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REPORT

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ON THE

GOVERNMENT CHINCHONA PLANTATIONS

ON THE

NILGIRI HILLS,

MADRAS PRESIDENCY.

BY

CAPTAIN CAMPBELL WALKER, STAFF CORPS.

DEPUTY CONSERVATOR OF FORESTS.

OOTACAMUND: PRINTED AT THE "OBSERVER" PRESS.

1878.

OOTACAMUND,
16th July 1878.

No. 133.

From

R. W. BARLOW, Esq.,
Acting Commissioner, Nilgiris.

To

C. G. MASTER, Esq.,
*Secretary to Government,
Revenue Department,
Ootacamund.*

SIR,

I HAVE the honor to forward for submission to Government, Captain Campbell Walker's report on the Cinchona plantations, received by me on the 10th instant, and retained for a few days to show to the members of the Cinchona Committee; but, as I learnt yesterday that Government require it emergently, I forward it at once.

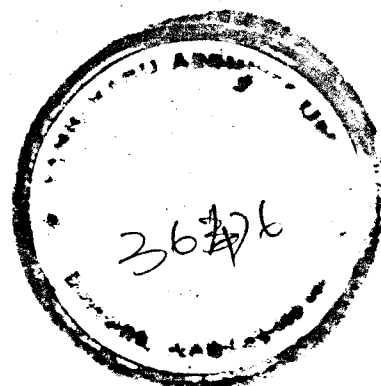
2. The report itself will be carefully considered by the Cinchona Committee now sitting, and I abstain therefore from any remarks at present. The question of a special officer, however, to be in charge of Cinchona plantations under the Commissioner or Conservator of Forests, for some time to come, may possibly be taken up by Government at once. I beg, therefore, to submit that I very strongly support the proposal that some duly qualified officer may be appointed as recommended by Captain Campbell Walker at pages 130, 131 and 132, head "System recommended" of this manuscript report.

I have the honor to be,

Sir,

Your most obedient Servant,

(Signed) R. W. BARLOW,
Acting Commissioner, Nilgiris.



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ERRATA.

Page	2	para	8	line	10	for	<i>at the end of the</i>	1863	read	<i>at the end of the year</i>	1863.
„	7	„	31	„	7	for	<i>between the trees and</i>				
							<i>the bark</i>	read	<i>between the ties and the bark.</i>		
„	10	„	38	„	8	for	<i>Chinchona</i>	...	read	<i>Chinchonæ,</i>	
„	11	„	42	„	1	for	<i>the bark of the Nilgiri</i>				
							<i>Crown barks</i>	read	<i>the Nilgiri Crown barks.</i>		
„	12	„	44	„	3	for	<i>and Guano were made</i>				
							<i>in 1869</i>	read	<i>and Guano in 1869.</i>		
„	35			„	6	for	<i>connected</i>		read	<i>consulted.</i>	
„	v	Appendix A.	Sub-division I	for	1873				read	1871.	
„	v	„	„	„	III	for	<i>16 grey barks</i>	read	<i>16 other species.</i>		

N.B.—The *C. Pubescens* referred to in the Report is the hybrid *C. Officinalis* var. *Pubescens*, and not the distinct species *C. Pubescens* Vahl.

The actual acreage *under Chinchona* in the Dodabetta Estate is 314·92 acres, 5·55 acres being under tea. This reduces the total acreage of the Chinchona Plantations from 848·47 to 842·92 acres, but does not affect the calculations of yield, &c., given in Report.

I. C. W.

OOTACAMUND,

10th July, 1878.

FROM

CAPTAIN I. CAMPBELL WALKER,

Deputy Conservator of Forests,

On Special Duty.

TO

THE SECRETARY TO GOVERNMENT,

Revenue Department,

Ootacamund.

SIR,

G. O., Revenue Department, No. 72, dated 15th January 1878, deposes me to prepare a Report on the Government Chinchona Plantations on the Nilgiris, and directs that "this Report shall embrace not only the number of trees on the plantations, but the present position and future prospects of these valuable State plantations; with any remarks upon the methods hitherto adopted for working them, harvesting, and preparing the bark for the market, and despatching it to England, and on the apparent results on the health of the trees, or suggestions as to future management."

2. I have now the honor to submit the Report, which I have divided into three Chapters, dealing with the past, the present, and the future.

I have the honor to be,

SIR,

Your most obedient Servant,

I. CAMPBELL WALKER,

Deputy Conservator of Forests.

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CHAPTER I.

PAST HISTORY OF THE PLANTATIONS.

INTRODUCTION.

1. THE history of the introduction of the Chinchonas into India, and their establishment on the Nilgiris and elsewhere, is written in successive Blue Books, dating from 1852, and voluminous Government records. I shall therefore confine myself strictly to the most salient points or stages which mark the progress of the experiment from its earliest conception up to the present time, when it may be said to have emerged from the experimental state and become an established fact. I restrict my attention also to the history of the Nilgiri Government Plantations under report.

2. Dr. Royle appears to have suggested the introduction of the Chinchonas into India as early as 1835, but no definite action seems to have been taken until seventeen years later, when we find Lord Dalhousie's Government writing to the Court of Directors on the subject, and suggesting that a qualified person should be sent to South America to collect seeds and plants. In 1856 Lord Canning, then Governor-General, wrote a minute to the same effect, which was forwarded to the Court of Directors. Plants were obtained through the Foreign Office from Her Majesty's Consuls in South America, some of which reached Calcutta, but all those early attempts resulted in failure from one cause or another.

Dr. Royle's early suggestions and failure of early attempts.

3. It was not until 1859 that the matter was taken up in earnest. In that year Mr. Clements Markham, then a clerk in the India Office, volunteered to proceed to the forests of Peru and Bolivia, with which he was already acquainted, and collect seeds and plants of the several species. His knowledge of the Spanish and Quichua languages, and acquaintance with the country and some of its public men and land-owners, eminently qualified him for the office, and the difficulties which he overcame and eventual success of his mission fully justified his selection which was approved by the Secretary of State on the 8th April 1859. To Mr. Markham's labors must be attributed the successful introduction of the Chinchonas into India, but the services of Messrs. Spruce, Cross and Pritchett, his assistants or co-adjutors in the enterprise, must not be lost sight of.

Mr. Clements Markham's Mission in 1859.

Messrs. Spruce, Cross & Pritchett's services.

4. Mr. Markham arrived in South America early in 1860, and returned to the Coast from his trip into the interior, during which he experienced great hardships and obstacles, on the 1st June of that year, with 456 living plants chiefly of the *C. Calisaya*. These he conveyed to England, losing 40 per cent. *en route*, and thence to the Nilgiris *via* Bombay, Calicut, and the Sispara Ghaut. Mr. Markham arrived at Ootacamund on the 12th October 1860, when we find from his Report (No. 58, page 132, Vol. I of Blue Book,) that "125 of these

Mr. Clements Markham in South America and India 1860.

original plants were potted" all that remained alive apparently, and those in a sickly state. Mr. McIvor, then Superintendent of the Government Gardens, who had been placed in immediate charge of the experiment, succeeded in obtaining 207 cuttings, which, at first, promised well, but eventually died off, as did also apparently the 125 original plants. Mr. Markham records (in his letter No. 61, page 139 of Blue Book, Vol. I) that the last of the green cuttings died in November, but that eight of the 125 plants or wood cuttings remained alive on the 10th February 1861, although showing symptoms of decay, which precluded hopes of the ultimate recovery of more than one (*C. Calisaya*). It would be interesting to trace this sole remaining plant, but beyond the fact that it was still alive, but showing no signs of growth on the 30th March (McIvor's report, No. 66 in Blue Book) I find no record of its fate. On the above date another plant (*C. Ovata* now *C. Pahudiana*) was still living.

Failure of plants brought by Mr. Markham.

Messrs. Spruce and Cross' endeavours successful. Introduction of Red and Yellow barks. Introduction of crown barks by Mr. Cross.

Mr. Pritchett procures plants and seed of the Grey Barks.

Introduction of *C. Pahudiana* from Java.

Propagation of Plants of the above species on the Nilgiris fully established in 1862.

5. The other collectors engaged by Mr. Markham had meanwhile not been idle, and on the 9th April 1861, Mr. Cross arrived at Ootacamund with 463 plants of *C. Succirubra*, (raised by himself and Mr. Spruce in South America) and six plants of *C. Calisaya*, which had been raised in Kew Gardens. Mr. Cross returned to South America and collected in the forests of Loxa seeds of the *C. Officinalis* or crown barks, which arrived in good order at Ootacamund on the 4th March 1862, a small packet having already been received from Mr. Markham on the 16th February.

6. Previous to this, Mr. Pritchett, to whom Mr. Markham had entrusted the task of collecting the grey barks in the forests of Huanaco, had despatched plants and seeds to India. The plants all died after leaving England, but the seeds were duly received, and contrary to expectation, germinated freely. In December 1861, Dr. Anderson brought 318 plants from Java, but Mr. McIvor reported that they were "all more or less affected with rot and fungi at the roots." Seed of the *C. Pahudiana*, then known as *Ovata* and *Lacumæfolia*, appears also to have been received from Java, but this proved a worthless variety.

7. I have thus traced the introduction of the yellow, red, crown, and grey barks, and the *C. Pahudiana* from the commencement. In June 1861 we find Mr. McIvor reporting to the Government that he had upwards of 2,000 plants in very promising condition, and on the 9th August of the same year, in his first report on the number and condition of the chinchona plants in the Government Gardens, he shows 3,536, of which 1,517 were red barks (*C. Succirubra*), six yellow (*C. Calisaya*) 1,742 grey (*C. Nitida* and *Micrantha*) and 271 "species without name." By the 30th April in the ensuing year, these numbers had increased to 31,495 and the supposed great difficulty of rearing young chinchona plants on the Nilgiris from seed and cuttings, had been overcome by Mr. McIvor's skill and care.

SITES.

8. The site originally selected by Mr. McIvor and the Conservator of Forests (Dr. Cleghorn) was at Dodabetta, the ravine behind the Government Gardens, which was approved of by Mr. Markham, who also selected the Neddivattam site at the top of the Gûdalûr Ghaut, about 18 miles from Ootacamund, which Dr. Cleghorn had previously indicated as suitable. In 1862 Mr. McIvor recommended a site at Pykarra, about 13 miles from Ootacamund and five miles by direct road from Neddivattam, which was sanctioned (G. O., 2nd October 1862). Dr. Cleghorn had also referred to a site on the Koondas about 8 miles beyond the Avalanche Bungalow (G. O. No. 1220, 18th August 1860) and at the end of the 1863 Mr. McIvor received sanction to open a plantation there. (G. O., No. 2,195, 3rd December 1863.)

9. Great objection was taken to the Dodabetta site by Doctors Macpherson and Anderson from Bengal, who had visited the Java Chinchona plantations, and the Madras Government, in their Order, No. 552, of 9th March 1861, directed that it should be abandoned, but a month later on receipt of a protest from Mr. McIvor and Captain Morgan, the Acting Conservator of Forests, modified their order, and gave "permission to continue operations at the garden ravine site." (G. O., 16th April 1861.)

Objection taken to Dodabetta site by Dr. Macpherson and Anderson. Mr. McIvor and Captain Morgan's protest.

10. The area of the Dodabetta site was originally only 60 acres, of which 15 had been planted out in October 1862. It was intended to plant out only five acres entirely in the open, retaining various degrees of shade from the shola trees to be left standing in the remaining 55, as an experimental measure. The Neddivattam site comprised about 150 acres, of which 21 had been planted in October 1862, and 129 acres more or less prepared.

Areas of original sites.

11. At this time the Governor, Sir William Denison, proposed that 150 acres annually should be added to the plantations for ten years, which was approved by the Secretary of State (No. 110, page 254, Vol. I, Blue Book). Sir William Denison estimated that the outlay including interest would reach £100 per acre in the tenth year when a return from lopping and pruning the trees should commence, sufficient, on Mr. McIvor's estimates, to recoup the capital expended, with interest, in about ten years more. When the return from loppings had commenced, Sir William thought that "the size of the annual plantation might be diminished." This shows that he contemplated planting even more than 1,500 acres. Sir William estimated the total cost to Government at £1,000 per acre at end of 40 years, supposing there to have been no return meanwhile, and that each acre should then yield 40,000 lbs. of bark, representing at the rate then ruling £16,000 per acre. These proposals and estimates are interesting to compare with actual results so far, as will be done in the next chapter.

