alkaloid, there is always in coppicing a certain amount of bark lost. It appeared therefore well worth while to give a trial to a method which would make sure of the entire bark of every tree touched. From the two experiments in uprooting which have been above recorded, we have learnt that this is by no means a difficult or expensive process, bark so taken having cost for collection about two and a fourth pies per pound when green, as against one and three-fourths pies per pound for green bark taken by coppicing. During the process of uprooting, a very thorough upturning cannot fail to be given to the soil, and I am hopeful that it may be found to answer to replant such ground at once with cinchona, and thus to secure gratuitously the advantage of a very complete kind of digging. With this view a certain proportion of the uprooted area will, during the earliest good planting weather that occurs, be replanted with red-barks, care being taken to avoid as far as possible the exact spots occupied by the uprooted trees. The great objection to immediate replanting with the same species is of course the obvious one that the soil is possibly to some extent exhausted for red-bark. But, after all, the only part of the former trees which has been removed is the bark; the leaves, branches, and (as far as the coolies can be prevented from appropriating it as fuel) the wood also, being allowed to decay on the ground. If experience should show that immediate replanting does not answer, a period of rest can be allowed to the soil. As regards the proportion of root to stem and branch-bark, the uprooted three-acre patch gives for healthy succirubra trees planted 4 × 4 feet, three and a half years old, and from which no bark had previously been taken, the following percentages of green bark:—root 26·5, stem 30·2, and branch 43·3 per cent. These percentages are, be it observed, for *green* bark. But in the process of drying these three sorts of bark lose weight in different proportions. The loss of weight in drying varies moreover with the season. In wet seasons green bark naturally contains more moisture than in dry seasons. The past cold season having been an exceptionally dry one, the loss of weight by drying was correspondingly small. The actual figures may thus be tabulated:—

	Pounds.
100 pounds green root-bark dried to	32·04
100 ditto stem-bark ditto	41·06
100 ditto branch-bark ditto	27·40

The thirty-five acres of uprooted nine-year old trees at Bishop yielded an exceptionally large amount of root-bark (nearly 50 per cent.), a result which is accounted for by the very large proportion of coppice-bearing stools to standard trees at the time of uprooting. The brief history of this patch, which has been already given, explains why there were so many coppice stools.

With regard to coppicing as a mode of harvesting bark, some experience has been gained during the year, and the basis has been laid down for a good deal more to be gathered hereafter. The progress during the year of the shoots from the stools of a number of trees coppiced under a variety of circumstances in 1874 confirms my belief that an almost complete coppicing, by which a minimum of standard trees is left (and that means a minimum of shade and of drip), is more likely to yield good results than a partial coppicing, by which only alternate plants or alternate rows of plants are cut. The shoots which follow a complete or nearly complete coppicing are in every case more healthy and vigorous, and in many cases more numerous also, than any which I have seen to rise from stools standing in shade. If the precaution of earthing up the stools be taken, the damage done to the young shoots by wind does not appear to be great. The cost of weeding and cultivating complete, or nearly complete, coppice will be about the same as for seedlings planted from the nursery. Experience alone will show whether coppicing or uprooting will pay best; and it would be premature as yet to form an opinion as to their respective merits as modes of harvesting. With regard to the third method of harvesting which has been proposed, viz. decortication of living trees, former experience having shown that renewal of bark under moss is a failure in Sikhim owing to the attacks of rats, no further experiments have been made by that method. Some trees which were partially stripped of their bark during the year 1874 have partially renewed it without the application of moss or straw or other covering of any kind. The renewed bark, however, although now more

than eighteen months old, is still only about half as thick as the original bark. Though not hopeful of very favourable results from this method, I have given instructions that 300 healthy trees be submitted to it during the rainy season.

4. *Expenditure for the year.*—The total expenditure on the plantation for the year (including the item of Rs. 584-4-11 for head office charges) was Rs. 53,469-4-1. Of this, the sum of Rs. 754-4-3, incurred on account of labour for the factory, has to be transferred to the debit of the quinology account, leaving a balance of Rs. 52,714-15-10 as plantation expenditure proper. This sum is made up as follows :—

				Rs.	A.	P.	Rs.	A.	P.
European establishment, mallies, chuprassies, carpenters, blacksmiths, &c.				13,097	0	5			
Head office writer, &c				584	4	11			
Contingencies				3,055	3	0			
							16,736	9	1
Note.—The above charges are in the proportion to the rest of the expenditure of 46·6 per cent.									
Cultivation of old plantations (Rungbee, Rishap, Mungpoo)							20,466	13	0
Cost of collecting the bark crop							8,340	0	0
Erection of godowns at Mungpoo							3,050	0	0
Extensions of Mungpoo plantation							1,432	11	9
Spent on new plantation at Sittong							2,138	14	0
			Total				52,713	15	10

This divides itself into two portions, viz. the sum of Rs. 42,937-6-1, which represents the working expenses of the plantation for the year, and which is therefore to be set against the crop, and the sum of Rs. 9,777-9-9, which is debitable to capital account. The composition of the working and capital expenditure is shown in the following table :—

