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CALCUTTA, THE 3RD SEPTEMBER 1889.

IS SEP 89
REV. DEPT.

FROM H. J. S. COTTON, ESQ.,

Offg. Secretary to the Government of Bengal,

TO THE SECRETARY TO THE GOVERNMENT OF MADRAS.

SIR,

I AM directed to forward, for the information of the Government of Madras, a copy of the Report on the working of the Government Cinchona Plantations and Factory in Bengal during 1888-89, together with a copy of the Resolution recorded by the Lieutenant-Governor thereon.

I have the honour to be,

SIR,

Your most obedient servant,

H. J. S. Cotton

Offg. Secretary to the Government of Bengal.

W. LeB.—Reg. No. 3888C—22—4-9-89.

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ANNUAL REPORT ON THE GOVERNMENT CINCHONA PLANTATION AND FACTORY IN BENGAL FOR THE YEAR 1888-89.

No. 560, dated Royal Botanic Garden, Seebpore, near Calcutta, the 13th July 1889.

From—GEORGE KING, ESQ., M.B., Superintendent, Royal Botanic Garden, Calcutta, and of Cinchona Cultivation in Bengal, and Officiating Government Quinologist.

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

I HAVE the honour to submit herewith the report of the Cinchona Plantations and Factory for the year 1888-89.

Twenty-seventh Annual Report of the Government Cinchona Plantation and Factory in British Sikkim, being that for the year 1888-89, *by* BRIGADE SURGEON G. KING, M.B., LL.D., F.R.S., *Superintendent of the Royal Botanic Garden, Calcutta, and of Cinchona Cultivation in Bengal, and Officiating Government Quinologist.*

1. The valley in which the plantation is situated participated in the dryness which was so general over the province during the earlier part of the season. But the effects of the unusual drought were but trivial, compared with the mischief caused by a violent hail-storm which occurred towards the end of the official year. By this storm many thousands of young plants in the nurseries were utterly destroyed. These plants had just been uncovered, in order that they might be hardened off prior to transplantation, and they were therefore little fitted to withstand a hail-storm of such extraordinary violence. Even the larger trees in the plantation by no means escaped. Their leaves were torn to shreds, and they will retain for some time the scars left on their smaller branchlets by the hail-storms.

2. *Changes in the Plantation.*—During the year, 395,003 trees either died or were uprooted for the sake of their bark. On the other hand, 353,730 trees were planted out. The renewals were thus slightly more numerous than the losses; but as the newly-planted trees are all yellow barks which yield only quinine, whereas those uprooted were red barks, yielding a mixture of quinine with cinchonidine and cinchonine, the alkaloidal value of the plantation has been very considerably increased. As will be seen by the table given as appendix D, the plantations now contain a total of 4,810,231 cinchona trees, of which nearly two-thirds are yielders of pure quinine. Seven years ago the proportion of pure quinine-yielders was but as one to four. The conversion of the plantation has therefore gone on pretty rapidly.

3. *The year's crop.*—The crop harvested during the year was the largest we have ever taken. It consisted of 207,460 pounds of red bark, 128,770 pounds of *ledgeriana*, and 36,870 pounds of other sorts, giving a total of 373,100 pounds. Of this total, 293,750 pounds were taken from the old plantation, 67,740 pounds from the younger one at Sittong, and 11,610 pounds from the youngest of all the Rungjung plantation in Bhootan. If the crop of the past year be added to those of previous years, the grand total of yield of these plantations since their beginning is brought up to 4,351,478 pounds of dry bark. During the year, 1,867 pounds were supplied on indent, or sold to Government institutions, the rest of the crop being made over to the factory as usual.

4. *Expenditure on the plantation for the year.*—The budget allotment for the year originally amounted to Rs. 84,975; but, as the year advanced, it was found necessary to transfer Rs. 11,000 from this allotment to that of the factory. Of the reduced allotment, only Rs. 72,549-5-6 were spent, so there was thus a saving of Rs. 1,425-10-6. The items of expenditure were as follows:—

	Rs.	A.	P.
European establishment (including all salaries, except that of Dr. King), cooly labour, and office establishment	67,039	3	9
Contingencies	4,419	12	9
Stores from England	688	13	0
Travelling allowance	401	8	0

*

Against this there was harvested a bark crop of 373,100 pounds of dry bark, the cost per pound of which was therefore, as near as may be, 3 annas 1·333 pies per pound.

5. *Factory.*—For the factory the sum of Rs. 30,025 was the budget allotment for the year; but, as stated in the last paragraph, it was found necessary to ask for a transfer of the sum of Rs. 11,000 from the plantation. The actual allotment thus stood at Rs. 41,025; but of this only Rs. 37,304-15-6 were spent, a saving being effected of Rs. 3,720-0-6. The factory expenditure was swelled to this unusually large sum by the cost of providing the stock of fusel and kerosine oils required for working the new process for manufacturing quinine. A considerable expenditure was also incurred in new machinery for the same process. A further sum on account of machinery will, moreover, fall to be debited during the year we have now entered on. All the charges hitherto incurred for factory buildings, plant, and machinery have regularly been debited to working expenses, and I propose to debit all future charges to the same head. The factory has no capital account, as some critics of its expenditure seem to suppose, every charge having been regularly debited against the outturn of manufactured product. The outturn for the past year was 8,575 pounds, in the proportions of 2,191 pounds of sulphate of quinine and 6,384 pounds of cinchona febrifuge. If the price of the raw material be added to the factory expenditure, the total cost of the outturn is seen to be as follows:—

	Rs.	A.	P.
Factory expenditure on chemicals, labour, and machinery	37,304	15	6
Raw material, viz. 162,940 pounds of bark crop of 1887-88, at 4 annas 2·713 pies per pound	43,037	6	0
145,420 pounds of bark crop of 1888-89, at 3 annas 1,333 pies per pound ...	28,277	12	10
	1,08,620	2	4

In other words, the outturn cost, as near as may be, Rs. 12-10-8·08 per pound. As a matter of convenience, I have taken the cost of febrifuge and quinine as the same; for in the present transition stage of the factory it is difficult to disentangle the expenditure in labour and salaries, which has been incurred respectively on the manufacture of the two products.