Sir William Denison's proposals & estimates.

12. The area to be planted was subsequently reduced to a maximum of 1,200 acres (G. O., Revenue Department, No. 48, dated 13th March 1866) which it was reported had been reached at close of the official year 1869-70, vide Messrs. Brecks and McIvor's Reports, recorded with G. O., Revenue Department, No. 2,082, dated 21st December 1870, in which the Madras Government "do not consider it advisable that the plantations at Pykara and Mailkoonda should be increased in size, and any additions to those at Dodabetta and Neddivattam, must be limited to the cultivation of those varieties of chinchona, the superiority of which has been, and may hereafter be, determined by Mr. Broughton's analysis." Mr. McIvor, however, appears to have estimated the area merely by the number of plants put out, and the area planted is only 894.30 acres, by the original survey, including the abandoned Mailkoonda Estate, which, even if we make the maximum allowances for difference between base and surface measurement, stated by Captain Sargeant of the Revenue Survey Department, to be 11.8 per cent for a slope of 1 in 2 falls considerably short of 1,200 acres.

Area to be planted subsequently fixed at 1,200 acres.

13. The Mailkoonda site was pronounced by Mr. Markham as "the best site for a Chinchona plantation that has yet been selected, superior either to Dodabetta or Neddivattam." From a variety of causes, chiefly the distance from Ootacamund, (stated by Mr. McIvor to be 33 miles, but I should think 23 was nearer it) want of a road which was never opened out though ordered, and consequent want of supervision, the planting on this site was never successful, and it was eventually ordered to be abandoned and sold (G. O., Revenue Department, No. 1,011, 8th June 1871, and 294, 3rd March 1874; but though advertised no purchaser came forward (G. O., No. 485, dated 21st April 1874) and nothing further has been done with regard to it up to date.

Mailkoondah site, plants unsuccessful, ordered to be sold but no offers received.

MANAGEMENT.

Mr. McIvor.

14. The late Superintendent, Mr. Graham McIvor, had charge of this important undertaking from the outset, and the undoubted success of the Government plantations, and general introduction of Chinchona cultivation on the Nilgiris is mainly due to his practical knowledge of gardening and general ability. His application of the mossing system as a means of harvesting and renewing the bark will be referred to further on. At the time of the introduction of the Chinchonas by Mr. Markham, Mr. McIvor was Superintendent of the Government Botanical Gardens at Ootacamund, an appointment which he continued to hold in conjunction with the Chinchona Plantations until 1870, when he was relieved of the former duty.

Dr. Cleghorn and Captain Morgan.

15. Mr. McIvor, as Superintendent of the Gardens, was subordinate to the Conservator of Forests, and acted under Dr. Cleghorn's orders and advice in the selection of sites and arrangements generally. Shortly after Mr. Markham's arrival, Dr. Cleghorn proceeded on leave and Captain (now Major-General) Morgan acted as Conservator, and as has been stated in para 9 protested against the abandonment of the Dodabetta site. The names of these officers should therefore not be lost sight of in a record of the introduction of the Chinchonas on the Nilgiris.

Mr. McIvor placed in independent charge.

16. In 1861 Mr. McIvor was placed in direct communication with Government, and the Chinchona experiment ceased to be under the control of the Conservator of Forests, who, however, was directed to "periodically inspect and report on his (Mr. McIvor's) operations," (Vol. I, Blue Book, page 185) and accordingly we find reference to the subject in the Acting Conservator's Reports for 1860-61 and 1862-63, after which it ceases, and, I presume therefore, that the Conservator was relieved of the somewhat invidious duty of inspecting and reporting on plantations over which, and the officer in charge, he had no authority. Mr. McIvor continued in independent charge until 1869 when the fact of his being agent for, and partner in, various estates on the hills having been strongly represented, he was placed under the Commission of the Nilgiris, then just formed into a separate District.

Mr. McIvor's death.

17. Mr. McIvor died on the 8th June 1876, and Government directed that pending further orders the management of each plantation should continue with its present Superintendent or Overseer, under the control and responsibility of the Commissioner (G. O., R. D., No. 1,390, 29th September 1876,) and subsequently declined to approve of a proposal of the Commissioner's that Mr. Rowson (the Assistant Superintendent, at Neddivattam) should act as Superintendent, and supervise all the plantations.

Mr. Rowson and Narrainsawmy Naidu.

18. Mr. Rowson came out in 1869, and was at first employed at Dodabetta but subsequently transferred to Neddivattam where he has done excellent service, and acquired a good practical knowledge of Chinchona cultivation. The Head Overseer in charge of the Dodabetta plantation, Narrainsawmy Naidu, has been connected with the undertaking from the outset. Mr. McIvor reported highly of him as steady, painstaking and honest, but Mr. Cockerell records that he "has no faculty for organising labor."

Mr. Broughton.

19. Mr. Broughton's name is intimately connected with the history of Chinchona cultivation on the Nilgiris. Mr. Markham after visiting the plantations in 1865, suggested the employment of a resident Quinologist; which met with the approval of the Government of Madras and the Secretary of State. Mr. Broughton, then Assistant to Dr. Frankland, at the Royal Institution, London, was selected, and his services engaged as Government Quinologist, in 1866. Mr. Broughton arrived at Ootacamund in January 1867, having received very full instructions as to his duties from the

Secretary of State (page 3, Vol. III of Blue Book). These are summarized by Dr. King in his "Manual of Cinchona Cultivation in India," as follows:—

"To discover by repeated analyses of bark from plants growing in different situations, the conditions as regards elevation, climate, soil and exposure best calculated to produce the largest possible yield of alkaloids; to ascertain the difference as regards yield and efficiency between green and dried barks; to analyse the leaves and flowers of the different species; to settle the best method of drying the bark; and, finally, to enable Her Majesty's Government to arrive at a decision with respect to the best and cheapest method of preparing the febrifuge for use among the poorer classes of the natives of India." Mr. Broughton laboured most assiduously and conscientiously towards the elucidation of the above points, and submitted many valuable reports. He established his laboratory at Ootacamund, and subsequently his Alkaloid Manufactory at Neddivattam, where he produced the "Amorphous Quinine," of which so much has been written. Differences of opinion unfortunately occurred betwixt him and Mr. McIvor, arising mainly from the difficulty of defining where the duties of the one, as a gardener or arboriculturist ceased, and those of the other, as a Chemist, began. Continual clashing and contradictory statements and reports were the result, and as it appeared from the report of a Commission that the working of the factory was unsatisfactory, and the manufacture of the Amorphous Quinine costly and wasteful, Government accepted Mr. Broughton's resignation then tendered (G. O., R. D., No. 217 and 405, dated 11th February and 11th March 1875) and no successor has been appointed, the manufacture having been entirely discontinued.

20. Besides the above Executive Officers, the Commissioners of the Nilgiris, Messrs. Brecks and Cockerell, evinced much interest in the plantations, and Mr. McCallum Webster, whilst Acting Commissioner, subsequent to Mr. McIvor's death, devoted much time and attention to their management. Doctors Cornish and Bidie have been employed by Government to submit reports on special points, especially with reference to the different views as to cultivation, treatment, &c., held by Messrs. McIvor and Broughton. Mr. Howard, the eminent Quinologist, has been ever ready with information and practical suggestions, for which he has received the thanks of the Secretary of State, and with mention of his name, I close the list of those who have been directly or indirectly connected with the management of the enterprise up to the present time.

Messrs. Brecks, Cockerell, Webster, Drs. Cornish and Bidie.

Mr. Howard.

CULTIVATION.

21. Mr. McIvor has fully explained the methods adopted in propagating young plants and their subsequent treatment in his "Notes on the propagation and cultivation of medicinal Chinchonas," originally published in 1863, and of which a revised and enlarged edition appeared in 1865. He treated the young plants originally received under glass in order the better to modify the conditions of moisture, temperature, &c., at will. The seeds received were sown in boxes, filled with carefully prepared soil. As soon as the original plants were fairly established, Mr. McIvor proceeded to propagate from them by layering, cuttings and leaf buds, and when he had thus secured a sufficient supply of fairly grown plants, he planted out a number under varying conditions, from the result of which he decided to plant out on open cleared ground instead of under shade or in comparatively small clearings in the virgin forest the method which had been adopted in Java.

Propagation.

Planting out.

22. This proved entirely successful, and a few years later the Dutch adopted Mr. McIvor's method and abandoned their own.

Mr. McIvor's method adopted by the Dutch.

Land
trenched or
pitted.

No. of trees
reported as
permanently
established
in 1873-74
and area
planted.

23. In some cases the land on which the young trees were planted out was trenched but, as a rule, pitting was the system adopted. The pits were 2' by 2' by 2' and the distances apart vary from 12' by 12' to 3' by 3'.

24. At the close of the official year 1873-74 the total number of trees reported to have been thus permanently established was as follows:—

	NUMBER.	ACREAGE.	
		Surface.	Base.
Total of Plants of all sorts on Neddivattam Plantation	474,740	455	371 24
Do. do. Dodabetta	345,980	378	287 25
Do. do. Pykarra	304,484	336	243 00
Do. do. Mailkoonda (abandoned)	65,254	75	40 28
TOTAL...	1,190,458	1,244	941 77

representing an average of 1,042 trees per acre (surface measurement) on Neddivattam, 915 on Dodabetta and 906 on Pykarra estates. The average height of the finest *Succirubras* being at this time given by Mr. McIvor at 32 feet with a circumference of stem at base 28 inches, and of *Officinalis* 25 feet by 18 inches.

Weeding,
Pruning, &c.

25. Subsequent to planting out little or no care was required beyond weeding, and a certain amount of pruning and removing of suckers which appears latterly to have been discontinued under Mr. McIvor's orders. In his Administration Report for 1874-75 Mr. McIvor recorded that, owing to cultivation having been neglected since 1870 the plants put out subsequent to 1866 had not thriven so well as those planted prior to that year, but to this statement Government took exception in para 11 of their order (No. 2,273, dated 10th July 1877) as the funds at the Superintendent's disposal appeared to have been "hardly fully utilised." Experiments have also been made from time to time since 1868 on the application of various descriptions of manure, the results on the whole, especially in the case of farm yard manure and bone dust proving satisfactory. Renovation pits in which the weeds, leaves, &c., are periodically buried have been dug in all the older plantations at Neddivattam.

HARVESTING THE BARK.

26. Mr. McIvor turned his attention to the method to be adopted for taking the bark crop at a very early date in the history of the Nilgiri Plantations. The method generally pursued by the bark collectors on the several estates of South America where the chinchona is indigenous is simply to fell the trees and strip off the bark. Mr. McIvor at first proposed to crop the plantations by loppings, prunings, and thinnings, and subsequently to plant the trees very closely together so as to admit of early thinning and yield of bark.

Mr. McIvor
first propos-
ed lopping &
thinning.

Wrote highly
of growth
of coppice
shoots.

27. It is very noteworthy that in 1863 and 1864 we find him writing highly of the growth of coppice shoots. In March 1864 he wrote "*I feel convinced that this will be our principal source of revenue, at least for many years to come, especially as the system tried experimentally of removing strips of bark from the stems of the plants has been found to injure their growth, and therefore cannot be profitably practised*" (Blue Book Vol. II page 48) and again that coppiced trees put out good shoots if cut down between March and August, but not if cut down between September and February, except *Crown Barks* which "*produce strong shoots at any season.*"

First
reference to
mossing
system.

28. I find the first reference to the mossing system as applicable to cropping the chinchona bark in Mr. Howard's Report on his analysis of the third

consignment of bark from the Indian plantations (Blue Book Vol. II page, 49). His words were "This large product of alkaloids might probably be still further increased by *surrounding the stem with moss in the manner Mr. McIvor has so happily suggested* since Dr. DeVry found 8.407 per cent of alkaloids in a stem which had been so treated."

29. In May 1865 specimens of both mossed and renewed bark appear to have been sent to Mr. Howard for analyses, and in sending them, Mr. McIvor stated that "the system of removing strips of bark from the stems of the plant can be practised without injury, *provided the wound is instantly covered with damp moss.*" In the Annual Administration Report for 1864-65 the mossing system is described at length and spoken of as the best. It appeared that a similar process had sometimes been adopted on a small scale by the collectors of the bark in South America.

Mr. McIvor
adopts it.