Working Expenses.							Rs.	A.	P.
Cultivation of the old plantations of Rungbee, Rishap, and Mungpoo during 1875-76							20,466	13	0
Proportion of European establishment, head office charges, skilled labour, and contingencies, equal to 46·6 per cent of the above							9,518	9	1
									29,985	6	1
Cost of collecting bark crop							8,340	0	0
Add 46·6 per cent							4,112	0	0
									12,452	0	0
Total Working Expenses									42,937	6	1
Capital Expenditure.									
Cost of extensions of plantation at Mungpoo							1,432	11	9
Add 46·6 per cent							680	0	0
									2,172	11	9
Erection of bark godowns at Mungpoo							3,050	0	0
Add 46·6 per cent							1,420	0	0
									4,470	0	0
Expended on new plantation at Sittong							2,138	14	0
Add 46·6 per cent							996	0	0
									3,134	14	0
Total Capital Expenditure									9,777	9	9

5. *Working Expenses.*—The charges against capital will be dealt with in the next paragraph, and the working expenses alone concern us in this one. Of the working charges above shown, Rs. 8,340 represent the actual amount spent in labour on the collection of the bark crop from the trees. This charge includes the cost of uprooting, coppicing, thinning, pruning, shrubby peeling, and damage to the temporary drying sheds, and it amounts, as nearly as may be, to eight pies (one penny sterling) for each pound of dry bark. The remainder of the working expenses (viz. Rs. 34,097-7-1) was spent on the cultivation of the Rungbee, Rishap, and Rungbee plantations, up-keep of roads and buildings, European establishment, head office charges, skilled labour (carpenters and blacksmiths), and on contingencies.

6. *Capital Account.*—In accordance with the wishes of Government, the mode of keeping the plantation accounts was recently recast by the Accountant-General, and they are now kept in the form suggested by that officer. One of the changes made is the opening of a capital account. The sum put to the debit of this account at 1st April 1875 is Rs. 3,50,000. To this has now to be added the expenditure on capital during the year. That expenditure amounts, as has been above shown, to Rs. 9,777-9-9. In their letter reviewing the plantation report for the year 1872-73, the Government of India expressed their desire to receive an estimate of the cost at which, with our present experience, a new cinchona plantation could be formed. This estimate was duly furnished, and in accordance with it all extensions which are being made on the slopes of the Sittong spur are being treated as forming a separate plantation, which is called the Sittong plantation. This is under the same European supervision as the older plantations, but separate accounts are kept of all expenditure on it. The sum spent on Sittong during the year, including a proportion of the cost of European

establishment, &c., was, as above shown, Rs. 3,134-14, and this forms the first charge against the Sittong capital account. It is accordingly not debitable to the capital of the old plantation, which includes only Rungbee, Rishap, and Mungpoo. The capital account of the latter, therefore, stands as follows :—

	Rs.	A.	P.
Capital at 1st April 1875	3,50,000	0	0
Expenditure during 1875-76	6,642	11	9
Quinologist's pay for 1875-76	10,000	0	0
Total Capital at 31st March 1876 ...	3,66,642	11	9

The Quinologist's pay has been added to capital, as the plantation not being yet in full working the charge can hardly be debited with fairness against the crop.

If interest be calculated at the rate of 4 per cent. on the above capital, an additional item of Rs. 14,664 will be added to the working expenses of the year.

7. *Cost of the bark produced.*—The bark taken during the year amounted, as has already been stated, to 211,931 pounds. From this there have, however, to be deducted 16,640 pounds which were accidentally destroyed by fire, leaving 195,291 pounds against which the working expenses of the year (Rs. 42,937-6-1) are chargeable. The cost of production, therefore, of each pound of dry bark was 3 annas 6·21 pies, being a fraction over three annas and a half, and as near as may be five pence half-penny sterling. If the charge for interest on capital (1 anna 2·23 pies) be added, these figures are raised to within a small fraction of four annas and nine pies, which is equal to seven pence and one-eighth sterling.

8. *Bark account.*—During the year 92,400 pounds of dry bark were made over to the Quinologist for conversion into cinchona febrifuge. The composition of this bark was as follows :—

	Pounds.
Dry Succirubra root-bark	4,800
,, stem-bark	42,800
,, branch-bark	44,800
Total ...	92,400

To the Presidency Medical Depôt 2,000 pounds were also supplied.

The remainder of the crop is stored at Mungpoo, and is being made over to the factory as required. It may be useful to put on record a complete statement of the bark yielded by the plantation since its commencement. The following table shows this at a glance :—

	Pounds.
Dry bark collected by pruning and thinning during 1869-70	2,400
Ditto ditto ditto 1870-71	12,600
Ditto ditto ditto 1871-72	39,000
Ditto ditto ditto 1872-73	Nil.
Ditto ditto ditto 1873-74	16,000
Ditto ditto ditto 1874-75	39,405
Crop of 1875-76	211,931
Total	321,236

	Pounds.	Pounds.
Supplied to Medical Depôt; sent to Her Majesty's Secretary of State, London; used in experiments; made over to Quinologist, &c., &c., prior to 1st April 1875	48,906	
Supplied to Medical Depôt, 1876-77 ...	2,000	
Made over to Quinologist, 1876-77	92,400	
Burnt accidentally ...	16,640	
		159,946
Balance in store, 31st March 1876		161,290

The total yield up to the end of the year has thus been 321,236 pounds of dry bark.

9. *Accidental burning of part of the crop.*—During the cold season a destructive fire occurred, by which a large shed, containing about 16,640 pounds of dry bark, was burnt to the ground. The fire appears to have originated through the carelessness of the man in charge of the shed. Certain changes were proposed by me in the arrangements to be followed in future in drying and storing bark, by adopting which similar accidents on such a large scale should be averted. Dry bark is, however, a substance which burns readily, and natives are proverbially careless about fire; there will, therefore, under any arrangements whatever, always remain a certain amount of risk of loss by fire.