6. *The new oil process for manufacturing quinine.*—This process has been in use for the manufacture of sulphate of quinine during the year, and no less than 2,191 pounds of that drug have been prepared by it. Arrangements have also been made for its application during the current year to the manufacture of cinchona febrifuge. Up to the year under review, the new process can scarcely be said to have been used on a manufacturing scale. But the production of 2,191 pounds is sufficiently large to entitle it to be fairly considered as a manufacturing experiment. This enlarged experience of the working of the process only increases our confidence in it. It works without a single hitch; the bark is entirely exhausted of the whole of its alkaloid; and the quinine produced is professionally reported to be as pure in quality, and as satisfactory in appearance as quinine of the best European brands. A brief account of cold oil process was submitted by me to Government in March 1888, together with a short history of its invention. The history then submitted was, however, by an unfortunate inadvertence, inaccurate in some respects; and sufficient credit was not allowed for his share in its conception and perfection to Mr. C. H. Wood, who for many years was Quinologist on the plantation. Mr. Wood has now prepared a short history of the invention, and a full account of the method of working the process. And this important and interesting paper I now enclose as appendix A of this report. I again take an opportunity of bearing my testimony, not only to the excellence and simplicity of this admirable process, but also to the generous way in which Mr. Wood, without any pecuniary reward, initiated and invented in his private laboratory, while Mr. Gammie perfected it in the Government Factory. Without Mr. Wood the process would not have been invented, while without Mr. Gammie it would not have been successfully applied to manufacture.

7. *Sales of febrifuge and quinine during the year.*—The total issues for the year were 6,178 pounds of febrifuge, 28¼ pounds of crystalline febrifuge and 1,283 pounds of quinine. The details are shown in the following table:—

Details of the distribution of Cinchona Febrifuge, Crystalline Febrifuge, and Sulphate of Quinine, during the financial year 1888-89.

	lbs.	oz.
To Medical Depôt, Calcutta—		
Cinchona febrifuge	1,340	0
Sulphate of quinine	800	0
To Medical Depôt, Bombay—		
Cinchona febrifuge	1,250	0
To Medical Depôt, Madras—		
Cinchona febrifuge	900	0
Sulphate of quinine	400	0
To Inspector-General of Civil Hospitals, Bengal (for district medical officers of Bengal)—		
Cinchona febrifuge	420	0
Crystalline ,, ...	5	0
To Inspector-General of Jails, Bengal (for jails and lock-ups in Bengal)—		
Cinchona febrifuge	114	12
Crystalline ,, ...	7	0
Sold to Government officers and to the general public—		
Cinchona febrifuge	2,153	0
Crystalline ,, ...	16	4
Sold to Government officers—		
Sulphate of quinine	82	0
Given as samples—		
Cinchona febrifuge	0	4
Sulphate of quinine	1	0
Total ...	7,489	4

The total issues of the previous year were 7,831¾ pounds of febrifuge (common and crystalline), and 257½ of quinine. There was thus during the year a considerable falling off in the issue of febrifuge. But this is hardly to be wondered at when the extraordinary cheap price of quinine in the open market is considered.

8. *Stock account.*—The amount of bark in stock at the end of the year was 359,790 pounds, which has been valued at the cost price per pound of the year's crop. The other manufactured products have been taken at their cost price, and the chemicals and stores at their actual value. The total value of stock, calculated in this way, stands at Rs. 1,10,699-10-8. As compared with the stock of the previous year, the account stands thus:—

Stock on 31st March 1888.	Rs.	A.	P.	*Stock on 31st March* 1889.	Rs.	A.	P.
Chemicals and stores ...	6,000	0	0	Chemicals and stores ...	10,000	0	0
Cinchona febrifuge, 1,169 pounds, at Rs. 12-13-10 per pound ...	15,038	11	2	Cinchona febrifuge, 1,375 pounds, at Rs. 12-10-8·08 per pound ...	17,417	3	10·00
Crystalline febrifuge, 82¼ pounds, at Rs. 16-6-2 per pound	1,347	11	2	Crystalline febrifuge, 54 pounds, at Rs. 16-6-2 per pound ...	884	13	0
Sulphate of quinine, 74 pounds, at Rs. 19-5 per pound ...	1,429	2	0	Sulphate of quinine, 982 pounds, at Rs. 12-10-8·08 per pound ...	12,439	1	2·56
Bark, 296,619 pounds, at 4 annas 2·713 pies per pound ...	78,346	0	7	Bark, 359,790 pounds, at 3 annas 1·333 pies per pound ...	69,958	8	8·07
...	1,02,161	8	11				
Increase in value	8,538	1	9·63				
Total ...	1,10,699	10	8·63	Total ...	1,10,699	10	8·63

9. *Financial result of the year's working.*—Collecting the figures above given, the financial result of the year's working is seen to be a profit of Rs. 27,843-15-9 as shown in the undernoted balance sheet:—

BALANCE SHEET.