30. Mr. McIvor subsequently applied for a patent for the mossing system which was refused by Government for various reasons, and their decision was approved of by the Secretary of State, who remarked "Mr. McIvor deserves great credit for the intelligent way in which he has applied a well known principle in arboriculture to chinchona cultivation, and for his suggestion that the application of moss to the bark might have a beneficial effect on the yield of febrifuge alkaloids; and I shall readily sanction any special remuneration which you may see fit to grant him on account of the benefit derived by the public from his intelligent labors."

Applies for
patent.

31. In the Report for 1865-66 Mr. McIvor formally renounced his previously recommended plan of lopping, pruning, &c., and adopted the mossing process, of which he wrote in the strongest terms of approbation. He states that his attention was first directed to it by the fact that "the deposit of alkaloid was invariably most abundant in the bark covered with clumps of moss which, in staking the young plants (a method adopted at the outset to protect them from the effects of the high winds) we had placed between the trees and the bark to prevent chafing." This curious and interesting fact led to close observation and suggested many experiments to test the manner in which the alkaloids were formed or deposited. The result of these observations is stated to have been the establishment of two points of vital importance in chinchona cultivation, viz., "first that there is a constant and never-ceasing quinine producing power going on in the leaves of the plants," whilst, second, "as if obeying a natural law to counter-balance the source of production, there is a continual waste on the surface of the bark."

Mr. McIvor
formally
abandons
lopping, &c.,
for the moss-
ing process.

32. The advantages claimed for the mossing process are that by the exclusion of light "the process of oxidation or waste is arrested and the alkaloids increased from 2½ to 20 per cent," and that it "more than doubles the bulk of bark, thus making the direct yield of alkaloid per acre fully thirty times the quantity that can be procured under any other system" (Mr. McIvor's Report for 1865-66, paras 12 and 13, G. O., R. D., No. 175, dated 15th January 1867). It appears unnecessary here to follow further the arguments for and against the mossing process, which will be further dealt with in Chapter II, suffice it that it has been mainly adopted in the plantations on the Nilgiris, and so far as we can judge, with the best results.

Advantages
claimed for
the mossing
process.

33. By G. O., R. D., No. 426 of 19th February 1869, Government sanctioned the mossing process being applied to 7,000 trees, viz., 1,000 Red Barks planted in 1862, 3,000 Red Barks planted in 1864, and 3,000 Crown Barks planted in 1864, and in August 1871, 3,000 lbs. of bark mainly from the trees which had been mossed, were despatched to England for sale. The rates realised were favorable, and in 1873 and 1874 Government sanctioned further

Mossing and
harvesting
commenced.

harvesting and consignments of bark to the Home market under the mossing system. The bark is now regularly shipped for sale towards the close of each year, and the consignments of 1876-77 realised £34,000 in round numbers for 88,708lbs. of dry bark of the various descriptions, the highest rate being 15s. 8d. per lb., realised for renewed Crown from the Dodabetta plantation. Besides the above 952lbs. were supplied to the Bombay Medical Department, valued at Rs.1,904.

Coppicing experiments on a limited scale. Experiment of 1865.

Experiment of 1871.

Experiments of 1873.

Experiment of 1875.

34. The experiments of harvesting under the coppicing system have, throughout, been on a very limited scale. In December 1865 (G. O. No. 3102) Mr. McIvor was ordered to cut down three acres of plants and in May 1867 he sent four chests of bark "obtained by felling a number of trees" presumably in accordance with the order above quoted. The number felled was not stated* but they yielded only 300 lbs. of dry bark which was sent home and realized prices then considered satisfactory. It would appear that these trees were not felled in a block, as Government evidently intended, and in 1873 Dr. Bidie was unable to find them all, but reported that those which he saw "had not done well." In May 1871, 240 trees were cut down, viz., 200 in the planting of 1862 on the western side of the valley, and 40 in the planting of 1864 on the eastern side. In the former case the suckers were left when the main stem was cut, and it is impossible now to determine which were suckers originally, and which are real coppice shoots from the stool,—besides which two or three shoots or suckers have been in several cases left growing. These now average 20 feet in height by about 10 inches in circumference at 4½ feet from the ground, but from the reasons just stated it is impossible to regard this in the light of a regular coppicing experiment at all. The 40 trees felled in 1864 plantation were in a single row, the suckers would appear to have been left, and the trees were not cut over close to the ground, neither were all the shoots save one or two removed. Twenty-six trees remain alive but poor and spindly, which is not to be wondered at considering that they are in dense shade. In 1873, three small experiments in coppicing were made, viz., one of 58 trees in May, and another of 57 trees in October in the 1862 plantation at Neddivattam, and one on 50 trees (crown barks) at Dodabetta in June. In the case of the 58 trees of which the suckers were left, one has died, the remainder are healthy, averaging 17 feet by 9½ inches, the increase in height since last measured in 1874 being given by Mr. Rowson at 107 inches, but here again it is impossible to say which are suckers and which real coppice shoots. The 57 trees felled in October were cut over as close to the ground as possible, and all suckers removed, 21 have failed to shoot, and the remainder average 12½ feet by 6 inches. The stools in this experiment were not rounded off, but left in a very rough state, which was doubtless the cause of so large a proportion rotting off and failing to throw up shoots. Of the 50 *C. Officinalis* trees felled in the Dodabetta Plantation in 1873, 43 have sprung very freely from the stool, the suckers, if any existed, having all been removed when the trees were felled. All the coppice shoots have unfortunately been left growing, some stools having as many as 18 or 20; otherwise we should have had some really fine trees. In Chapter III, I suggest what should now be done in the case of this, the most successful coppicing experiment I have seen in the Government Plantations. The 50 trees yielded pounds 202 stem bark and pounds 17 branch bark. They were planted in 1863 (Sub-division No. II. 1863 B) and were therefore just 10 years old when felled. A further experimental coppicing of 115 trees *C. Succirubra* took place at Neddivattam in June 1875 under orders of the Commissioner. The trees were situated in the 1862 plantation (sub-division

* Given by Dr. King at 100, viz., 50 in December 1866 and 50 in January 1867, vide his Manual, page 44.

No. II, 1862 B.) and yielded 248lbs. of green bark; of these trees 86 have sent up coppice shoots which exhibit an indifferent growth, both the situation, and trees selected, having been confessedly unfavorable and poor. On the 2nd June 1876 seven trees were felled by order, and in presence of, His Grace the Governor, in order to examine the state of the wood. These trees, (*C. Succirubra*), were ten years old (Sub-division No. XIV, 1866 B.) and had been barked and mossed three times. Three have sprouted from the stool, but one died off, and the shoots of the other two exhibit a poor growth of some 3 or 4 feet with a sickly appearance, the other four threw up no shoots. About a week later 12 trees (*C. Succirubra*) were felled in presence of Captain Aylmer, A.D.C. They were 12 years old (Sub-division No. VIII, 1864 E.) and unbarked. Eleven have sprung very freely from the stool, and each has several fine healthy shoots. The remaining one has at present no shoot but is quite green and healthy and appears to have sent up a shoot which has died back, or been broken off in weeding. The above comprise all the coppice experiments in the Government plantations. I shall endeavour in Chapter II to compare the respective merits of the mossing and coppicing systems, but fully agree with Dr. Bidie, who wrote in 1874: "So far we may be said to have had no experience whatever of this method of harvesting the bark as the few experiments which have been made have been on too small a scale, and not conducted in a manner likely to throw much light on the subject." The same is true in 1878.

Experiment to examine state of the wood in 1876.

Little or no real experience of the Coppicing method of harvesting.

DRYING THE BARK.

35. This was one of the points to which Mr. Broughton's attention was especially called by the Secretary of State, and in February 1870 (G. O., R. D., No. 268) he reported the results of experiments conducted at various times during the preceding two years. He found that it was preferable to deal with the bark in its green state "the labour of drying and powdering preparatory to the extraction of the alkaloids is avoided, and in addition to this from the softness of the tissues, the alkaloids are obtained in a state of solution, with greater ease and less expenditure of acid." He estimated the saving from the latter cause at "rather more than one-fourth." It being however clearly impossible to get the bark to England in its green state, he proceeded to consider the best means of drying the bark, so as to preserve, as far as is consistent with economy, the contained alkaloids from alteration.

Mr. Broughton's attention specially directed to this point by Secretary of State. His opinions.

36. He prescribes the general conditions to be fulfilled in drying the bark, as indicated by the results, as follows: "to dry it at a low temperature,—as quickly as possible,—and without prolonged exposure." He corroborates the opinion of M. Pasteur that "the drying of Chinchona bark in the sun is injurious" but qualifies it by the statement that the injurious action of sunlight is comparatively slow, whilst the bark dries rapidly under the fierce sun and dry rarified air of the Nilgiris. As bearing immediately on the subject, he proceeds to show that bark should not be taken during the South West monsoon when there is a marked decrease in the quantity of alkaloids obtainable which is greatest in May and October, just before and just after the monsoon months. On this point he is very strong, stating that "it will always be a loss to collect bark in any quantity during the monsoon."

General conditions to be fulfilled.

Bark should not be collected during the monsoon.

37. He recommends "that the bark of the Government Plantations should be dried by natural means only," and considers that, "if due care be taken, the bark may be thus dried and prepared for export without appreciably deteriorating from the quality it possessed in its fresh state." The main obstacle to this is clearly the fact that, under the stripping and

Bark should be dried by natural means only.

months, when it separates freely from the tree, and during most part of these months, drying any quantity by natural means, in the climate of Neddivattam at any rate, is quite out of the question, whilst, Mr. Broughton tells us, that

Keeping it undried impairs its appearance and commercial value. keeping it in an undried or partially dried state, impairs its appearance, and hence its commercial value, and to a certain extent its yield of alkaloids, although in this respect he found by experiment after 3 and 6 weeks that the deterioration was not so great as he had expected. It appears to me however, that he rather begged the question of how to reconcile the retention of the stripping and mossing system, which must be carried on during the monsoon, with the fact that the percentage of alkaloids was then at its lowest, and that the bark could not be dried except under cover, and by the aid of artificial heat. In any case the Superintendent and Commissioner appear to have disregarded his advice as to the season of harvesting and means to be adopted for drying, for the bark is now taken almost entirely during the monsoon months, and dried in sheds artificially heated. My suggestions on this point will be found in Chapter III.

ANALYSES AND COMPARATIVE RICHNESS OF VARIOUS SPECIES.

Chief alkaloids found in the Chinchona barks. 38. The barks of the Chinchonæ yield chiefly the following four alkaloids—Quinine, Chinchonidine, Quinidine and Chinchonine, and are valuable mainly in proportion to their yield of the first mentioned, which alone has a fully recognized medicinal value. It is not sufficient that the bark should contain a certain percentage of ante-febrile alkaloids, but these, especially the quinine, must be present in such form as renders them readily capable of being converted into crystallized salts. It has been therefore matter of primary importance to ascertain how far the bark of the Chinchona acclimatized on the Nilgiris conformed to the above conditions, and how it was affected by the system of cultivation and harvesting, and much attention has accordingly been devoted to this point, the result being a mass of recorded results rather difficult to analyse and condense.

Analyses. 39. Besides Mr. Broughton's analyses, which were very complete and constant, specimens of all descriptions of bark, natural, mossed, and renewed, have been periodically sent home to Messrs. Howard and DeVriz for analyses and report. A comparison of those analyses leaves us in considerable doubt and uncertainty as to the result of the mossing system on the yield of alkaloids, for we find those of one apparently contradicted by those of another so much, doubtless, depending on the condition of the tree and period at which the samples were removed.

Analyses generally favorable to stripping and mossing system of cultivation. 40. On the whole, however, the analyses are favourable. The renewed bark of the *C. Succirubra* has been found to yield a larger amount of alkaloids than natural bark from trees of the same age, and a larger proportion of sulphate of quinine. Mr. Howard was, however, disappointed in his expectation that this species might have been led to form quinine instead of chinchonidine. In crown barks (*C. Officinalis*) the results appeared even more favorable and constant, but bark renewed without moss also improved the result in the short period of ten months, being reported as follows: Yield of crystallized sulphate of quinine in natural bark 1.78; yield in renewed but unmossed bark, 10 months old, 2.20. There appeared a marked tendency throughout to develop chinchonidine rather than quinine, which was mainly ascribed to the effects of sunlight, both Messrs. Howard and DeVriz having recorded the opinion, with special reference to some Ceylon bark, that "the yield of quinine is greater in bark grown in the shade than when the trees were exposed." These experimental analyses have been continued at intervals

up to the present time, and Government have recently ordered (G. O., R. D., No. 274, dated 20th February 1878) a complete set of specimens being sent home for analysis.