10. *Present condition of the plantation.*—The cold season was characterised by a drought unparalleled in Sikkim since meteorological observations began to be recorded in the district. The excessive dryness made any planting during the cold season an impossibility; but beyond killing entirely a few trees in very rocky ground, and injuring the upper shoots of a good many others, it did but little harm to the plantation. Trees standing in some of the wetter nooks of land, so common on the older parts of the plantation, seem even to have been benefited by the lengthened absence of rain. The present condition of the plantation is on the whole encouraging. The younger parts which occupy the Mungpoo

ridge continues to be very luxuriant and healthy. A small part, however, of the lower Rishap plantation, which has for some years been rather sickly, still continues so; and as it does not seem probable that it will improve, I have decided to uproot it during next barking season. During the year no additions were made to the permanent plantations. This is chiefly attributable to the unusual drought of the cold weather. The nursery stock of red-barks on the old plantation has, however, been increased by 230,000, and 125,000 young plants have been provided for the new plantation at Sittong. These will be planted out, as far as possible, during the year 1876-77, and ought to add considerably to the area under trees. Of the yellow-bark tree (*C. calisaya*), 2,000 stock plants (kept under glass for purposes of propagation) have been added during the year. The seedlings of this species, of which 116,000 were returned last year, were not planted out, experience having shown that *calisaya* seed, however carefully it may have been collected from only the varieties yielding good bark, produces an uncertain and mongrel offspring. These 116,000 have therefore been written off. An addition of 25,000 has been made to the stock of young yellow-barks raised from cuttings. Of the new variety referred to in the former reports as a hybrid, no plants have been put out during the year, but the stock plants of it have been increased from 1,000 to 5,000. As seedlings of this sort show similar peculiarities to those of *calisaya*, the seedling stock of 15,000 returned last year was not planted out, and has been written off. *Cinchona pitayensis* is a species allied to *C. officinalis*, which was introduced on this plantation about five years ago. Sixteen plants of it were returned in last report. These all pined away during the year, and none are now left. Regarding the other species in cultivation, I may remark that *officinalis* was long ago discovered to be unsuited to the climate of Sikhim. Of this species, 125,000 appear in the returns, but before another year passes the majority of these will be cut down. The numbers returned of *C. micrantha* and *C. pahudiana* are respectively 50,000 and 5,092, and are the same as last year. Both species yield bark which is comparatively worthless, and no effort has for some years been made to multiply either.

11. *Manuring.*—The results of the application of manure to cinchonas, as noted in my last annual report, were not encouraging. I agree, however, with Mr. Wood in thinking it desirable to make a further trial of manuring, and I have accordingly asked Mr. Gammie to do this as soon as practicable. The manured plants reported on last year are now undistinguishable in appearance from their neighbours. It should not be forgotten that all the cinchonas in the plantation are to a certain extent regularly manured, for the weeds cut and uprooted in cleaning the plantation are laid in rows between the trees and the vegetable manure yielded by the decay of these is very considerable.

12. *Survey of the Plantation.*—In accordance with the wishes of the Government, the whole plantation was surveyed and mapped last year by an officer of the Revenue Survey Department. Owing, however, to certain official changes which caused, I understand, the breaking up of the party to which this officer belonged, I have, I regret to say, not yet been able to get a copy of the map. The plantation has now arrived at a point in its history when it must begin to be worked on some systematic plan, with reference to the amount of bark to be annually taken from it, and it is high time that an accurate map of it were available. The boundaries of each year's planting should be shown on such a map as well as on the ground. I have impressed on Mr. Gammie the desirability of having as soon as possible, substantial marks put in the ground which may clearly indicate the limits of the planting of each year.

13. *Distribution of seed.*—During the year twenty-one ounces of seed were given away to two applicants. This shows a great falling off from the former year, when no less than three hundred and fifty-eight ounces were distributed.

14. *Land rent.*—The sum of Rs. 1,601-12-10, received for land rent and grazing dues from settlers on parts of the reserve unsuitable for cinchona, was paid into the Darjeeling treasury.

15. *Estimated crop of* 1876-77.—In his report for last year, the Government Quinologist, Mr. C. H. Wood, estimated the yield of the Rangbee, Rishap, and Mungpoo plantations, when in full working, at 366,000 pounds of dry bark per annum. These figures were arrived at as the result of Mr. Wood's own calculations, and were accepted by Government. My calculations lead me to believe that this amount of bark can, advantageously to the plantation, be taken during the year 1876-77, and I beg therefore to submit 366,000 pounds of dry bark as my estimate for the crop of the year now entered upon. Unless, however, arrangements are made for working the alkaloid factory on a larger scale than at present, I would hesitate to advise the whole of this amount being taken, as there would be a difficulty about storing such a bulky crop. I feel convinced, however, that in justice to the plantation this amount should be taken. If taken, I estimate that (including interest on capital, working expenses, and Quinologist's salary,) it can be turned out at about the price estimated by Mr. Wood in his report already referred to, viz. three and a half annas, or five pence farthing per pound. Production of the raw material to this amount and at this price would enable Mr. Wood to supply during the year the "cinchona febrifuge"—as he has named his preparation of the mixed red-bark alkaloids—in a quantity vastly exceeding the total Government importations of quinine and the other cinchona alkaloids for the whole of India for the year 1875, and at a cost of less than one rupee per ounce.