DR.	Rs.	A.	P.	CR.	Rs.	A.	P.
To value of stock on 31st March 1888	1,02,161	8	11	By value of stock on 31st March 1889	1,10,699	10	8
To cash received from the treasury during 1888-89 for expenditure on the plantations, viz., Kunghee, Mungpoo, Sittong, and Rungjung ...	72,549	5	6	By cash receipts from sale of sulphate of quinine, cinchona and crystalline febrifuge, seed, plants and bark ...	37,706	0	0
To cash received from treasury during 1888-89 for factory ...	32,653	3	2	By credit from Medical Depôts for cinchona febrifuge, viz:—			
To stores from England ...	4,651	12	4	Calcutta ... 22,110 0 0			
Profit on the year's working ...	27,843	15	9	Bombay ... 20,625 0 0			
				Madras ... 14,850 0 0	57,585	0	0
				By credit from Medical Depôts, for sulphate of quinine, viz:—			
				Calcutta ... 14,495 13 4			
				Madras ... 8,282 5 8	22,778	3	0
				By credit from Medical Depôt, Calcutta, for cinchona bark ...	1,959	0	0
				By credit from Inspector-General of Civil Hospitals, Bengal, for cinchona febrifuge and crystalline febrifuge, supplied to medical officers of Bengal, viz:—			
				For cinchona febrifuge 6,937 0 0			
				For crystalline febrifuge ... 122 0 0	7,059	0	0
				By credit from Inspector-General of Jails, Bengal, for cinchona febrifuge and crystalline febrifuge supplied to jails and lock-ups in Bengal, viz:—			
				For cinchona febrifuge ... 1,896 0 0			
				For crystalline febrifuge ... 169 0 0	2,065	0	0
				By credit from Inspector-General of Jails, Bengal, for cinchona bark supplied to the medical officer of the Alipore Jail Hospital	8	0	0
Total ...	2,39,859	13	8	Total ...	2,39,859	10	8

This shows a net profit on the transactions of the year of Rs. 27,843-15-9—a result which, in the face of the unprecedentedly low prices for cinchona products which have ruled during the year, may, I trust, be considered as financially satisfactory. The chief cause of the extraordinary low price which has for some time ruled for cinchona bark, and as a consequence for quinine and the other cinchona alkaloids, is the immense exportation of bark from Ceylon. When coffee, which for a long time was the staple production of Ceylon, began some years ago to fail because of a disease which attacked the coffee tree, cinchona was largely substituted by the planters of that colony for the failing staple. And some idea of the extent to which this was done may be gathered from the following figures. During the year ending 30th September 1880 (using round numbers), one and-a-quarter million pounds of cinchona bark were exported from Ceylon to London. During the year 1883-84 the quantity rose to eleven millions, and the following year the quantity was about the same. During 1885-86, fifteen million pounds, and during 1886-87, fourteen million pounds were exported. In 1887-88 the quantity fell to eleven millions, and during the current year it is expected to show a further fall. The explanation of all this is simply that, when cinchona began to fail from disease and depreciation in quality, the Ceylon planters turned their attention to tea-planting with such energy that they cut down their cinchona trees to make way for tea

bushes; and, not being able to hold their bark, they were obliged to force it on the London market, to be sold for what it would fetch. The result has been an enormous fall in price, bark having been freely obtainable in London for several years past at prices considerably below the cost of production; and quinine having, as a consequence, fallen to a figure far below any thing previously heard of. The exportation of bark from Java has also greatly increased of late years. South American bark, which a few years ago was our only source of quinine, has practically been driven out of the market. And the world has thus been draining its supplies of quinine for some time past, chiefly from bark grown in British and Dutch colonies in Asia. The efforts of the Governments of Great Britain and Holland, to secure for their tropical subjects a cheap remedy for the commonest of all tropical diseases, have thus culminated in a more triumphant success than was ever anticipated. But this state of affairs cannot last much longer. Ceylon planters will not go on planting cinchona trees to sell their product at a loss. As a matter of fact, planting has already ceased; and exportations are beginning to diminish. And, in the course of a year or two, the price of cinchona products must rise. The invention of the new oil process of Messrs. Wood and Gammie, and the free publication of it by Government, will no doubt contribute materially to maintaining them permanently below the rates which have been hitherto considered as normal prices, because this invention makes it possible for any intelligent planter to make quinine on his own estate. From the general depression of the cinchona industry, the Government estate could not hope to escape; and from a commercial point of view, the past year has not been so good as many previous years when prices were high. But inasmuch as quinine has been materially cheapened (and thus put more within reach of the masses), the result is, I think, gratifying.

10. The crop of bark for the coming year will be regulated by the demand for quinine and febrifuge. And, as by the new process of manufacture a much larger outturn of alkaloid is obtained from the bark, the annual draft in the plantation for raw material should now begin to diminish.

11. The sum of Rs. 2,150 received from the settlers within the cinchona reserve for land rent and grazing dues was paid into the Darjeeling Treasury, and no credit is taken for them in the plantation accounts.

12. The growth of the fuel plantation has been remarkably good, and the experiment, so far as it has gone, has been an unmitigated success. A small addition to its area was made during the current year. From the older parts of this plantation it will soon be possible to thin out a good many poles for building sheds and coolies' huts.

13. For the seven months of the year under review, I was absent on furlough, and my duties were performed by Mr. J. Gammie, the Deputy Superintendent. Mr. Gammie's services are already too well known to Government to require anything more than mention by me. Mr. Pantling, Mr. Parkes, and Mr. Gammie, junior, conducted their respective duties to Mr. Gammie's satisfaction and to mine. The head-writer in the Cinchona office, Baboo Gopal Chandra Datta, and the second writer, Baboo Devendranath Basu, and the other members of the office staff, have also worked diligently and well.

14. The usual statistical returns, together with Mr. Wood's memorandum on the new process for making quinine, are submitted as appendices.

APPENDIX A.