41. I have before me the last analyses of barks of the *C. Officinalis* from all the Government Plantations made by Dr. Paul in February last, the result of which is not altogether favorable to the mossed and renewed barks, but it is gratifying to observe that the older the tree the better the yield, both of total alkaloids and crystallized sulphate of quinine, that from a 13 year old tree natural bark being respectively 5.13 and 4.11 per cent, whilst from 9 and 10 year old trees the yield is 3.47 and 2.90 per cent. Still, as I have said, so much depends on the local circumstances under which the tree is grown that I do not think we can arrive at any satisfactory conclusions from the individual specimens hitherto sent home, and even the commercial value realised, as exhibited by the account sales received, is somewhat vague and perplexing. This unsatisfactory state of things is doubtless due to want of sufficient care in the selection and description of specimens from trees of known and equal age, grown under similar circumstances, and inaccurate classification both here and at home, and too much care cannot be taken in future to obviate such discrepancies, and arrive at accurate data as to the real yield of trees of known ages subjected to different conditions and treatment.

42. So far as well known species are concerned, the bark of the Nilgiri Crown barks (*C. Officinalis*) carry off the palm, but even here there is considerable uncertainty, as we have not only several known varieties of these, but many apparently new varieties or Hybrids, the barks of which are all classed with the Crown barks. I shall presently allude to the two most valuable which have come under notice. Of distinct species the Yellow barks (*C. Calisaya*) come next in order, but these have never hitherto thriven on the Nilgiris and, at the present time, are fast dying out. Then comes the *Succirubra* or Red bark with a comparatively poor yield of alkaloids, but of a robust habit, thriving well at low elevations, and last the *Micranthæ* or Grey barks which have also not done well and are more or less dying out, or assuming a stunted and shrubby form. The *Pitayensis* Wedd a variety of *C. Rugosa* is described as valuable, but has been cultivated to a very limited extent in our plantations, whilst *C. Pahudiana*, a variety of the same species, which came to us from Java has been condemned as worthless.

43. In September 1868 Mr. Broughton first directed attention to "a valuable variety, or perhaps a species, of Chinchona whose bark surpassed in quality that of any kind previously known," and in April 1869 (G.O., R.D. No. 1740 of 19th June 1869) he reports the results of a series of analyses with its bark. Those exhibit a yield of as much as 11.50 per cent total alkaloids and 10.13 per cent of Crystallized Sulphate of Quinine compared with 4.52 and 1.50 per cent respectively in adjoining trees of *C. Officinalis*. These results were confirmed on analysis by Mr. Howard and this valuable description has been named *C. Angustifolia*, and is now being extensively propagated at Dodabetta, though it would appear not to have received the attention and development which it deserved. In 1873 Mr. McIvor appears to have sent to Mr. Howard specimens of bark from a Hybrid since called *C. Pubescens*, which on analysis was found to yield the extraordinary high percentage of 12.20 total alkaloids and in 1874, in noticing the analysis of a further consignment, (2nd strips) Mr. Howard writes "it is clear that you have an extraordinary bark and one which, with its other good qualities throws the *C. Mirabilis* (*Angustifolia*) quite into the shade." The "other good qualities" referred to are doubtless its robust habit more closely resembling

ling the *Succirubra* than any other, although it is believed to be a cross between the *C. Calisaya* and strong growing variety (*Qr. Uritusinga*) of *C. Officinalis*.

Little would appear to have been done towards the propagation and dissemination of this valuable hybrid. We have recently heard much of the *Ledgeriana* and *Sta Fe* varieties of *C. Calisaya*, the latter being, I hear from Mr. Markham, now on its way to us, but it appears to me that in the *Angustifolia* and *Pubescens* we have acclimatized descriptions deserving of our primary attention. That there are many other varieties of which we know but little in the Government plantations, I have but little doubt, but their identification and description does not fall within the scope of this report, of which I close this section with the remark that, but little or nothing appears to have been done by the late Superintendent in the shape of scientific hybridization and record of results. I find mention of such in successive annual reports but little or no trace of it in existence. Doubtless, Mr. McIvor had made extensive private notes, but these are, unfortunately, not available, and it remains for us to ascertain and make public the descriptions which promise best under the varying conditions of altitude, temperature, and soil without the advantage of his great experience and special knowledge of the subject. The results obtained by private planters on the Hills, in the Wynaad, Ouchterlony Valley, &c., which would doubtless prove of great interest and be readily placed at the disposal of Government if required in the interests of the public, appear hitherto not to have received the attention they deserve.

EFFECTS OF THE APPLICATION OF MANURES.

44. In consequence of a suggestion of Mr. Broughton's, several experiments in manuring were made in 1867 with stable manure and with Ammonic Sulphate and Guano were made in 1869, and the results were reported by Mr. Broughton in 1872 (G. O., R. D., 10th April 1872, No. 584). The application of stable manure to *C. Officinalis*, although no improvement in growth, was apparent, exercised a most markedly favorable influence on the yield of alkaloids, the total yield being found in 1872 to be 7.49, compared with 4.68 in unmanured trees, whilst there was 7.15 of pure quinine in the manured against 2.40 in the unmanured trees, an increase of 4.75 per cent. of pure quinine, sufficient to double the value of the bark in the English market. It must further be noted that the per centage of pure quinine to total alkaloids 7.15 out of a total of 7.49, renders the bark sufficiently pure for use without the expensive process of separating the sulphate of Quinine from the Chinchonidine, &c.

The results of the application of the Ammonic Sulphate and Guano to the *C. Succirubras*, were less satisfactory, and Mr. Broughton records his opinion that "as the gain in the most successful case consists mainly of alkaloids other than quinine, it will not be profitable to manure this species." In the case of *C. Officinalis* however, the gain from the application of Ammonic Sulphate (lb. $\frac{3}{4}$) was 1.22 of total alkaloids, of which 0.57 was quinine and of Guano (lb. 1) 2.53 per cent of which 2.01 was quinine, the latter thus increasing the value of the bark by 1s. 6d. per lb., whilst the cost of the Guano was not more than 2½d. per lb.

45. The application of these nitrogenous manures caused no apparent increase in the luxuriance of growth and the improvement in the bark was only apparent on analysis. Mr. Broughton had "long been of opinion that the alkaloids in the bark of the trees are not specially active constituents in the processes connected with the life and growth of the plant, and this supposition is supported by the circumstance that the increased amount of alkaloids produced

Little or no scientific hybridization has been carried on.

Experiments made in consequence of Mr. Broughton's suggestion.

Effect of stable manure.

Ammonic Sulphate and Guano.

Alkaloids not active constituents in life and growth of plant.

by the manure causes no change in the appearance and rate of growth of the tree." This has an important bearing on the stripping and mossing process, for, if Mr. Broughton's deductions be correct, they go far to account for the extraordinary fact that the repeated decortication of the trees appears so far not to have interfered with their growth and healthy condition.

46. On receipt of Mr. Broughton's report, Government ordered further experiments with the nitrogenous manures, but I find no record of their having been carried out. They also ordered that "ordinary farm-yard manure should also have a competitive trial." This description of manure has subsequently been applied with favorable results. At Neddivattam its application caused the bark of trees which it had been found impossible to remove, to lift freely, and Mr. Rowson is in favor of its general application. At Dodabetta 20,000 trees planted in 1869 and 1870 were manured with stable manure last year with good results, and a similar number will be manured this year. As Mr. Broughton remarked, "it thus appears that the action of manures promises a new direction in which the cultivation of the chinchona alkaloids can be still further improved."

OBJECTS OF GOVERNMENT IN UNDERTAKING AND RETAINING THE PLANTATIONS.

47. Much has been written at various times regarding the retention of the plantations by Government after the establishment of the Chinchonas on the Nilgiris had become an accomplished fact. They have been accused of interfering with private industry, and even threatened with legal proceedings for sending the bark to England for sale. It appears therefore advisable to refer briefly to past correspondence on this point. Government have, throughout, disclaimed any intention of interfering or competing with private enterprise, their sole object being, on the contrary, to establish and increase the production of so valuable a tree, and, by careful experiments, conducted over a series of years, to arrive at definite conclusions as to the descriptions most likely to produce good results under various circumstances of elevation, soil, and climate. The first part of the programme has been successfully carried out, but it is matter for much regret that the late Superintendent did not do more towards furthering the latter, or at least kept the results of his experiments and observations so much to himself that the public in 1878, sixteen years after the opening of the first plantations, are still quite in the dark as to what to grow, and where to grow it.

48. In 1862 the Secretary of State indicated the principles which should guide Government in the undertaking. He wrote "the two first objects of the experiment are the provision of an abundant and certain supply of bark for the use of hospitals and troops, and the spread of the cultivation throughout the hill districts, in order to bring the remedy within the reach of frequenters of jungles and of the native population generally." The commercial advantage to be derived from it were to be quite a secondary consideration, although, "of course, a return for the outlay, and the spread of Chinchona cultivation by private enterprise are very desirable in themselves" (page 255. para 4, Vol. I of Blue Book).

49. Government, in 1871, considered the advisability of selling the Pykarra and Mailkoonda Estates, but, on the Commissioner reporting that he saw no probability of disposing of them at a fair price, and that the total extent had been miscalculated, orders were issued for retaining the former, abandoning only the upper portion of the Mailkoonda plantation and retaining the lower portion as "a wild Chinchona wood as an experiment." This did not succeed, and the abandonment of this (the Mailkoonda) estate was sanctioned in 1874 as

Further experiments ordered.

Objections raised.

Objects of Government not inimical to private enterprise.

The Secretary of State indicated general principles in 1862.

Government thought of selling Pykarra and Mailkoonda in 1871.

Despatch of Secretary of State, stating reasons for retaining other plantations.

Mr. McIvor's views on this point.

Secretary of State endorses views of Madras Government as to retention of plantations.

Chinchonidine deserving of more attention.

already stated (para 13). The other estates the Government considered "should certainly be retained" and wrote accordingly to the Secretary of State, giving their reasons which may be epitomised in the fact that although "Chinchona planting in India was a proved success, it had not yet altogether lost the character of an experiment which it would be unsafe to entrust to private hands." The same is true at the present day. These views were in accordance with those of the Commissioner and Mr. Broughton, but Mr. McIvor appears to have been in favor of disposing of the plantations which, writing in *August* 1871, he thought would be best effected "in three or four years hence." I find, by a subsequent unpublished report written in 1875, that he materially qualifies this opinion, for he requests that he and his department should be left unfettered and independent, and that Government should decide on "a clear and definite plan of administration" and only in the event of Government considering this "inconvenient or undesirable" does he consider that "it may prove greatly to the advantage of the State and the community at large for the Government to retire from this cultivation, and leave its full development to private enterprise." "*Aut Caesar aut Nullus*"! either Mr. McIvor, as Superintendent of the Government Chinchona plantations was to be left entirely independent, or Government should abandon the enterprise!

50. The Secretary of State, in reply to the communication from the Madras Government, concurred fully in their views. He remarked "I incline to the opinion that a portion of the plantations should remain *permanently* under Government superintendence." He proceeds, "it should be clearly understood that the intention of Government in sending their surplus bark to England for sale in the open market is not to enter into permanent competition with private growers, whose success would be received by Government with great satisfaction, but rather to act as their pioneer and to establish the reputation of Indian grown bark for their advantage. At the same time the Government will do rightly in continuing the sale of bark until the outlay attendant upon the introduction and cultivation of the plants is repaid." And again, writing in 1873 (G. O., R. D., No. 286, dated 2nd March 1874) "the means of supplying the Chinchona febrifuge to the people of India in a cheap form, and in sufficient quantity, is a question which must always be considered as paramount in the conduct of the plantations. The object is to be attained in two ways, which must supplement each other: first, the manufacture from bark on the spot; and second, for some years to come at least, the purchase of the febrifuge in the cheapest available form in Europe." Government appear to have acted generally in accordance with these principles up to the present time, but the gradual introduction, and more general use of the comparatively cheap alkaloid *Sulphate of Chinchonidine*, in which the red bark is so rich, has apparently not received the attention which it deserves.

LOCAL MANUFACTURE OF A CHINCHONA FEBRIFUGE.

Mr. Broughton's Amorphous Quinine.