16. *General considerations.*—With regard to the "cinchona febrifuge" issued by the Quinologist, I may observe that, in most ordinary cases of malarious fever, it appears to be an efficient remedy. Powerful testimony to this effect is borne by the four physicians in and near Calcutta, to whom, about eighteen months ago, a quantity was given for trial and report. Coolies on the plantation often get fever by attending markets in the Terai, and they are invariably cured by a dose or two of this mixed alkaloid. In the neighbourhood of the Botanical Garden at Calcutta fever of a bad type is very prevalent, and I have given the cinchona febrifuge to garden coolies and to villagers living near the garden, in the same doses as quinine, and with as unvarying good effect. It is probable that for very severe and critical cases of malarious fever, especially amongst Europeans, sulphate of quinine will long remain in the estimation of the medical profession the best remedy; but everyone who has had much experience of India knows that bad cases of fever are more the exception than the rule, and that there is a simply incalculable amount of fever prevalent amongst the natives of the country which rarely takes the form of a violent or fatal attack, but which expends itself in a succession of attacks, each sufficient to incapacitate the sufferer from work for a time, and a repetition of which too often ultimately induces malarious cachexia and disease of the spleen. There appears to be ample medical evidence for believing that, for malarious fever of this ordinary type, the "cinchona febrifuge" is a most efficient remedy. Everybody who knows much of rural life in this country must also be aware that at present the great majority of such attacks of fever receive no medical treatment whatever, or at least none of an efficient kind, and for the simple reason that no febrifuge is accessible to the sufferers. Quinine is a costly drug, quite beyond the means of a large proportion of the population. Moreover, it is not to be had except at dispensaries and in large bazars in neighbourhoods where Europeans happen to be settled. It is no exaggeration whatever to say that, to three-fourths of the population of India, quinine is simply *unobtainable even by purchase*. Its high price leads, moreover, to its extensive adulteration, and there is too good reason for believing that much of the substance sold in the bazars as quinine consists partly, and some of it entirely, of other preparations. A febrifuge even less efficient than the cinchona febrifuge would, if accessible to the vast fever-stricken population (and accessibility depends on cheapness), be an immense boon. It appears to be, therefore, a matter for congratulation that Government is now in possession of the means of throwing into the country next year several tons of an efficient febrifuge, and of year by year increasing the supply, and that too at an annually diminishing cost price per ounce.

17. A Manual of Cinchona Cultivation in India, which I prepared at the request of the Government of India, has been printed and published since my last annual report.

18. In conclusion, my acknowledgments are due to Messrs. Gammie, Biermann, Parsons, and Jeffray for their services during the year.

19. The usual tabular returns are annexed.

Table showing the growth of Cinchonas in the Darjeeling Plantations during the six months ending 1st April 1876.

Names.	Number.	Date of planting.	Height in inches, 1st January 1876.	3rd Plantation, 4,000 feet. Height, 1st Oct. 1875.	Height, 1st April 1876.	Growth during 6 months.	Date of planting.	Height in inches at first planting.	4th Plantation, 5,500 feet. Height, 1st Oct. 1875.	Height, 1st April 1876.	Growth during six months.	Date of planting.	Height in inches at first planting.	5th Plantation, 5,000 feet. Height, 1st Oct. 1875.	Height, 1st April 1876.	Growth during 6 months.
C. Succirubra	1	30th March	29	30	36	6	26th July	6	361	393	12½	15th Oct.	...	306	306	...
Ditto	2	30th	30	808	809	1	26th	6	670	674	0	15th	4	194	224	14
Ditto	3	30th	28	300	300	...	26th	6	295	295	0	20th July	4	230	242	12
Ditto	4	30th	24	304	314	10	15th Oct.	10½	260	260	0	20th	4	237	247	10
Ditto	5	30th	37	50	43	7	26th July	12	318	318	...	26th	5½	253	302	14
Ditto	6	30th	30	318	326	8	26th	6	340	354	14	20th	5	216	231	15
Ditto	7	30th	17	295	299	4	26th	6	412	412	0	20th	4	404	420	16
Ditto	8	30th	30	291	291	...	26th	6	275	285	10	20th	4½	278	276	7
Ditto	9	30th	30	304	304	...	26th	6	278	278	0	20th	4	210	210	...
Ditto	10	30th	32	305	305	...	26th	6	295	295	0	20th	4	274	274	...
C. Micrantha	1	16th	17	250	250	...	15th Oct.	6	155	155	...	20th	4	158	158	...
Ditto	2	16th	14	250	250	...	26th July	24	145	145	...	20th	4	167	167	...
Ditto	3	16th	14	240	240	...	26th	24	154	154	...	15th Oct.	3	156	162	6
Ditto	4	16th	14	240	240	...	26th	24	150	150	...	20th July	4	246	246	...
Ditto	5	16th	14	320	320	...	15th Oct.	24	320	324	4	15th Oct.	6	324	324	...
C. Calisaya	1	30th June	25	300	300	...	30th June 1875.	*1875	170	170	...	15th June 1876.	7	181	181	...
Ditto	2	30th	16	300	300	...	26th	31	170	170	...	15th	8	200	200	15
Ditto	3	30th	16	240	240	0	26th	171	137	137	...	15th	8	240	250	10
Ditto	4	30th	16	288	288	0	26th	16	234	240	6	15th	8	181	187	7
Ditto	5	30th	24	274	280	6	26th	11	240	240	0	15th	8	240	245	5
Ditto	6	30th	24	300	300	...	26th	103	169	174	5	15th	8	189	189	...
Ditto	7	30th	24	264	264	0	26th	103	272	272	.....	15th	8	230	240	...
Ditto	8	30th	18	254	254	0	26th	24	150	150	.....	15th	8	230	230	11
Ditto	9	30th	24	258	270	12	26th	24	170	170	.....	15th	7	231	231	...
Ditto	10	30th	24	300	312	12	26th	16	301	311	10	15th	8	140	140	...