Memorandum on the fusel oil process of manufacturing quinine, by C. H. WOOD, Esq., F.C.S., F.I.C., *&c., &c., late Government Quinologist to the Government of Bengal.*

AT the time I received the appointment of Quinologist under the Government of Bengal (1873), I was instructed by the Secretary of State to give my chief attention to the production on a large scale of a cheap and efficient febrifuge from the cinchona bark grown in British Sikkim; and I was specially directed to consider the suitability of the method which had been proposed by Dr. De Vrij for this purpose. It was in accordance with these instructions that the manufacture of the preparation now known as "cinchona febrifuge" was established at Mongpoo. This preparation is made exclusively from the bark of *C. succirubra*, which at that period was the principal product of the plantations. The process selected for its manufacture was not well adapted for extracting the alkaloids from the more valuable bark of *C. calisaya*. Several varieties of this species, however, were then under extensive cultiva-

tion, and a considerable supply of bark from this source was likely to follow. The manufacture of cinchona febrifuge from the produce of *C. succirubra* being well established, it became important to make arrangements for working up the *calisaya* bark by some other method.

It was obvious that the most satisfactory way of utilizing this bark would be to prepare from it pure sulphate of quinine; but this could not be economically done with such crude appliances as sufficed for the manufacture of febrifuge. A suitable building furnished with the requisite machinery and apparatus was considered to be essential, and representations to this effect were made to Government by Dr. King and myself. Accordingly, in 1879, the Government of Bengal had agreed to sanction the formation of a small factory for the manufacture of pure quinine from the calisaya bark. Experiments which had been in progress for some time had enabled me to select a process for the purpose which promised to give satisfactory results. This process was to receive an extended trial in the new factory. The principal details of the method of working had been settled, and rough sketches of the apparatus made. The solvent I proposed employing in extracting the alkaloids from the bark was the "fusel oil" of commerce. This substance is a bye-product obtained in the manufacture of spirit, and could be then purchased in London at about 9*d.* per gallon. I presume it has acquired the name of "oil," because it floats on water, but its chief chemical component is *amylic alcohol*. There was no likelihood of any difficulty in the importation of fusel oil from Europe for use in the process; but should any unforeseen obstacle arise whereby fusel oil could not be got, ordinary spirit was to be used in the extraction, and Government had sanctioned its exemption from duty for such purpose. I had abundant evidence that the whole of the alkaloids could be advantageously obtained from the bark by the process I had selected; but its economical employment on the large scale depended on the use of suitable apparatus whereby the solvent could be recovered from each operation with very little loss. It was for this reason that I considered a properly furnished factory to be essential to success; and, as I have stated, the Government was prepared to sanction the expenditure necessary for this purpose.

At this time then the arrangements were matured for starting a factory and putting the fusel oil process in operation. But at the same period there were reasons of a personal kind which made me anxious to return to England, and on this account I wished to tender my resignation. It seemed to me a suitable time for taking this step, because any successor to my appointment having to take the superintendence and control of the manufacture would naturally prefer that the factory and its appliances should be arranged under his own direction. Some informal correspondence on these points passed between the Lieutenant-Governor and myself, in which Sir Ashley Eden at first very kindly asked me to reconsider the course I wished to take; but ultimately my resignation was accepted. It was suggested that the Secretary of State would possibly select a young chemist for the appointment, who would be willing to take up and carry out the plans already made for starting the manufacture. In that case I undertook to work with him on the subject for a time in London, and render him what assistance I could in acquiring information that might be useful to him in putting the process into operation.

I returned to England in the autumn of 1879, and a few months later I had an opportunity for making myself further acquainted with the employment of mineral oils in the extraction of quinine. The use of these agents had been already tried in India. Mr. Broughton experimented with them, but did not obtain any economical success (see his Report, dated 1st December 1873). Some experiments with such oils had been also made by myself, but with no very satisfactory results. Nevertheless, in some of the principal quinine factories of Europe, a process of extraction with mineral oil was being employed. Indeed, the oil process had largely superseded all others. I found that only certain kinds of oils, namely, the paraffine oils obtained in the distillation of "brown coal," or schist, were well adapted for this process, the products of American petroleum being unsuitable for the extraction of quinine. I procured some oil from Young's Paraffine Works, and made some trials with it in the extraction of calisaya bark from the Sikkim plantations, and obtained much better results than I had done before. Nevertheless, it appeared to me that the employment of this process in India would be attended with considerable difficulty.

Fusel oil still presented to my mind many advantages for use in that country, but I began to see the way to a further simplification in the method of employing it. In the process I had selected in India, fusel oil alone was used as the solvent. It now occurred to me that by previously diluting it with some liquid hydrocarbon a considerable improvement would result. In this case the fusel oil would be the active solvent; but the presence of a considerable proportion of a hydrocarbon, such, for instance, as any mineral oil or naphtha, would exclude some of the impurities otherwise taken up by the fusel oil when used alone, and the alkaloids would be at once obtained in a much greater state of purity. I soon satisfied myself that the employment of a mixed solvent of this description would have many advantages over the use of fusel oil alone. But a considerable time had elapsed, and no fresh appointment to the post of Quinologist had been made. I learnt that the Government did not consider it desirable to send out another chemist. Under these circumstances, I was not in a position to make any further suggestions regarding the process of manufacture at Sikkim, and I therefore let the matter drop.