51. After repeated experiments in the manufacture of a "cheap febrifuge" Mr. Broughton in 1870, decided on the preparation subsequently named *Amorphous Quinine* by the Inspector General, Indian Medical Department, Madras. The process followed in its manufacture was described at length by Mr. Broughton in a Report dated December 1873 (G. O., R. D., 1st April 1874 No. 408). It consisted in "precipitating the alkaloids in an insoluble state and subsequently separating them from the mass of impurities with which they were mixed by solution in alcohol" and Mr. Broughton claimed for the method that "the very cheapest materials are used, and the greatest economy is practicable—the only material of which the consumption is large being wood fuel." The

process was first tried in the small laboratory at Ootacamund, and subsequently on an extended scale, with the approval of Government, at Neddivattam.

The results of its medical trial are given in a Report by the Inspector General, Indian Medical Department recorded in G. O., R. D., No 29 of 11th January 1871, who cites the testimony of several Medical men as to its efficacy, and suggests its extended use which was approved of by Government. First results favorable.

Dr. King tells us in his Manual page 53 that "up to the end of the financial year 1872-73 about 600 lbs of Amorphous Cinchona alkaloids have been produced at the Nilgiri factory." Quantity produced.

52. Doubts as to the economy of the manufacture having arisen, the Government appointed a committee consisting of Dr. Cornish and the Commissioner (Mr. Cockerell) to investigate the subject (G. O., R. D., No. 759, dated 22nd June 1874) with special reference to (1) the cost, and (2) the medicinal value of the product. The report of these gentlemen recorded with G. O., R. D., No. 217 of 11th February 1875 forms a valuable contribution to the literature of the chinchona experiment. They showed that "on the most favourable calculation Government are paying twice as much for the amorphous quinine as it is worth" and that "the drug, as prepared and issued, is of uncertain composition; sometimes it is rich in quinine; at others chinchonidine and chinchonine predominate." Under these circumstances the Government decided on abandoning the manufacture stating that similar attempts had failed in Java and America, and that, should circumstances hereafter render it desirable to revive the attempt to manufacture, it could easily be done. Mr. Broughton resigned his appointment early in 1875 and, as stated in para 19, no successor has since been appointed, nor the manufacture revived. Committee appointed to investigate. Government abandon the manufacture

53. It appears unnecessary to enter further into the various questions which have from time to time presented themselves in the past history of the plantations which are fully detailed in Dr. King's excellent "Manual of Cinchona cultivation in India" already referred to.

FINANCIAL STATEMENT OF THE PLANTATIONS.

54. I have prepared a statement of receipts and expenditure for the plantations from the commencement up to the close of the official year 1875-76, including interest on annual balance of charges at the rate fixed by the Government of India viz. $4\frac{1}{2}$ per cent. The statement is based on the figures supplied by the Accountant General but excludes all charges and receipts on account of Mr. Broughton's manufactory. The quantities of bark delivered to him for manufacture, their quality, and consequently the proper rate at which they should be charged are still to a great extent unsettled. It is therefore deemed best to exclude them altogether as well as the value of buildings originally erected for the Quinologist's department, but since transferred and made use of by the Superintendent of the plantations. The statement also contains no charge on account of rent or purchase of land. As it was all Government waste and unproductive, partly forest and partly grass, it would be almost impossible to assess it fairly. Private planters must, however, take this item into account in framing estimates for their own guidance. Receipts and expenditure. All receipts and expenditure on Factory account excluded. No charge for rent or purchase of land.

55. The rates of assessment on Government lands on the Nilgiris are at present Rs.2 for forest and As.8 for grass land per acre per annum after five years occupancy, plus cost of demarcation and survey, and any further sum which the land may be run up to when exposed to auction. Land may be acquired in fee simple at 25 years purchase. More favorable rules for the acquisition of waste lands are under the consideration of Government. Existing rates for Government waste land on the Nilgiris.

31st March
1876 selected
as date for
closing the
capital ac-
count.

56. The close of the official year 1875-76 has been considered appropriate for closing the capital account of the existing Plantations. All extensions had then ceased, the regular yield of bark had commenced and the Superintendent, who had inaugurated and conducted operations up to that time; died very shortly afterwards. The 31st March 1876 therefore suggests itself in every way as closing a marked epoch in the past history of Government Chinchona cultivation on the Nilgiris.

Capital
account.

57. The statement of Capital Account is as follows:—

CAPITAL ACCOUNT.

Statement of Receipts and Expenditure on account of the Chinchona Plantations from the commencement up to the close of 1875-76 compiled from the Accountant Generals Books, returns of sale from India Office, and other sources.

Years.	RECEIPTS.								CHARGES.											
	Sale of Plants, Seeds, &c.		Value of Bark sent to Eng- land and sup- plied to other Governments or Depts.		Total.		Establishment including Superinten- dent's salary.		Buildings and Plant.		Working charges.		Value of Convict labor.		Interest on balance of charges.		Total.			
	Rs.	a. p.	Rs.	a. p.	Rs.	a. p.	Rs.	a. p.	Rs.	a. p.	Rs.	a. p.	Rs.	a. p.	Rs.	a. p.	Rs.	a. p.		
1860-61	...	...	...	...	...	...	...	...	...	...	4,821	15 0	...	...	...	...	4,821	15 0		
1861-62	...	...	...	...	...	...	...	...	...	...	22,914	15 4	...	...	216	15 4	23,131	14 8		
1862-63	...	...	...	...	...	...	...	...	...	...	48,890	0 0	...	...	1,257	14 4	49,647	14 4		
1863-64	...	...	...	...	...	...	12,726	14 7	...	...	53,173	9 2	...	...	3,492	0 10	69,392	8 7		
1864-65	...	...	...	...	...	...	24,444	8 11	...	...	59,666	12 0	...	...	6,614	11 5	90,726	0 4		
1865-66	...	...	...	...	...	...	25,449	14 0	3,700	0 0	58,887	5 0	...	...	10,697	6 2	98,734	9 2		
1866-67	2,450	0 0	...	...	2,450	0 0	23,803	9 10	3,025	0 0	52,632	0 0	48,666	10 8	15,140	7 1	143,267	11 7		
1867-68	...	...	237	8 0	237	8 0	26,087	3 1	2,000	0 0	43,295	14 4	48,666	10 8	*19,637	7 6	140,337	3 7		
1868-69	1,680	0 0	...	...	1,680	0 0	25,671	7 10	2,030	0 0	30,636	1 0	48,666	10 8	27,779	7 8	134,783	11 2		
1869-70	...	...	...	...	...	...	25,783	5 4	1,650	0 0	19,163	0 0	...	...	33,769	2 3	80,365	7 7		
1870-71	323	14 0	...	...	323	14 0	23,730	5 4	300	0 0	6,143	0 0	...	...	37,385	9 5	67,558	14 9		
1871-72	...	...	3,479	3 6	3,479	3 6	17,157	5 4	850	0 0	13,160	4 9	...	...	40,411	2 8	71,578	12 9		
1872-73	227	1 4	4,388	2 1	4,615	3 5	12,724	0 0	550	0 0	16,441	0 0	...	...	43,475	10 4	73,190	10 4		
1873-74	300	9 0	36,417	6 3	36,717	15 3	12,574	0 0	553	0 0	15,091	14 0	...	...	46,561	8 8	74,785	6 8		
1874-75	273	4 0	...	...	273	4 0	16,406	8 0	1,700	0 0	17,417	0 0	...	...	48,274	9 3	83,798	1 3		
1875-76	2,000	0 0	60,404	7 11	62,404	7 11	17,234	0 0	...	...	28,973	0 0	...	...	52,033	3 1	98,240	3 1		
Total...	7,254	12 4	104,976	11 9	112,231	8 1	263,793	2 3	16,963	0 0	490,807	0 7	146,000	0 0	336,797	4 0	1,304,360	6 10		

*For the Financial year of 11 months.

NET RESULT.

Total charges Rs.1,304,360 6 10
Total receipts „ 112,231 8 1

Balance of charges or Capital Account 1,192,128 14 9 or Rs.1,405 per acre (excluding Nurseries.)

CHAPTER II.

PRESENT CONDITION OF THE PLANTATIONS.

PRELIMINARY.

1. I turn, with pleasure, from a *resumé*, of the somewhat vague, and often conflicting, records of the past, to the present condition and prospects of the plantations, which is matter on which I can write from my own knowledge and observations. My enquiry, although somewhat monotonous and wearying, so far as the mere enumeration was concerned, has become daily of greater interest as I have gradually arrived at some idea of the great importance of the subject, and the many and varied aspects in which it should be considered. I do not claim to have made myself *thoroughly* conversant with these during the comparatively short time I have been employed on the special duty, especially as I have not had the advantage, of any one as a guide, who could possess a thorough knowledge of the several plantations, and their past management. This knowledge the late Superintendent alone possessed, and much of it died with him, or is left on record in private memoranda to which we have not access. I have thus been obliged, in a great measure, to presume and draw conclusions for myself without knowing *why* a particular course was adopted, or a certain result ensued.

2. I may premise my statement of the existing state of things by an expression of opinion that they are, on the whole, satisfactory. Although the number of trees falls far short of what was represented, and ought to have been found on the estates, they stand, as a rule, close enough together;—although more cultivation might, and ought to, have been had for the money, what there is is generally good, considering the difficulties which have been experienced as to labor supply;—and,—although it is a matter for question whether any one, in the late Superintendent's position, should have been left so long virtually uncontrolled, the scope and freedom thus enjoyed have not been without advantage;—affording a greater latitude in petty expenditure which, had a hard and fast rule been laid down, as must have been the case had the plantations formed part of any department, might have proved inimical to the success of the undertaking at any stage. This, doubtless, induced Government to place Mr. McIvor in the specially independent position he enjoyed.

THE ENUMERATION.

3. Immediately on arrival I commenced on this, the immediate duty for which I was detailed, and, in consultation with Mr. Webster, decided to commence with the Dodabetta plantations, with the intention of reading up the records, &c., in the Commissioner's Office during spare hours. This I soon found to be impossible as, after seven or eight hours spent in enumeration, the preparation of a daily return from my notes was all that could be accomplished.

More accurate boundaries and subdivisions found necessary.

Revised survey and plans.

Subdivisions defined on the ground by stones.

Methods pursued in enumeration

Time occupied.

Results.

4. I saw at once that it would be necessary to subdivide the plantations into blocks of convenient size, which would prove of permanent advantage, by facilitating systematic management and supervision. Besides this I found the boundaries of each year's planting very imperfectly laid down, either on the ground or plans, and it was found quite impossible, in some instances, to ascertain them, either by marks, or the growth of the trees. I therefore proceeded to lay them down afresh, being guided as much as possible by the Overseer's knowledge, the apparent age of the trees, and whatever boundary marks were found on the ground or plan. The year's plantings were then subdivided into blocks, natural features and plantation roads being made the boundaries, or dividing lines, wherever practicable. The whole of these new boundary lines have been surveyed and entered on the plans by Mr. Raynsford Russell, whose services, in the absence of a Government Surveyor, I was authorized to employ (G.O. No. 309, dated 26th February 1878). New plans shewing the subdivisions and area of each, are now being struck off by the Revenue Survey, and will accompany this report, with which a skeleton or key map is bound up for facility of reference. Each subdivision is now being clearly marked on the ground by means of stones bearing a consecutive number, corresponding with tabular statement in Appendix. This was sanctioned by G.O., R.D., No. 621, dated 25th April 1871.

5. As to the method pursued in enumeration,—as it was impossible, owing to irregularity of planting, and the intermixture of species, to arrive at anything like accuracy by merely counting out selected areas of limited extent,—I found that, where the lines were pretty straight, and trees of the same species planted together, I could make most progress, consistent with sufficient accuracy, by placing four or six sharp coolies in the lines, and making them count them up and down, the Overseer or Assistant Superintendent being at one end and myself at the other. In this way I found I could get through as many as 25,000 a day; but, where the lines were crooked, or species mixed together I had to adopt much slower methods: viz., subdividing by ropes into very small portions, and setting one or two men to count each species, under close supervision and check by the Overseer and myself; or by having a tape tied to each individual tree, and then collected, species by species, and counted by me. This last, a native plan, suggested to me by Sir William Robinson, ensures great accuracy, but is very tedious.

6. By these methods, steadily pursued, the enumeration of the trees in all the plantations has been effected in about $2\frac{1}{2}$ months, or rather less if we allow for Sundays, holidays, &c., whilst Mr. Brecks estimated in 1871, that it would take six months; Major Hessey put it at as many years; and the late Superintendent at "a life time!"