MUNGPOO DIVISION.

Table showing the number and distribution of Cinchona Plants in the Government Plantations near Darjeeling on the 1st April 1876.

NAMES OF SPECIES OF CINCHONA.	Number in permanent plantation.	Number of stock plants for propagation.	Number of seedlings or rooted cuttings in nursery beds for permanent plantations.	Number of rooted plants in cutting beds.	Number of cuttings made during the month.	Total number of plants, cuttings, and seedlings.
C. Ledgeriana	21,660	5,650	.....	8,000	.....	30,660
C. Succirubra	2,990,060	.....	325,000	200,000	.....	3,515,060
C. Calisaya	854,580	2,000	.....	100,000	.....	956,580
C. Micrantha	50,680	.....	.....	.....	.....	50,680
C. Officinalis and varieties	125,000	.....	.....	.....	.....	125,000
C. Pahudiana	3,692	.....	.....	.....	.....	3,692
Total	3,945,322	7,650	325,000	308,000	.....	4,631,592

SITTONG DIVISION.

Table showing the number and distribution of Cinchona Plants in the Government Plantations near Darjeeling on the 1st *April* 1876.

NAMES OF SPECIES OF CINCHONA.	Number in permanent plantation.	Number of stock plants for propagation.	Number of seedlings or rooted cuttings in nursery beds for permanent plantations.	Number of rooted plants in cutting beds.	Number of cuttings made during the month.	Total number of plants, cuttings, and seedlings.
C. Succirubra	.....	.....	75,000	50,000	.....	125,000
C. Calisaya	.....	.....	.....	.....	.....	.....
C. Micrantha	.....	.....	.....	.....	.....	.....
C. Officinalis and varieties	.....	.....	.....	.....	.....	.....
C. Pahudiana	.....	.....	.....	.....	.....	.....
Total	.....	.....	75,000	50,000	.....	125,000

BARK CROP OF 1875-76.*

		Quill-bark.	Stem-bark.	Branch-bark.	Total.
		Pounds.	Pounds.	Pounds.	Pounds.
1	Got by thinning and pruning the plantns of 1867 at Rungbee ...	.....	6,017·25	14,588·81	20,606·8
2	Ditto ditto of 1868 at Rungo ...	.....	16,908·65	57,165·77	74,074·4
3	Ditto ditto of 1870 at Mungpoo, including five acres severely thinned ...	4,303·47	3,013·13	3,225·25	17,593·25
4	Got by original sixth crop at Rungbee	.....	6,800·00	3,781·00	10,181·0
5	Do. spreading 25 acres at Kaylan	61,471·42	19,677·48	21,870·00	83,027·70
6	Do. thirty acres of 35-year old trees at Mungpoo ...	1,153·43	1,365·89	1,666·10	4,085·42
7	Do. completely removing three acres of 35-year old trees at Mungpoo	.....	1,659·07	1,514·05	3,173·72
8	Do. severely thinning five acres of 35-year old trees at Mungpoo, results included under No. 3	.....	.....	.....	.....
	Total ...	66,928·05	57,339·43	107,809·98	317,097·81

* The figures in this return represent dry red bark in pounds avoirdupois.

W. H. [illegible]—Esqr. No. 358—500—2-11-76.

QUINOLOGIST'S REPORT FOR 1875-76.

During the past year the work in the Quinologist's Department has been chiefly confined to the production of febrifuge upon an extended scale. The total quantity of mixed alkaloid that has been produced from the commencement of the manufacture to the end of March 1876 is 1,989 pounds; only 49 pounds, however, had been issued before September 1875, consequently 1,940 pounds have been sent out during the last seven months.

Altogether 107,130 pounds of bark have been used in the factory, consequently the average yield of febrifuge hitherto has been rather under two per cent. This amount, however, includes all the bark consumed in experiment; it also includes much that was of very poor quality. More than one-half was branch bark from the worst portion of the plantation, and containing but a small proportion of alkaloid. All the old store of bark has been now exhausted, and future working will doubtless show a larger yield.

The following statement gives the actual manufacturing expenses up to date:—

	Rs.	A.	P.
Muriatic acid, 8,137 pounds	1,792	3	9
Bottles and packages for ditto	884	10	0
Sulphuric acid, 504 pounds	63	0	0
Bottles and packages for ditto	39	6	0
Carriage of acids from Calcutta	1,310	4	0
Caustic soda, 8,984 pounds	1,110	0	0
Carriage from Calcutta	524	10	0
Charcoal, 510 maunds	211	14	0
Sundries	106	5	6
Factory labour	880	0	0
Bark, 107,130 pounds at 3½ annas per pound ...	23,434	11	0
Total ...	30,355	0	3
Febrifuge produced, 1,989 pounds at Rs. 16 per pound...	31,824	0	0

It will be seen that the foregoing only comprises current expenditure; it does not include the cost of erecting the sheds and purchasing the barrels, &c. The amount thus expended on manufacturing plant is under Rs. 1,500. It does not include the cost of the Calcutta experiments, or the charges for the analytical laboratory. These sums should be massed together to form a capital account, interest upon which should be a charge against manufacture in future years. Moreover no charge has been yet made on the manufacture for the Quinologist's salary. During the greater part of the last year the Quinologist has been chiefly employed in another appointment, and previous to this the factory was a very small one, intended simply to test the practicability of the process. Up to date the Quinologist would be a fair charge against capital, his work having been to devise and start the process. It is only within the last two or three months that the manufacture has reached proportions which would bear the full charge for supervision.