Later on, however, I heard that Mr Gammie, who still conducted the manufacture of febrifuge, was also attempting the manufacture of pure quinine sulphate from the calisaya bark; and a correspondence began between Mr. Gammie and myself on this subject. At about this time Dr. King came on a visit to Europe, and in the autumn of 1884, I had an

opportunity of discussing with him the practicability of the efforts Mr. Gammie was making at Mungpoo. At that time a spirit process was under trial, and the results promised considerable success. The alkaloid was completely extracted from the bark, but it was associated with much impurity, and its purification rendered the process somewhat too complicated for use on the plantations. Dr. King, during his stay in Holland, had acquired some valuable information regarding the paraffine oil process as used in the Continental oil factories, and he consulted me regarding it. I was impressed with certain difficulties, which I thought would attend its employment by Mr. Gammie, and I did not feel that I could then assist him much in that direction. It seemed to me, however, a favourable moment to make a further trial of the modification of the fusel oil process to which I have already referred, namely, the employment of fusel oil diluted with some liquid hydrocarbon for the extraction of the bark. Accordingly, I resumed my experiments on the use of such a mixed solvent, and worked out two or three alternative processes. These differed from each other chiefly in the nature of the diluting hydrocarbon. In one, the mixed solvent was formed by diluting the fusel with five or six times its volume of the volatile portion of coal tar naphtha. The principle of this process I communicated to Dr. Radwood, one of the editors engaged in preparing a new Pharmacopœia, as likely to furnish the basis of a convenient analytical method for determining the alkaloidal value of the cinchona bark used in medicine, and the process is now the official test for that purpose in the present British Pharmacopœia. The use of a volatile naphtha, whether derived from coal, shale, or petroleum, for diluting the fusel oil, presented several advantages for a manufacturing process; but it was probable that there would be great difficulty in obtaining any such naphtha in India. In another of the processes I devised, the fusel oil was therefore diluted with ordinary kerosine. As this oil is so largely used for illuminating purposes in India, and is therefore so readily obtainable there, this method offered the greatest facilities for immediate trial.

When Mr. Gammie visited England in the summer of 1885, he came to my laboratory and witnessed the experimental working of this process; and formed a favourable opinion of its adaptability for use on the plantations. On his return to Mungpoo, he began a trial of the method in extracting calisaya bark, and the satisfactory results he obtained encouraged him to go on. With great perseverance he mastered one detail after another, using only the simple appliances that he found at hand, until he was able to employ the process on a considerable scale. The valuable results, therefore, which have been thus far attained in the practical application of the process, are entirely due to his skill and energy.

A description of the process as it was being conducted at the commencement of this year was drawn up by Mr. Gammie, and was published with the Government Resolution of the 26th March 1888. Since then, I believe, he has effected a further improvement in the mechanical arrangements, and is now in a position to work from 3,000 to 5,000 lbs. of bark per week. A considerable quantity of quinine sulphate has been produced and issued. Samples of this have been analysed, and the results show that both in purity and appearance it is equal to the best European quinine. There appears to be no doubt that the extraction is complete, the amounts of quinine obtained corresponding well with the known composition of the bark.

As yet only calisaya bark has been worked by this process. This bark contains a large amount of quinine associated with very little cinchonidine; consequently the final operations for obtaining pure quinine sulphate are very simple. But the plantations will also furnish much bark, especially from hybrids, which contains a considerable amount of quinine associated with a large amount of cinchonidine. Such bark will no doubt be utilised in the preparation of pure quinine as soon as the further arrangements necessary for separating the extracted alkaloids are provided. Succirubra bark can be as readily extracted by this method as any other; and it seems that from the acid solution of the total alkaloids so obtained, "cinchona febrifuge" can be prepared equal in every respect to that hitherto prepared by the acid process, and with the advantage of a greatly increased yield.

Comparing this process of extraction with others that have been tried in India, the chief advantages it presents appear to be—(1) that the alkaloids are completely extracted from the bark in a much greater state of purity, so that the final operations for obtaining pure and finished products are much simplified; (2) that the whole process of extraction can be performed at common temperatures; (3) that the apparatus and appliances required are all of a simple character, and therefore well suited for use on the plantations.

No very exact estimate can yet be formed of the cost of manufacturing quinine and other alkaloids by this process. It is only now slowly passing from the experimental stage, which is necessarily an expensive one. Further improvements conducing to greater economy are probable. But even as it is, I gather from Dr King, under whose skilful superintendence all efforts at local manufacture have been so ably fostered, that quinine can be produced on the plantations at a cost not exceeding the present unprecedentedly low market price of the valuable medicine.

APPENDIX B.

Table showing the number and distribution of Cinchona Plants in the Government Cinchona Plantations, Sikkim, on the 1st April 1889.

Mungpoo Division.

	Plantations.				Nursery.			
	Number in permanent plantations on 1st April 1888.	Number of plants uprooted and died during the year 1888-89.	Planted during the year 1888-89.	Number in permanent plantations on 1st April 1889.	Number of stock plants for propagation on 1st April 1889.	Number of seedlings and rooted cuttings in nursery beds for permanent plantation.	Number of rooted plants in seed and cutting beds.	Total nursery stock on 1st April 1889.
Cinchona Hybrid	854,100	...	109,510	963,610	4,000	150,000	...	154,000
,, Succirubra	1,982,000	240,000	...	1,742,000	...	...	...	...
,, Calisaya Ledgeriana ...	921,160	50,000	135,460	1,006,660	...	150,000	...	150,000
,, ,, Verde and Morada	194,500	7,000	...	127,300	...	...	...	...
,, Micrantha	...	...	...	16,000	...	...	...	...
,, Officinalis	20,000	5,000	...	...	...	...	...	...
,, Pahudiana	... 4	... 3	...	... 1	...	...	...	...
,, Hard Carthagena ...								
Total ...	3,971,564	302,003	244,970	3,854,471	4,000	300,000	...	304,000

Sittong Division.