7. Every living tree, or young plant likely to grow into a tree, has been counted, the result being a total of 569,031, as compared with 1,190,458, estimated by the late Superintendent, namely:—

Plantations.	Number of trees estimated by the late Superintendent.	Number of trees actually found on enumeration.	Remarks.
Dodabetta	345,980	226,936	* A few hundred trees remain in the Mailkoonda plantation, chiefly Red barks, but so overgrown that it would probably cost more than they are worth to clear away the brambles. I have therefore entered it as blank.
Neddivattam	474,740	208,780	
Pykara { Wood Hooker }	304,484	45,758	
		87,557	
Mailkoonda	65,254	...	
TOTAL...	1,190,458	569,031	

Of this number, however, I consider that fully one-fifth or 20 per cent., being either supplies or stunted trees, should be deducted, and that Government would be unwise to consider that they have more than 450,000 fully established healthy trees in the plantations, which is certainly not a sufficient crop for the area under cultivation, being an average of only 530 trees per acre.

CLASSIFICATION.

8. This may be considered as twofold, viz., first, according to species, and second according to age and growth. With regard to the former, I have not attempted to classify according to *varieties*, as such would have taken too much time, and necessitated my examining almost every individual tree, and seeing it in flower, but have confined myself to the main classification of *Red, Crown, Yellow, and Grey Barks, and other species*. Under this system, we certainly lose sight of hybrids, which are incorrectly classed with the parent whose growth they most resemble, and of varieties of the *Officinalis, Calisaya, and Micrantha*, some of which are much more valuable than others, but all this can form subject of future enquiry and record in the ordinary working of the plantations, and will be greatly facilitated by the subdivision of the blocks, and knowledge of the total number of trees in each.

9. According to the above classification, we have the following, compared Results with the late Superintendent's statement:—

Descriptions.	Numbers given by the late Superintendent.	Numbers actually found on Classification.	Remarks.
Red Bark	579,938	260,837	
Crown Bark	531,282	305,432	
Yellow	34,250	552	
Grey	28,759	1,874	
Other Species	16,229	336	
Total.....	1,190,458	569,031	

from which it appears that both the yellow and grey barks are fast dying out as already reported. There may be a few more still existing, but not many, as I carefully noted these species. As regards trees classed under "*other species*" which includes *C. Pahudiana, Pitayensis* &c., the return is not strictly accurate, for, as explained above, hybrids and varieties, which were doubtless originally classed under "*other species*" when planted out, are now temporarily classed either with red or crown barks.

10. To arrive at the second classification, according to age and growth, I have measured 30 or 40 average trees in each subdivision, and struck an average for the year's planting, the girth measurement being taken at breast high, or about $4\frac{1}{2}$ feet, and not at foot of stem as was Mr. McIvor's plan. Where trees of more than one description occurred, in any quantity, in a subdivision the average measurements of each were taken.

Classification according to species.

Classification according to age and growth.

Results.

II. The results are as follows:—

YEARS PLANTING.	AVERAGE HEIGHT IN FEET.					AVERAGE GIRTH IN INCHES AT 4½ FEET.				
	Red Barks.	Crown Barks.	Yellow Barks.	Grey Barks.	Other Species.	Red Barks.	Crown Barks.	Yellow Barks.	Grey Barks.	Other Species.
1862	24	18½	...	...	...	17	11	...	...	...
1863	14½	16½	...	...	...	10½	11½	...	...	...
1864	12½	15½	...	...	...	10½	9½	...	...	...
1865	19½	14	...	20½	...	11½	8½	...	8	...
1866	17½	10½	...	...	...	11½	6½	...	...	...
1867	12½	9½	...	...	...	8	7½	...	...	...
1868	14½	11	...	...	...	8	7	...	...	...
1869	12	8½	...	15½	...	7	4½	...	6½	...
1870	9½	7½	...	...	...	6½	4½	...	...	...
1871	...	...	...	...	...	...	...	...	...	...
1872	...	5	...	...	...	...	2½	...	...	...
1873	...	9	...	...	...	...	3½	...	...	...

The above statement is compiled by taking the averages of the several subdivisions in all the plantations in each years planting, and finding the means. The averages vary greatly in separate subdivisions, even of the same year, according to conditions of soil, exposure, &c., but the statement shows the maximum average growth, both of *Succirubra* and *Officinalis* to be in the oldest planting 1862 (Neddivattam only) that of 1865 (Neddivattam, Dodabetta and Wood Estates) coming next, whilst the measurements of the planting of 1872 (Dodabetta only) are the lowest. The highest individual trees which I measured were *Succirubra*, 37½ feet, in the 1862 planting at Neddivattam, and *Officinalis*, 26½ feet, in the 1863 planting at Dodabetta, and the greatest girths, at 4½ feet from the ground, 28 inches for *Succirubra* and 23¼ for *Officinalis* both at Neddivattam. The 1865 measurements of *C. Micrantha* were taken on the Wood, and the 1869 measurements on the Hooker Estate; they compare favorably with those of *Succirubra* and *Officinalis* of the same age. No measurements of *C. Calisaya* were taken as in the only subdivision in which they occur in any number, (No. XXIX 1870 C. Neddivattam) they are sickly and fast dying out. Full details as to the average height and girth in each subdivision are given in the remarks column of Statement A. in Appendix.

PARTICULARS OF ENUMERATION AND CLASSIFICATION AND COMPARISON WITH MR. McIVOR'S ESTIMATES.

12. Full particulars as to the enumeration and classification are appended in tabular statements A., B. and C. The detailed statement of each subdivision is intended mainly for the future guidance of the Superintendent and Overseers, who it is hoped, will thus have a guide towards what is required in each, and be in a better position to check labor and yield of bark, &c.

13. Mr. McIvor's last statement (G.O. 10th July 1877, No. 2,273,) gave the numbers planted out at 1,190,458, from which he claimed a deduction of 30 per cent (357, 137, trees) for failures—to this I add 65,254, stated to have been planted out in the Mailkoonda Plantation of which, for reasons stated, I have taken no account, making 422,391 trees in all to be deducted, which ought to have left 768,067 in the Dodabetta, Neddivattam, and Pykarra plantations instead of only 569,031 as now shown. I do not, however, believe that 1,200,000 plants could ever have been planted out in the plantations which, even according to Mr. McIvor's estimate of surface measurement, had an area of only 1,244 acres; (including Mailkoonda); for this would have given an average of nearly 1,000 trees per acre, or 6½ feet a part over all, whereas a very

Full particulars of enumeration and classification in tabular statements appended.

Comparison with Mr. McIvor's estimates.

small proportion is planted at this distance; many being at 7 feet (848 to acre), 8 feet by 9 feet (605 to acre), 9 feet (537 to acre), and some even 12 feet (302 to acre) apart. I should not therefore have been surprised at the comparatively small number of trees found on accurate enumeration, were it not for the number of supplies or renewals made from time to time, especially on the Dodabetta plantation, which should have brought the numbers of existing trees above five hundred and sixty-nine thousand, or, as I have stated, really four hundred and fifty thousand healthy living trees.

14. It must further be borne in mind that the late Superintendent's returns showed 2,640,000 plants as having been propagated, of which number rather less than 200,000 were supplied to the public. Thus 2,400,000, or allowing for loss in transplanting 2,000,000, would appear to have been planted out from time to time in the Government plantations, of which less than one quarter survive. In para. 13 of their Order No. 2273 of 10th July 1877, Government called for an explanation regarding the 1,200,000 plants (2,640,000—1,200,000—200,000=1,200,000) which appeared "to have perished or been otherwise disposed of," but I am not aware that any has been furnished. With these facts before me, I cannot refrain from an expression of regret that we have no record of the disposal of so large a number of valuable plants.

Mr. McIvor's return shewed 2,640,000 plants propagated.

No record of the disposal of 1,200,000.

15. A further subject for regret, to my mind, is the comparatively few trees of the yellow and grey barks remaining alive in the plantations, compared with Mr. McIvor's estimates (552 and 1,874 versus 34,250 and 28,759 respectively), and the apparent dying out of the former valuable species, without any adequate steps having been taken to ascertain the real cause, and experiments, by cuttings and seed-sowing, to acclimatize it in more congenial soil and climate.

Small number of Yellow and Grey barks remaining.

16. Again, although I have no doubt that the numbers classed under "other species" should be largely increased by the addition of Hybrids, partly self-sown and partly planted out, I can find no record of either to justify Mr. McIvor's returns. I find mention in almost every annual report of the number of Hybrids propagated, but neither the Assistant Superintendent at Neddivattam, nor Head Overseer at Dodabetta know any thing of them, and I am reluctantly led to the belief that the Hybrids we have are, for the most part at all events, the result of accident and not of careful hybridization, such as Mr. McIvor's reports would lead one to believe had been carried on, which accounts for our finding them for the most part interspersed amongst the other species all over the plantations, and not planted out separately, save in the small extension (Subdivision No. XIII, Appendix A. Hooker); on the Hooker estate, where they have almost all perished, or show little or no analogy to the species or variety to which they were said to belong.

Hybridization apparently the result of accident, and no sufficient record found

EXISTING CIRCUMSTANCES OF EACH PLANTATION.

17. I proceed to a description of the existing circumstances of each plantation commencing with propagation.

18. There are two propagating houses for Dodabetta, situated in the Government Gardens, and capable of containing about 40,000 plants; when I visited them there were roughly 44,000, viz., 35,000 *C. Angustifolia*, 7,000 *C. Pitayensis*, 1,000 *C. Calisaya* and 1,000 *C. Succirubra*, but a good many of those best established had to be kept outside. The young plants, whether reared from cuttings or seed, are in earthenware saucers filled with a prepared soil of loam, sand, and brick dust, and kept in a temperature heated by artificial means until the roots are well struck. The plants of *C. Angustifolia* were from cuttings, and those of *C. Calisaya* and *Succirubra* from seed received from Neddivattam; all looked very healthy. Orders have only been registered

Propagation

for 100 of *C. Calisaya* by General Morgan, the remaining plants being available for Government estate purposes, or general distribution. Until now there has been no regular propagating house at Neddivattam, but Mr. Rowson has recently built one in which he estimates he can rear 50,000 seedlings or 20,000 cuttings at a time. The estimated cost was Rs.1,000, but it will cost a little more, owing to great wastage in converting the teakwood received from the Government depôt at Ootacamund. The building is very cheap, and will supply a great want. There are no propagating houses on the Wood or Hooker estates.

Nurseries.

19. The nursery at Dodabetta near the old jail is 2.11 acres in extent and contained 350,000 plants when I inspected it in April. These were all *C. Officinalis* with the exception of 3 beds, containing about 3,000 Hybrids. 300,000 plants are bespoken by private planters, and 50,000 reserved for supplies in the Dodabetta plantations. The nursery requires a little working up as the soil appeared sodden and baked in some places, but this was after long drought. The area of nurseries at Neddivattam is 1.26 acres; they contain 300,000 plants of which all are *C. Succirubra* except one bed of 2,000 obtained from the propagating house at Dodabetta, and said to be *C. Angustifolia* and *C. Pitayensis* (the latter certain). Orders are registered for all the plants which were ready for delivery in January, but planters object to removing them before the monsoon has well set in, i.e., in June. The plants are well grown and appear very healthy. The nurseries on the Wood and Hooker estates are 0.80 acres in extent viz., Wood 0.40 acres, Hooker 0.40 acres. They contained about 150,000 plants when I inspected them in March. The plants were almost all *C. Succirubra*, and are all bespoken by private planters. The nurseries appeared well situated and carefully managed.

Plantation area.