During the next year (1876-77) it is intended to work 240,000 pounds of bark, and on this scale the entire charge for the Quinologist can be borne. But even this will be only two-thirds of the estimated producing power of the plantations; as soon as the full scale of 360,000 pounds of bark per annum is attained, the manufacture of febrifuge at a rupee an ounce, even by this present process, will pay all expenses of plantation and factory, with interest on the whole capital; and it is to be considered that the present process is not the one which professes to make the most economical use of the bark. It has been adopted as a temporary measure to save the cost of erecting a permanent factory.

The following is the estimate for manufacture during the year 1876-77:—

Estimated expenditure—

	Rs.	A.	P.
Acid, 15,600 pounds at 8 annas per pound (including carriage to plantations) ...	7,800	0	0
Soda, 15,600 pounds at 3½ annas per pound (including cost in England, sea and land carriage to plantations) ...	3,412	8	0
Charcoal, 416 maunds at 7 annas per maund ...	182	0	0
Factory labour, Rs. 120 per month ...	1,560	0	0
Quinologist	10,000	0	0
Native Assistant for laboratory	480	0	0
Servants for laboratory	480	0	0
Bark, 240,000 pounds at 3½ annas per pound	52,500	0	0
Total ...	76,414	8	0

Estimated produce—

Febrifuge, 4,800 pounds at Rs. 16 per pound ...	76,800	0	0

It will be seen therefore that the febrifuge produced will fully equal in value the total grant for cinchona for the year. Unfortunately, however, the estimate will be seriously affected by the delay in the arrival of soda from England, and some increased expenditure or reduction in the scale of work may result on this account.

The following statement shows how the febrifuge produced up to date has been disposed of:—

	£ lbs.	oz.
To Medical Store Department	1,607	14
To India Office, London	9	3
To Dr. King, Botanical Gardens	6	8
In store at factory	365	6
Total ...	1,989	0

A description of the present manufacturing process is appended to this report.

C. H. Wood,

Government Quinologist.

Rev-4835/78

C. E. O.—Reg. No. 3286—2-11-79.

Description of the process at present used for Manufacturing "Cinchona Febrifuge" at the Sikkim Plantations.

BY C. H. WOOD, GOVERNMENT QUINOLOGIST.

General object of the process.—The present method of treating cinchona bark was adopted as a temporary measure to afford the means of ascertaining the medicinal value of the proposed febrifuge. It was considered undesirable to incur any expenditure for factory buildings, machinery, or skilled labour, until the efficacy of the product as a remedial agent had been thoroughly determined by extensive trials. Consequently, it was necessary to so arrange the process that it could be conducted for some time on a considerable scale, and involve no other appliances than such as were already at hand.

General nature of the process.—The dry bark is crushed into small pieces (but not powdered) and is put into wooden casks, where it is macerated in the cold with very dilute hydrochloric acid. The liquor is then run off into wooden vessels and mixed with an excess of a strong solution of caustic soda; a precipitate forms, which is collected on calico filters, and well washed with water. The precipitate is then dried at a gentle heat and powdered. It constitutes the crude febrifuge, which is next submitted to a process of purification. In the latter process a certain weight of the crude product is dissolved in dilute sulphuric acid, and a small quantity of a solution of sulphur in caustic soda is added to the liquor. After the lapse of 24 hours the liquor is carefully filtered. The filtrate is mixed with caustic soda, and the resulting precipitate collected on calico, washed with a small quantity of water, dried and powdered; it is then ready for issue, and is sent out under the name of "Cinchona febrifuge."

Arrangement of the factory sheds.—A position was chosen conveniently near the dry bark godowns, and so situated on the side of the hill, that a copious supply of water could be obtained at a level with the roof of the sheds in which the maceration is conducted.

These sheds are rough temporary erections, constructed with saplings and a mat or thatch roof. Down the centre an open drain is cut to carry off the waste liquor. Over this drain some wooden stands are placed, on which the calico filters rest. The filters are formed by tying a square piece of calico to a wooden frame by the four corners. On each side of the shed is placed a row of 21 casks, standing on end upon a stand which elevates them about 2 feet from the ground. They are empty beer barrels, which have been purchased from the Commissariat Department at Darjeeling, the head removed, and the cask thoroughly cleansed; a hole is cut in the side of the cask at a level with the bottom, and closed with a cork. In front of the casks a row of tubs, formed by cutting beer barrels in halves, is placed, so that on uncorking the barrels the liquor will run out into the tubs.

Outside the shed, at one end, are a couple of large wooden vats at such an elevation that liquid can flow from them along a bamboo trough into any one of the barrels in the shed. The capacity of the vats, up to a mark on the inside near the top, is accurately determined. Water is run into the vat up to the mark, and a certain quantity of muriatic acid is added, and the whole well mixed. This diluted acid can then be run into any one of the casks in a line with the vat by means of a bamboo trough. In addition to the macerating sheds, there is a small brick building, heated with charcoal, in which the precipitate is dried; also a separate shed in which the process of purification is conducted.