Cinchona Hybrid	148,000	...	24,400	172,400	...	50,000	...	50,000
,, Succirubra	800,000	50,000	...	750,000	...	...	...	...
,, Calisaya Ledgeriana ...	76,000	30,000	24,400	70,400	...	50,000	...	50,000
,, ,, Verde and Morada	15,000	3,000	...	12,000	...	...	...	...
Total ...	1,039,000	83,000	48,800	994,800	...	100,000	...	100,000

Rungjung Division.

Cinchona Hybrid	...	...	9,160	9,160	...	...	...	...
,, Calisaya Ledgeriana ...	867,000	...	50,960	517,800	...	25,000	...	25,000
,, ,, Verde and Morada	34,000	...	...	34,000	...	...	...	...
Total ...	901,000	...	59,960	560,960	...	25,000	...	25,000

APPENDIX C.

Table showing the actual details of the year's planting, 1888-89.

	Hybrid.	Calisaya Ledgeriana.	Total.
Mungpoo Division	109,510	135,460	244,970
Sittong ,, ...	24,400	24,400	48,800
Rungjung ,, ...	9,160	50,800	59,960
Total ...	143,070	210,660	353,730

APPENDIX D.

Table showing the total number of Cinchona trees of all sorts standing in the permanent Plantations on the 31st March 1889.

	Red Cinchona Succirubra.	Yellow Cinchona Calisaya Ledgeriana.	Yellow Cinchona Calisaya, Verde and Morada.	Hybrid, unnamed variety.	Other kinds.	Total of all sorts.
Mungpoo Division ...	1,142,000	1,006,560	127,300	963,610	15,001	3,254,471
Sittong ,, ...	740,000	70,400	12,000	172,400	...	994,800
Rungjung ,, ...	.....	517,800	34,000	9,160	...	560,960
Grand total of all sorts	1,882,000	1,594,760	173,300	1,145,170	15,001	4,81,0231

APPENDIX E.

Account of dry Cinchona Bark collected during season 1888-89.

	Root.	No. 1 stem.	No. 2 stem.	Branch.	Total.	
SUCCIRUBRA—						
Mungpoo, uprooting ...	33,740	710	32,130	16,490	83,070	
Rungbee, ditto ...	14,400	2,960	11,400	9,440	38,200	
Sittong, ditto ...	2,640	70	1,050	1,560	5,320	
	50,780	3,740	44,580	27,490	126,590	
Mungpoo, thinning ...	16,000	...	14,000	7,900	36,900	
Rungbee, ditto ...	1,180	420	1,500	1,370	4,470	
Sittong, ditto ...	16,850	...	11,890	10,760	39,500	
	33,030	420	27,390	20,030	80,870	
Total Succirubra ...	83,810	4,160	71,970	47,520	207,460	207,460
LEDGERIANA—						
Mungpoo, thinning ...	24,610	...	15,570	20,740	60,920	
Labdah, ditto ...	11,480	...	11,460	11,490	34,430	
Sittong, ditto ...	8,850	...	4,040	8,920	21,810	
Rungjung, ditto ...	2,680	...	4,730	4,200	11,610	
Total Ledgeriana ...	47,620	...	35,800	45,350	128,770	128,770
HYBRID—						
Mungpoo, thinning ...	6,050	...	6,020	4,950	17,020	
Labdah, ditto ...	750	...	910	1,370	3,030	
Rungbee, ditto ...	590	160	610	1,740	3,100	
Total Hybrid ...	7,390	160	7,540	8,060	23,150	23,150
VERDE AND MORADA—						
Mungpoo, thinning ...	2,980	...	1,650	4,380	9,010	
Labdah, ditto ...	630	...	670	670	1,870	
Sittong, ditto ...	390	...	210	510	1,110	
Total Verde and Morada ...	3,900	...	2,530	5,560	11,990	11,990
OFFICINALIS—						
Labdah, thinning ...	200	...	230	1,300	1,730	
Total Officinalis ...	200	...	230	1,300	1,730	1,730
Grand total of all sorts ...	142,920	4,320	118,070	107,790	373,100	373,100

APPENDIX F.

Stock of Bark on 1st April 1889.

		lbs.
Succirubra	bark	60,871
Calisaya Ledgeriana	,, ...	206,791
Officinalis	,, ...	7,740
Micrantha	,, ...	3,977
Pahudiana	,, ...	600
Hybrid	,, ...	67,821
Verde and Morada	,, ...	11,190
	Total ...	359,,

APPENDIX G.

Table showing the produce of the Government Cinchona Plantations in British Sikkim since their beginning.

Mungpoo Division.

					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	...	39,405
Crop of 1875-76	...	...	...	...	211,931
„ „ 1876-77	...	...	...	...	207,781
„ „ 1877-78	...	...	...	...	344,225
„ „ 1878-79	...	...	...	...	261,659
„ „ 1879-80	...	...	...	...	345,740
„ „ 1880-81	...	...	...	...	348,560
„ „ 1881-82	...	...	...	...	298,780
„ „ 1882-83	...	...	...	...	358,100
„ „ 1883-84	...	...	...	...	255,270
„ „ 1884-85	...	...	...	...	300,125
„ „ 1885-86	...	...	...	...	152,460
„ „ 1886-87	...	...	...	...	146,979
„ „ 1887-88	...	...	...	...	217,780
„ „ 1888-89	...	...	...	...	293,750
			Total	...	3,850,445

Sittong Division.

					lbs.
Dry bark collected by pruning and thinning during			1879-80	...	15,850
Ditto	ditto	ditto	1880-81	...	28,965
Ditto	ditto	ditto	1881-82	...	42,790
Ditto	ditto	ditto	1882-83	...	38,880
Ditto	ditto	ditto	1883-84	...	51,890
Ditto	ditto	ditto	1884-85	...	39,076
Ditto	ditto	ditto	1885-86	...	52,950
Ditto	ditto	ditto	1886-87	...	78,652
Ditto	ditto	ditto	1887-88	...	72,630
Ditto	ditto	ditto	1888-89	...	67,740
			Total	...	489,423

Rungjung Division.

			lbs.
Dry bark collected by thinning during 1888-89	...	...	11,610
	Total	...	11,610

APPENDIX H.