20. The total area under cultivation by the revised survey is now 848.47 acres, viz:—

Dodabetta	...	...	...	...	320.47
Neddivattam	...	...	...	...	301.63
Wood...	...	...	...	...	72.18
Hooker	...	...	...	...	154.19

The original survey in 1872 made the area, excluding Mailkoonda, and deducting 5.04 acres under tea, 863.39 acres. I am quite unable to trace the source whence Mr. McIvor got his areas on which Budget estimates have been framed, but which vary almost every year. In his statement recorded with G. O. No. 2,273 of 10th July, 1877, he makes the base area 941.77 and surface 1,244 acres. The figures I give below are exactly those of the original Revenue Survey Maps, viz:—

Dodabetta (excluding tea)	...	...	...	...	307.31
Neddivattam	...	...	...	...	340.10
Wood	...	...	...	...	69.54
Hooker	...	...	...	...	146.44
Mailkoonda	...	...	...	...	30.91

Base area...894.30

to which, even if we add 11 per cent. for a slope of one in two over all, it makes only acres 992.67 and not 1,244. I have omitted Mailkoonda altogether as there remain only a few hundred trees, chiefly *C. Succirubra*, in the lower portion, which is so overgrown with brambles and scrub that it is impossible to enter it, and clearing it would, I fear, cost as much as the value of the trees. The upper portion of a grass hill at Neddivattam (Subdivision No. XXVIII

Appendix A) is also now struck out from the cultivated area, as the planting has failed, and it is proposed to replant with accacia for firewood supply. Small extensions have been made in the Dodabetta and Hooker plantations, and a small portion of 1864 and 1867 planting, which was somehow omitted in the survey of the Wood estate is now included. Plantation roads, which were included under cultivation in original survey, are now taken out in calculating the actual area.

DODABETTA.

21. The Dodabetta plantation is situated at an elevation of from 7,500 to upwards of 8,000 feet above the sea; the surface mould in the ravines is rich and often two feet deep, the substratum being gneiss with, here and there, decomposed felspar and hornblende; on the upper portions of the grass hills there is but little surface soil over the rock which crops out frequently. The portion first taken up for planting contained, according to Mr. Markham "*Osbeckias holly, wild cinnamon, Michelias, Vaccinium, Sapota, &c.*, with an undergrowth of *Lobelia, Acanthus*, and fern, and nine species of Chinchonaceous shrubs." The average rainfall is 44 inches per annum, and Dr. King states that observations, calculated on the returns for five years, show that there are no fewer than 218 dry days in the year. The mean temperature in the shade may be taken at 60 degrees and the maximum at 70 degrees Fahrenheit, whilst, during the months of December, January, and February, there is often sharp frost at night which does considerable damage to the Chinchona trees in the low lying portions of the plantation.

22. I divided the plantation into 39 subdivisions, some of which are of small extent, owing to the configuration of the ground, plantation roads, &c. My enumeration gives 226,936 trees in the 320.47 acres cultivated, of which by far the greater number (226,647) are *C. Officinalis var Condaminia, Bonplandiana*, and *Crispa*. There are many varieties and Hybrid plants which require careful observation and study to define the species to which they belong.

23. The cultivation appears to have been very good, the whole plantation being weeded, and soil well worked by the "mamotie" (Indian spade) several times each year. There has been no dearth of labor here as at Neddivattam and Pykarra. The trees are, on the whole, very healthy, but the percentage of renewals or supplies has been very great, reaching to 50 per cent in some subdivisions (e.g. Nos. XXX, XXXI and XXXII Appendix A, Dodabetta), and the renewals would appear in many cases to have been repeated several times. The hill sides are, as a rule, very steep, and the wash during the monsoon must be very great; catch-drains have been made to a certain extent, but I do not think there are enough, or of sufficient breadth and depth, to carry off the surface water. The weeds are buried for most part in rows between the trees. All descriptions appear to grow best on a northerly exposure, and, as Mr. McIvor has placed this on record, I was astonished to find that he had planted so much with a south-westerly exposure. This is markedly the case with the younger plantations (Subdivisions XXXIV, XXXV and XXXVIII in Appendix A, Dodabetta) in the low lying portion below the old jail where the growth, especially of Crown Barks, is poorest and most irregular. The causes of the southerly exposure being unsuitable are not far to seek. The sun during the hottest and driest months of the year is in the south, and the Chinchonas on hill sides facing the south are exposed to the full force of his rays, mitigated, as a rule, by no clouds. The effect, especially on trees barked late in the year, is very marked; they are literally burnt up on the exposed side. I observe also that Mr. Broughton

found that exposure to the sun-light, decreased the amount of alkaloids in the bark. Besides this they are exposed to the full force of the south-west monsoon.

Manuring.

24. Besides the experiments carried on by Mr. Broughton in 1867 and 1869, and a small experiment on 355 trees with patent manure from Melbourne in 1873, cattle manure was applied to 20,000 trees last year with good results, and the same has been done during the present year.

Harvesting the bark.

25. Harvesting has been carried on entirely under the mossing system, with the exception of 50 trees *C. Officinalis* coppiced as an experiment in 1873. Almost all the trees in the older plantations have been barked three times, and even in the plantations of later date most of the trees have been already barked once if not twice, perhaps somewhat prematurely;—55,435 trees in all have been barked. The bark appears to renew well, and I observed no trees which had failed to renew altogether, and comparatively few which had failed partially. Owing to the majority of the trees being *C. Officinalis*, and the growth generally slow at so high an altitude, the yield per tree or acre is less than that of the Neddivattam or Pykarrá plantations, but it has been generally supposed that the bark had a higher market value being found richer in alkaloids. Recent sales, however, do not bear out this theory.

Yield.

26. The yield last year was as follows:—

Natural Crown bark...	...	lbs.17,478½
Mossed do	...	„ 10,066
Renewed do	...	„ 5,401½
Branch do	...	„ 5,855½

Total... „ 38,801½

and that for the current year, is estimated at lbs.40,000 of dry bark, viz:—

Natural	..	...	20,000
Mossed	...	...	10,000
Renewed	...	...	6,000
Quill (or branch)	...	...	4,000

which, if the season prove favorable, will be harvested. No record of the number of trees barked in each working season has hitherto been kept, but this will be done this year.

Moss supply and cost.

27. The supply of moss is obtained from the sholas on Dodabetta, Snowden, and the neighbourhood, and is ample, there being no private plantations in the vicinity, although, even so, it has now to be gathered 8 and 10 miles away. The Head Overseer estimates the cost per bundle of lbs.100 at annas 8, and the average cost of stripping and mossing 25 trees at Rs.1-13 viz:—

lbs.200 of moss as above	...	Rs.1 0 0
fibre	...	„ 0 0 6
1 barker	...	„ 0 4 6
2 mossers, at 4 annas each	...	„ 0 8 0

Total... 1 13 0

25 trees of the *C. Officinalis* yield, on an average, lbs.50 green bark, equal to, say, lbs.18 dry; according to this estimate each pound of dry bark costs annas 1-7½ for collection and mossing the tree. In the Administration Report for 1876—77 (recorded with G.O., R. D. 20th February 1878, No. 274) Mr. Webster estimated the average cost of collection and mossing at As.1-10·4 per pound of dry bark, but this estimate was arrived at by merely dividing the total expenditure, classed under “mossing and collection of bark,” by the total yield which included branch bark loppings, &c. The estimate cannot therefore lay any claim to accuracy, but corresponds very nearly with my calculations which show

As.1-10·8 as the average cost for all the plantations.

28. As the bark is collected, it is taken by the barkers to the drying shed, formerly the old jail, where it is dried on stages which can hold about lbs.1,500 green bark at a time; six coolies at As.4 each are employed in drying and packing. They can get through on an average lbs.1,500 per diem, which makes the cost of their labor As.1-7½ per lbs.100. Previous to last year it was dried in the sun, but hot air flues have now been introduced. The bark loses about two-thirds of its weight in drying. It is then packed in bales of lbs.100 nett, the covering being waterproof packing bags, supplied from Bimlipatam by Messrs. Arbutnot and Co., at a cost of Rs.1-3-0 each, including delivery. The bales are next despatched to the store, formerly Mr. Broughton's Laboratory. Two coolies can carry four bales or lbs.400 daily, their wages being As.4 each per diem. This makes the cost of this carriage As.2 per lbs.100. When a sufficient quantity of bark is ready in store, it is forwarded to Mettapolliem in carts, each cart taking 10 bales, lbs.1,000, for Rs.6, or rather less than As.1 per lbs.100.

29. Thus the Dodabetta bark costs about Rs.12-1-8 per lbs.100 or Rs.271-2-1½ per ton for stripping, mossing, (which I am obliged to include as the same three men strip and moss) packing, and carriage to the Railway at Mettapolliem, viz:—

Cost of collection and mossing per lbs.100	...	Rs.10 1 1½
Drying and packing	...	„ 0 1 7½
Packing bags and carriage to store	..	„ 1 5 0
Cartage to Mettapolliem	...	„ 0 9 7½
Miscellaneous, e.g., packing on carts, and Railway trucks, peon's batta, &c....	...	„ 0 4 0½
		12 1 8

excluding share of supervision, cost of buildings, &c. Thence the cost of carriage to Madras and London is, of course, the same for the bark from all the plantations, viz., Rs.8-11-6½ per lbs.100 or Rs.195-6-3½ per ton, making a total charge of Rs.20-13-2½ per lbs.100 on Dodabetta bark. Subsequent to this there are brokers' charges, deductions, &c., which appear very heavy, and require looking into, in order to arrive at the actual cost to Government of placing its bark in the London market.

30. The actual expenditure incurred on the Dodabetta plantation, including pay of establishment, new buildings, &c., was Rs.14,246-0-1 for the official year 1877-78, viz:—

Establishment	...	Rs.2,074 0 0
Working charges	...	„ 5,111 3 9
Buildings	...	„ 1,488 2 6
Nurseries	...	„ 464 13 0
Manure	...	„ 400 5 6
Collection of crop	...	„ 4,589 14 10
Contingencies &c.	...	„ 117 8 6

The account sales received in the Commissioner's office do not show the amounts realized for the bark from each plantation separately; besides which the amounts received for one year's crop are, as a rule, not credited till the following official year has commenced, as recently pointed out by Mr. Webster. Hence it is all but impossible to arrive at the net result of any particular year's working by placing the receipts and expenditure in juxtaposition.

NEDDIVATTAM.

Elevation,
soil, &c.

31. The Neddivattam plantation, situated 18 miles from Ootacamund, varies in elevation from 5,000 to 6,000 feet above the sea, the lower portion, extending to the verge of the steep descent to Gudalur, and the Wynaad table-land. The superstratum is a very rich and deep vegetable mould, its basis being, according to Markham, "a mixture of syenite and laterite, curiously combined in strata." Dr. McPherson described the superstratum as a "marl" and the substratum, as granite and trap in process of disintegration, but Captain Morgan and Mr. McIvor both objected to this description, stating that there is no *marl*, properly so called, on the hills, and the former suggesting "a compound of mica and felspar" as more probable. Mr. Markham found in the original forest, *Hymenodictyon Excelsum* (called by Roxburgh *Cinchona excelsa*) an *andromeda*, wild yam, cinnamon, pepper, coffee, wild ginger; an *osbeckia* with purple flowers, and numerous ferns and orchids." The prevailing undergrowth was *Acanthus*, *Melestomaceæ*, &c., and, according to Dr. McPherson, "the exact same small fern which covered the plants imported by Mr. Markham." The average rainfall is 105 inches, which, according to Dr. King's statement, based on the returns for five years, falls on 125 days of the year, leaving no less than 240 days on which no rain falls. The mean temperature in the shade may be stated as 60° with a maximum of 80° and minimum of 54° Fahrenheit. From November to May the sky is generally clear and sun's rays very powerful, but, from May to November, there are generally clouds, and, even if rain does not fall, the air is cool and moist.

Rainfall and
temperature.Subdivision
and enumer-
ation.
Number and
description
of trees.

32. I divided the plantations into 29 subdivisions, of which, however, one is blank. The area by revised survey is 301.63 acres and the number of trees 208,780, of which 164,456 are *C. Succirubra*, 43,694 *C. Officinalis*, 193 *C. Micrantha*, 421 *C. Calisaya*, and 16 "other species". Here also there are many varieties, or Hybrids, the most frequent being *C. Anglica* (?) *C. Pubescens*, and what is locally known as the broad-leaved *Condaminea* ("Uritusinga?")

Cultivation.

33. The cultivation is, on the whole, similar to that of Dodabetta, but has suffered from the difficulty of getting and retaining sufficient labor owing to there being no *Badagas* available as at Dodabetta, and great competition for the *Canarese* in the large planting districts of the Wynaad and Ouchterloney Valley, which are in the vicinity of the plantations. Weeding has, for this reason, been but superficial in some years, and the soil probably not so much worked as at Dodabetta, where, however, it is more required, being, as a rule, much poorer and not half the depth. The general condition of the plantations and trees leaves, however, nothing to be desired, and there is a marked absence of the frequent renewals or supplies which appear to have been found necessary at Dodabetta. There are, on the other hand, many more self-sown trees coming up between the rows especially in the vicinity of water channels, whereas at Dodabetta, there are scarcely any; doubtless due to the greater working or digging in the latter. The hills are not so steep as at Dodabetta or Pykarra, and the greater proportion of the *C. Succirubra* gives this estate the appearance of being much further advanced, and the ground better covered than any of the others. The growth of the *Succirubras* in the older plantations is very fine, the average height and girth being 24 feet by 18½ inches as shewn in para 11 of this chapter. The best results with this species are obtained in the ravines, formerly covered with forest trees, and attempts to grow it on the upper slopes and grass hills have not been very successful. The *C. Officinalis*, on the other hand, appears to prefer a comparatively high elevation and is

Growth of
the Red
Barks.