Method of conducting the process.—The casks are worked in sets of three, and are marked A. B. C.

In each shed there are 14 sets; seven on each side. Each cask receives one maund of dry bark, which undergoes four successive macerations, the liquor being moved in rotation through the 3 casks. Each maceration lasts half a week. The liquid used for the fourth and last maceration is acidulated water drawn from the vat. When this is run off, it is moved into the next cask to form the third liquor. When this is drawn off, it forms the second liquor for another cask, and, when transferred from that, it goes on to new bark, from which it is drawn off and precipitated. The following table will show the manner in which this rotation is effected. Of course in starting a new shed every cask contains dry bark, consequently the system of rotation is not brought into full operation until after the first fortnight; and it is only after the shed has been in operation for 3½ weeks (June 7 in table) that the liquor for precipitation has been used for four macerations. The table is drawn for a new shed; after June 7th, it is in regular order.

The liquor that is for precipitation is run into the tubs. The other liquors are drawn into wooden buckets and poured into the proper casks. The new acid is then drawn from the vats. The diluted acid is made in the vat by adding 1 gallon of muriatic acid to every 100 gallons of water (10 fluid-ounces to each cubic foot).

If three sheds are employed, No. 1 is worked on Mondays and Thursdays, No. 2 on Tuesdays and Fridays, and No. 3 on Wednesdays and Saturdays. It will be seen by the table that each set of three casks exhausts one maund of dry bark per week. Three sheds therefore, containing 42 casks each, would exhaust 42 maunds of bark every week.

The weight of acid used in the exhaustion is 6½ per cent. of the weight of dry bark. It is obtained from Mr. Waldie's chemical works, at a cost of 8½ annas per pound in Calcutta.

To precipitate the saturated liquor, a solution of caustic soda is added in excess. The caustic soda is obtained from England in 6-cwt. drums, costing from £15 to £20 per ton in London. One part of this is dissolved in 3 parts of water, and the solution stored in iron vessels. The quantity to be added to the bark liquor must be judged of by the appearance produced. When a sufficient quantity has been introduced, the precipitate assumes a somewhat curdy condition.

About 6½ pounds of solid soda are used for every 100 pounds of dry bark.

The filtration is not commenced until the following day, when the liquor is transferred to the calico strainers which have been well wetted. The first portions that run through are returned until the liquid passes of a bright ruby colour; it is then allowed to flow away by the drain. After all the liquor has drained off, water is passed through the precipitate until it ceases to acquire a red tint. The alkaloids on the filter should then be of a uniform cream color. The precipitate is now dried and reduced to a fine powder, which is stored in suitable bins. It constitutes the crude febrifuge.

The process of purification.—The precipitate during the act of drying acquires a slightly reddish-brown colour. It is therefore submitted to a process of purification. Fourteen gallons of water are mixed with two pints of sulphuric acid, and twenty pounds of the dry powder are introduced. The alkaloids dissolve, and a quantity of colouring matter remains insoluble. About half a pint of a solution of sulphur in caustic soda is now stirred in, and the whole allowed to stand for twenty-four hours. It is then filtered through calico into a clean vessel, care being taken to get the liquor perfectly bright. About 6 gallons of water are used to wash the sediment left on the filters. The clear filtrate is thoroughly mixed with solution of soda to precipitate the alkaloids; the precipitate is collected on calico, washed with a small quantity of water, drained, dried, and reduced to fine powder; it is then ready for issue.

Wooden tubs are used for this process, but they are not so well suited for the purpose as enamelled iron or earthenware. The purification is conducted in a separate shed by a man who is continued to that work.

The labour employed.—The only workmen employed in the factory are Nepalese coolies. When the process is once brought into full operation, it is found that these men readily master every detail, and conduct the whole thing with all the care and accuracy that is required. But of course the factory is under the supervision of Mr. Gammie, the officer in charge of the plantations, who visits it once a day, and sees that the work is being properly performed.

The bark used.—Dry succirubra bark only is employed. Moreover care is taken to mix the root, stem, and branch bark together in as nearly as possible the proportions in which they are yielded by the plantations. This mixture is broken into small pieces, and a maund of it goes into each cask. This is done to insure uniformity of composition in the product. Green bark is never operated on. It will be seen that the arrangement of the process requires that a certain weight of bark should be put into the casks every week throughout the year. This could not be done with green bark, because bark is only taken from the trees twice per annum. Apart from this, however, it has been found that dry bark yields a much better product, and quite as large a quantity. The small cost of drying the bark is more than counterbalanced by the advantages gained.

Temporary object of the process.—It must be remembered that this method has only been adopted to furnish a large supply of febrifuge for trial; it does not profess to make the most economical use possible of the bark. The factory is estimated to turn out during the present financial year 4,800 pounds of febrifuge, which, at a rupee an ounce, will pay the whole cost of the plantations and manufacture for the year. If the product proves to be of permanent value as a remedial agent, it is probable that the process will be considerably modified to produce greater economy, but involving the use of permanent buildings and machinery.

SHED No. 1.

Casks marked A. B. C.