Table showing the amount of Cinchona Febrifuge, Crystalline Febrifuge, and Sulphate of Quinine produced from the commencement to 31st March 1889, and the stock at the latter date.

	lbs.	oz.
Manufactured in 1874-75	48	10
Ditto 1875-76	1,940	6
Ditto 1876-77	3,750	12
Ditto 1877-78	5,162	0
Ditto 1878-79	7,002	0
Ditto 1879-80	9,434	13
Ditto 1880-81	9,296	0
Ditto 1881-82	8,010	0
Ditto 1882-83, viz :—		
Cinchona febrifuge	10,363	4
Crystalline „	300	0
Manufactured in 1883-84, viz :—		
Cinchona febrifuge	8,464	0
Crystalline „	250	0
Manufactured in 1884-85, viz :—		
Cinchona febrifuge	6,079	0
Crystalline „	385	0

	lbs.	oz.
Supplied to Medical Depôt, Calcutta, viz :—		
Cinchona febrifuge ...	29,323	3
Crystalline „	24	8
Sulphate of quinine ...	1,057	8
Supplied to Medical Depôt, Bombay, viz :—		
Cinchona febrifuge ...	12,850	0
Supplied to Medical Depôt, Madras, viz :—		
Cinchona febrifuge... ...	5,730	0
Crystalline „	20	0
Sulphate of quinine ...	400	0
Supplied to Straits Settlements ...	30	0
Supplied to Colonial Government, Mauritius	150	0
Supplied to Commissariat Department for Port Blair	80	0

APPENDIX H—*concluded.*

	lbs.	oz.
Manufactured in 1885-86, viz :—		
Cinchona febrifuge	4,625	0
Crystalline „	118	0
Manufactured in 1886-87, viz :—		
Cinchona febrifuge	6,641	0
Crystalline „	149	0
Manufactured in 1887-88, viz :—		
Cinchona febrifuge	6,916	0
Crystalline „	1	0
Sulphate of quinine	331	8
Manufactured in 1888-89, viz :—		
Cinchona febrifuge	6,384	0
Sulphate of quinine	2,191	0
Total ...	97,847	5

	lbs.	oz.
Supplied to Inspector-General of Civil Hospitals, Bengal (for district medical officers of Bengal), viz :—		
Cinchona febrifuge	5,011	12
Crystalline „	77	12
Supplied to Inspector-General of Jails, Bengal (for jails and lock-ups in Bengal), viz :—		
Cinchona febrifuge... ...	429	4
Crystalline „	43	12
Sold to Government officers for cash, viz :—		
Sulphate of quinine... ...	82	0
Sold for cash, viz :—		
Cinchona febrifuge... ...	39,013	4
Crystalline „	973	0
Samples, viz :—		
Cinchona febrifuge... ...	129	6
Crystalline „	10	0
Sulphate of quinine ...	1	0
Stock in hand on 31st March 1889, viz :—		
Cinchona febrifuge... ...	1,375	0
Crystalline „	54	0
Sulphate of quinine ...	982	0
Total ...	97,847	5

APPENDIX I.

Cash income for 1888-89.

	Rs.	A.	P.	Rs.	A.	P.
Cash received from sale of cinchona febrifuge and paid into the Bank of Bengal	35,660	0	0			
Cash received from sale of crystalline cinchona febrifuge and paid into the Bank of Bengal	406	0	0			
Cash received from sale of sulphate of quinine and paid into the Bank of Bengal	1,640	0	0			
Cash received from sales of cinchona seed, plants, and bark, &c., and paid into the Bank of Bengal ...	702	4	3			
Credit for cinchona febrifuge supplied to Medical Depôts, viz :—						
Calcutta	22,110	0	0			
Bombay	20,625	0	0			
Madras	14,850	0	0	57,585	0	0
Credit for sulphate of quinine supplied to Medical Depôts, viz :—						
Calcutta	14,495	13	4			
Madras	8,282	5	8	22,778	3	0
Credit for cinchona bark supplied to Medical Depôt, Calcutta				1,959	0	0
Credit for cinchona febrifuge supplied to Inspector-General of Civil Hospitals, Bengal (for district medical officers of Bengal)				6,937	0	0
Credit for cinchona febrifuge supplied to Inspector-General of Jails, Bengal (for jails and lock-ups in Bengal)				1,896	0	0
Credit for crystalline cinchona febrifuge supplied to Inspector-General of Civil Hospitals, Bengal (for district medical officers of Bengal)				122	0	0
Credit for crystalline cinchona febrifuge supplied to Inspector-General of Jails, Bengal (for jails and lock-ups in Bengal)				169	0	0
Credit for cinchona bark supplied to Inspector-General of Jails, Bengal (for the Alipore Jail Hospital) ...				8	0	0
Total credit in India ...				1,29,862	7	3

GEORGE KING, M.B., *Brigade Surgeon,*

Supdt., Royal Botanic Gardens, Calcutta, and of Cinchona Cultivation in Bengal, and Officiating Government Quinologist.

E. D'S.—Reg. No. 1648J—332—22-7-89.

FINANCIAL DEPARTMENT.

MISCELLANEOUS M $\frac{1\cdot C}{6}$ 2.

CALCUTTA, THE 24TH AUGUST 1889.

RESOLUTION.

READ—

The Annual Report of the Government Cinchona Plantation and Cinchona Factory in Bengal for the year 1888-89.

The plantation was visited during the year by a severe hailstorm, which completely destroyed thousands of young plants in the nurseries and injured even the larger trees.

2. The total number of cinchona trees of all sorts on the plantations was 4,810,231, two-thirds of which are pure quinine yielders. The crop of the year, which was the largest ever harvested, amounted to 373,100 pounds of dry bark, of which 207,460 pounds were red, 128,770 pounds *Ledgeriana*, and 36,870 pounds of other sorts. The whole of this crop was, with the exception of a small quantity supplied on indent or sold to Government institutions, made over to the febrifuge factory for disposal.

3. The outturn from the factory, which is regulated by the demand, was 8,575 pounds, of which 2,191 pounds were of sulphate of quinine and 6,384 pounds of cinchona febrifuge. The total outturn for the previous year amounted to 7,250 pounds. The issues during the year fell from 8,089 pounds in 1887-88 to 7,489 pounds in the current year, as will be seen from the following table:—

	1888-89.		1887-88.	
	lbs.	oz.	lbs.	oz.
To Medical Depôt, Calcutta... ...	2,140	0	757	8
„ ditto, Bombay ...	1,250	0	1,400	0
„ ditto, Madras ...	1,300	0	2,000	0
„ Inspector-General of Civil Hospitals	425	0	541	4
„ ditto of Jails ...	121	12	85	4
Sold to Government officers and to the public	2,251	4	3,225	4
To Commissariat Department for Port Blair	.....		80	0
Given as samples	1	4	.....	
Total ...	7,489	4	8,089	4

The decline in the issues is due to the extraordinary cheapness of quinine in the market caused by the development of cinchona cultivation in Ceylon. It is anticipated that as cinchona gives place to tea in the Ceylon plantations, the price of cinchona products will again rise.

4. An account of the method of manufacturing pure sulphate of quinine by a process recently discovered in the Government Factory at Mungpoo, together with a brief history of its invention, was published in the *Calcutta Gazette* of the 28th March 1888. This, Dr. King now points out, was incomplete, inasmuch as it did not allow to Mr. C. H. Wood, formerly Quinologist in the Plantation, sufficient credit for his share in the conception and perfection of the new process. Dr. King has appended to his report a memorandum prepared by Mr. Wood, which gives a fuller account and history of the invention. The Lieutenant-Governor fully endorses Dr. King's opinion of the value of Mr. Wood's services in this matter, and he is glad to take this opportunity of recording his appreciation of Mr. Wood's action, which has been marked by an evident desire to place at the disposal of Government the knowledge and experience which he has acquired by careful and laborious experiments in England. The Lieutenant-Governor is also glad to acknowledge Mr. Gammie's successful efforts in applying the new invention to manufacture. It is satisfactory to find that no less than 2,191lbs. of pure sulphate of quinine were prepared in the first year of its manufacture by this new process.

5. The revenue derived from the sale of the febrifuge, sulphate of quinine, seeds, plants, and barks amounted to Rs. 1,29,160-3, against Rs. 1,37,511-3-8 in the previous year as shown below:—

	1888-89. Rs.	A.	P.	1887-88. Rs.	A.	P.
By sale of febrifuge, sulphate of quinine plants and bark to the public	37,706	0	0	53,737	11	0
By credit from the medical depôts, Calcutta, Madras, and Bombay ...	82,322	3	0	71,928	8	8
By credit from Inspector-General of Civil Hospitals, Bengal ...	7,059	0	0	9,059	0	0
By credit from Inspector-General of Jails	2,073	0	0	1,466	0	0
By credit from the Commissariat Department, Port Blair ...	.....			1,320	0	0
Total ...	1,29,160	3	0	1,37,511	3	8

The net profit on the year's working amounts to Rs. 27,844.

6. The Lieutenant-Governor's thanks are again due to Dr. King and Mr. Gammie for their efficient management of the Department. The other Assistants are well spoken of.

ORDER.—Ordered that a copy of this Resolution, and of the Report referred to, be submitted to the Government of India, in the Home Department, to the Superintendent of the Government Cinchona Plantation, to the Government of Madras, and to the Inspector-General of Civil Hospitals, Bengal, for information.

By order of the Lieutenant-Governor of Bengal,

H. J. S. COTTON,

Offg. Secretary to the Government of Bengal.

No. M $\frac{1\text{-C}}{6}$ 3.

COPY forwarded to the Superintendent of the Cinchona Plantation for information.

No. M $\frac{1\text{-C}}{6}$ 4.

COPY, with a copy of the Report, forwarded to the Inspector-General of Civil Hospitals, Bengal, for information.

No. M $\frac{1\text{-C}}{6}$ 5.

COPY, with a copy of the Report, forwarded to the Political (Medical) Department of this Government for information.

By order of the Lieutenant-Governor of Bengal,

F. J. MONAHAN,

Offg. Under-Secretary to the Govt. of Bengal.

CALCUTTA,
The 3rd September 1889.

C. E. G. & W. LeB.—Reg. No. 2468C—413—3.9.89.

Rev. 7/9/89

(1889.)

REVENUE DEPARTMENT.

No. 1187

ABSTRACT.

G.G. mis. Registered

From The Govt of Bengal
Finl Dept.

Communicated to the Govt. Botanist and Director of Govt. Cinchona Plantations

Hle
26 Sept

Dated 3 Sept 1889.
Received 16 " "
Enclosures 2

No 8 1-C/6 7.

To

The Govt. Botanist.
Rev. 1-10.

SUBJECT.

Forwarding for information a Copy of the Report on the working of the Govt Cinchona Plantations and Factory at Bengal during 1888-89 together with a Copy of the Resolution recorded by the Lieutenant Governor thereon.

P.T.C.