Thursday, May 13th ...	Put dilute acid in A.		1st liquor for A. (New bark is in A.)
Monday, „ 17th ...	Run liquor from A. and precipitate.		
	Put dilute acid in A.		2nd liquor for A.
Thursday, „ 20th ...	Move liquor from A. to B.		1st liquor for B. (New bark is in B.)
	Put dilute acid in A.		3rd for A.
Monday, „ 24th ...	Run liquor off B. and precipitate.		
	Move liquor from A. to B.		2nd liquor for B.
	Put dilute acid on A.		4th for A.
Thursday, „ 27th ...	Move liquor from B. to C.		1st liquor for C. (New bark is in C.)
	Move liquor from A. to B.		3rd for B.
	Clean out A.		
Monday, „ 31st ...	Run liquor off C. and precipitate.		
	Move liquor from B. to C.		2nd liquor for C.
	Put dilute acid on B.		4th for B.
Thursday, June 3rd ...	Move liquor from C. to A.		1st liquor for A. (New bark is in A.)
	Move liquor from B. to C.		3rd for C.
	Clean out B.		
Monday, „ 7th ...	Run liquor off A. and precipitate.		
	Move liquor from C. to A.		2nd liquor for A.
	Put dilute acid on C.		4th for C.
Thursday, „ 10th ...	Move liquor from A. to B.		1st liquor for B. (New bark is in B.)
	Move liquor from C. to A.		3rd for A.
	Clean out C.		
Monday, „ 14th ...	Run liquor off B. and precipitate.		
	Move liquor from A. to B.		2nd liquor for B.
	Put dilute acid on A.		4th for A.
Thursday, „ 17th ...	Move liquor from B. to C.		1st liquor for C. (New bark is in C.)
	Move liquor from A. to B.		3rd for B.
	Clean out A.		
Monday, „ 21st ...	Run liquor off C. and precipitate.		
	Move liquor from B. to C.		2nd liquor for C.
	Put dilute acid on B.		4th for B.
Thursday, „ 24th ...	Move liquor from C. to A.		1st liquor for A. (New bark is in A.)
	Move liquor from B. to C.		3rd for C.
	Clean out B.		

C. E. O.—Reg. No. 4868—3.11.76.

No. 120., dated Rungbee, the 12th September 1876.

From—Dr. GEORGE KING, M.B., Supdt. Royal Botanical Garden, Calcutta, and in charge of the Cinchona cultivation in Bengal,

To—The Acting Assistant Secretary to the Government of Bengal.

I HAVE the honor to acknowledge your letter marginally noted, forwarding copy of the annual report of Mr. Wood, the Government Quinologist, and calling for any remarks thereon which I may wish to make.

No. 2835, Financial Department (Agriculture), dated 1st September 1876.

2. I would now therefore submit a few comments, not by way of criticising Mr. Wood's report, but of explaining a few points in which his report as Quinologist, and my own report as Superintendent of the Plantation, might seem to be at variance.

3. I would observe—

(1)—That in paragraph 3 of his report Mr. Wood takes the cost price of the 107,130lb of bark supplied to him at 3½ annas per pound, giving a total of Rs. 23,434-11. Now 3½ annas is the prime cost of the bark as calculated in my annual report if no charge for interest on capital be made; but I understand interest on capital is to be charged at the rate of 4 per cent. per annum. With interest at that rate the cost of the bark is raised to 4 annas and 9 pies per pound, and the 107,130lb supplied to Mr. Wood represent Rs. 31,804 instead of Rs. 23,434—a difference of Rs. 8,370, which raises the prime cost of the alkaloid from Rs. 16, as estimated by Mr. Wood, to about Rs. 20-8 per pound. Three and a half annas per pound is the estimated prime cost, including interest of the bark when the plantation shall be in full working, *i. e.* when it shall be turning out 366,000lb of dry bark annually. The plantation yielded only 213,000lb of bark during the year under review, and was far from being in full working. I think it would therefore be quite justifiable to let 3½ annas stand as the price of the bark made over to Mr. Wood, and to charge the interest (Rs. 8,370) to capital account. During the current year 1876-77 the plantation should, as estimated in my annual report recently submitted, reach full working power, and should turn out 366,000lb. of dry bark, which, including the Quinologist's pay and interest on capital, will I estimate cost 3½ annas per pound. This leads me to observe—

(2)—That in the 5th paragraph of his report Mr. Wood puts down only 240,000 lb as the outturn for the present year, and frames his estimate accordingly. His estimate should, I think, be increased so as to provide for the working of all the estimated crop.

(3)—With regard to Mr. Wood's estimate as it stands in paragraph 6 of his report, I would observe that while accurate as showing the real prime cost of the alkaloid, it is obviously not intended for the Accountant-General as a budget estimate, as it includes an item for soda supplied by the Secretary of State. It also includes Quinologist's pay (Rs. 10,000)—an item which, if 366,000lb of bark be taken, would be included in the sum of 3½ annas, which in my annual report I have put down as the prime cost of the bark.

J. A. P.—Reg. No. 8287—3-11-76.

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Rec. 1876. Dept
No 42835

From
The Offg Secy of the
Ext of Interior
No 3425

Dated 30 Oct } 1876
Read 11th Nov }

3m 4.

Encs, for information,
in continuation of previous correspondence, copy of
a Resolution in regard to the working of the
Gold Carolina Plantation in Virginia dated 1875.

No 1915
Order

Communication called for by the
Senate of Resolution
of the Convention of Gold
Carolina Plantation &
the Secretary of the Interior
the Register, &c
the Receiver, Fayetteville
Nov 11th 76
Nov 18th 76