Crown Barks

not averse to the open grass hills. Some of the latest planting (1869 and 1870) which is chiefly of this species, in the higher portion of the plantation where the upper road leads to the Ossington Estate, promises to be as successful as that of the Red Barks near the Assistant Superintendent's Bungalow. Trees of the *C. Calisaya* have been planted in various parts of the estate, with varying conditions of soil and aspect; but none have done well. After the first few years they assume a shrubby appearance, with numerous stems, none of which attain any size; afterwards they become sickly, and but few live beyond the 10th or 12th year of growth. The cause of this is difficult to ascertain. I was inclined to ascribe it to want of drainage, and overmuch moisture at the roots, but have convinced myself it is not so, as the soil in which they were planted, even in the lower portions of the estate, has a subsoil composed of small gravel, affording excellent drainage, and their roots, on being dug up, exhibit no signs of rust or decay. The causes must therefore be sought for elsewhere, and I confess I am not at present in a position to offer a decided opinion. It has been suggested to me that the rainfall of Neddivattam is too great for them, but after perusal of Mr. Markham's descriptions of the climate of the Forests of Caravaya (Peru) where they are indigenous, I do not think this can be the cause; much more probable is Mr. McIvor's surmise, which has Mr. Howard's concurrence, that it is the four or five months drought which is inimical to this species, which probably requires a moderately moist climate during the whole year. It is very noteworthy that neither the *Calisaya* nor *Micranthæ*, both from Caravaya, have done well any where on the Nilgiris, whereas the *Succirubra* and all varieties of *Officinalis* which come from Ecuador, 10 degrees further north, have succeeded.

Yellow
Barks.

34. In 1869 Mr. Broughton applied nitrogenous manures to some of the trees in this plantation with no apparent influence on their growth, but with good results on the yield of alkaloids, as described in Chapter I, para 45. Subsequently stable manure has been applied in various portions of the plantation, exercising apparently a favourable effect on the health of the trees, as evinced in the case of 6,000 *Succirubra* trees manured in January 1877, by the bark stripping much more freely during the succeeding barking season. In all the older planting, Mr. Rowson has also dug renovation pits between the trees in which the weeds, and leaves which fall from the trees, are buried; when decayed and mixed with earth this forms a very fine description of leaf-mould as manure.

35. With the exception of the few limited experiments in coppicing recorded in Chapter I, para 34, the bark has been harvested by the stripping and mossing process. Roughly speaking two-thirds of the trees have been so treated since the commencement. Mr. Rowson has furnished me with statements of the subdivisions in which trees were barked in 1877-78, and in which he proposes barking during the current year. The former is too vague to be of use as it contains such entries as "all trees of size in subdivision—", and on working out the totals as accurately as possible the numbers are far in excess of those given in his annual report 91,860 *versus* 58,500. I therefore reject it altogether. According to his statement Mr. Rowson proposes, roughly speaking, to bark 157,444 trees in the current year of which 121,146 are red, 46,096 crown, 168 grey and 34 yellow barks, but I can scarcely imagine that he will get through so many, representing three-quarters of the whole estate; nor does the estimated yield coincide. Were there time to refer he would probably qualify his statement by the remark "all trees of size." The older trees have all been barked

Harvesting
the Bark.Mr. Rowson's
estimate of
Trees barked
in 1877-78.Number of
trees to be
barked in
current year.1,000 experi-
mental trees
barked six
times.

three or four times, and those known as the 1,000 experimental trees, *C. Succirubra*, in subdivision I, 1862A, no less than six times, having yielded lbs.14,327 of dry bark in all, and lbs.3,200, or an average of lbs.3.2 per tree on last barking (1877-78.) These are the trees referred to in para 8 of G. O., R. D. No. 274 dated 20th February 1878. The bark is every where renewing freely, and the trees show no outward signs of deterioration from being subjected to the stripping process.

Yield.

36. The yield of dry bark last year was as follows:—

Natural Crown	...	...	...	...	lbs.9,400
Mossed do.	...	...	...	...	„ 9,669½
Renewed do.	...	...	...	...	„ 4,962
Natural Yellow	...	...	...	...	„ 1,845½
Natural Grey	...	...	...	...	„ 150
Natural Red	...	...	...	...	„ 11,748
Mossed do.	...	...	...	...	„ 16,407
Renewed do.	...	...	...	...	„ 14,090
Dust do.	...	...	...	...	„ 58
Mixed	...	...	...	...	„ 181

Total lbs. 68,511

and that for the current year is estimated at lbs.76,000, viz.:—

Natural Crown	...	...	...	...	4,000
Mossed do.	...	...	...	...	8,000
Renewed do.	...	...	...	...	12,000
Natural Red	...	...	...	...	20,000
Mossed do.	...	...	...	...	8,000
Renewed do.	...	...	...	...	24,000

A record of the number of trees barked to obtain this amount will be kept.

Moss supply and cost.

37. The moss supply is derived from Government Sholas at the head of the Ouchterloney Valley and towards Pykarra Bungalow. The Assistant Superintendent is apprehensive of its running short, and it certainly appears very advisable to reserve the supply in all reserved sholas in the neighbourhood for the use of the Government Estate. The attention of Government has already been called to this subject (G. O., R. D. No. 120, dated 23rd January, 1878.) Mr. Rowson estimates the cost of collection, barking and mossaing at As.1-7-86 per lb. of dry bark, of which the collection costs As.1-0-6 and the labor of stripping and mossaing Pies 7-80. The total cost per pound is therefore very similar to that at Dodabetta (As.1-7½) and may be accepted as correct.

Drying and packing the bark.

38. The bark is dried in the old jail which is fitted with stages and hot air flues. The building is in a very shaky condition, and the roof leaks considerably during the monsoon. Plans and estimates have been framed and submitted for the erection of a new drying shed and store to cost Rs.35,730. The matter lies over pending the experiment of sending some of the bark to Coimbatore to be dried, in accordance with G. O., No. 95 dated 18th January, 1878, meanwhile the old building has been patched up, and the roof covered with tarpaulins which cost, including carriage, about Rs.1,200. I state my opinion as to this point in Chapter III.

Cost of collection and carriage.

39. I have not the details of petty expenditure in drying and packing the bark as for Dodabetta, and do not delay the report to get them, suffice it that the total cost of collection and mossaing, drying and packing (including bags) and carriage to Mettapolliem amounts to Rs.14-15-6½ per lbs. 100, or

Rs.335-5-7 per ton. The extra cost compared with the Dodabetta bark, is of course due to cartage from Neddivattam to Ootacamund. The Neddivattam bark costs, according to the above estimates Rs.23-11-1½ per lbs. 100 delivered in London.

40. The actual expenditure on the Neddivattam plantation, including pay of establishments, new buildings, &c., was Rs.25,790-2-8 as detailed below:—

Expenditure for 1877-78.

Establishment	...	...	...	...	Rs.4,725	0	0
Nurseries	...	...	...	...	„ 1,610	8	3
Working charges	...	...	...	...	„ 5,734	1	11
Buildings (Repairs)	...	...	...	...	„ 3,476	8	4
Do. (New works)	...	...	...	...	„ 1,121	10	10
Collection of Crop	...	...	...	...	„ 9,014	3	4
Miscellaneous	...	...	...	...	„ 108	2	0

The revenue for the year cannot be stated as explained in para 30.

PYKARRA.

41. There are two separate plantations at Pykarra, situated on different sides of the Pykarra river, viz.:—the Wood Estate on the right, and the Hooker Estate on the left bank. The cultivated area of the former is 72.18 acres and of the latter 154.19 acres. The circumstances of both being very similar, I shall consider them together. The highest elevation is 6,200 feet at top of what is known as “The Avenue” in the Wood, and in the upper portion (sub-division No. VI, Appendix A) of the Hooker Estate, and the lowest somewhat below 5,000 feet in the Wood Estate. The upper soil is humus and a dark brown loam of a rich description, with a sub-soil of fairly retentive clay composed of decomposed felspar. The indigenous flora closely resembles that of Neddivattam. I have no data as to the rainfall, and mean temperature, but they must be almost identical with those of Neddivattam, from which the Hooker Estate is distant only three miles, and the Wood Estate five miles as the crow flies.

Situation of Wood and Hooker Estate.

Elevation, soil, &c.

Rainfall and temperature.

42. I divided the Wood Estate into nine and the Hooker into thirteen sub-divisions. The enumeration and classification of trees gave the following results:—Wood Estate 45,758 trees of which 37,779 are *Succirubra*, 7,182 *Officinalis*, and 797 *Micrantha*. Hooker Estate 87,557 trees of which 58,537 are *Succirubra*, 27,909 *Officinalis* and 858 *Micrantha*. Hybrids and varieties are, as a rule, classed with species which they most nearly resemble, as in the other plantations.

Subdivision and enumeration

Number and description of trees.

Cultivation.

43. The cultivation of these plantations has, I consider, not been so careful and systematic as that of either Dodabetta or Neddivattam. This is doubtless due in great measure to their not having been so much under the immediate eye of the Superintendent and Assistant Superintendent, and to frequent changes in the Overseer in charge, the Estates being sometimes left without any reliable person to supervise labor. In the case of the Wood Estate, the Pykarra river becomes unfordable in the monsoon, and it is necessary in order to reach it from Neddivattam to go round by Pykarra Bungalow and bridge, making the distance at least ten miles. A wire for the transport of the bark, &c., has been stretched across the river at the plantation ford, on which I believe coolies sometimes cross, but the want of a foot bridge is much felt. A separate Overseer, under the Assistant Superintendent, for each plantation has recently been sanctioned, and I have no doubt the result in improved cultivation will soon be apparent. The system is similar to that pursued at Neddivattam. The growth in the “Avenue,” on the Wood Estate, is generally very good, although, from the situation being fully exposed to the south-west monsoon, the trees present a somewhat weather-beaten appearance, being more

Growth.

Crown barks or less covered with lichen. In the lower portion of this estate the trees, especially the crown barks, exhibit a poor growth, due, apparently, to the southerly exposure, and ill drained soil. The elevation of this portion, from 5,500 to 5,000 feet, is also not favourable to the growth of *C. Officinalis*. The Grey barks patches of *Micrantha* in the lower portion of the Avenue exhibit a good but somewhat shrubby growth, each tree having several stems. This is probably the natural habit of the tree. This species have recently shewn signs of general decay, chiefly attributed to moisture at the roots caused by leakage from a water channel above. The red barks on the upper portion of the Hooker Estate have done very badly, but the crown barks, even on the open grass hills, exhibit a good and healthy growth. In the lower portions this is reversed, and some of the red barks, *e.g.*, in sub-division I and VII, are excellent specimens. Extension. A clearing of 25 acres was made in 1873 for extension; the avowed intention being to plant new and valuable descriptions in rows, alternately with red barks. Only about ten acres appear to have been planted, and the rest allowed to revert to jungle, and the planted portion has not done at all well, a large proportion of the trees, especially of the new varieties, having died.

Manuring. 44. So far as I am aware no experiments in manuring have ever been carried on in the Pykarra plantations. The application of manure would doubtless exercise a most beneficial effect in the poorer portions to which I have alluded.

Harvesting the bark. 45. The harvesting has all been effected by the stripping and mossing system. The oldest plantings in each estate appear to have been barked three times, but there is little data to go on. Mr. Rowson's statement for 1877-78 shows a total of 70,103 (Red barks 46,694, Crown barks 23,409) barked in the two plantations during the year, but I expect this is considerably over the mark. His estimate for the current year is 16,381 trees all crown barks, of which 6,463 are in the Wood, and 9,918 in the Hooker Estate. The bark in some portions of both estates appeared not to be renewing so well as one could wish, but, in the case of the red barks on Hooker, it was explained to me that the trees were barked very late last season.

Yield.	46. The yield last year for both estates was as follows:—
	Natural Crown 5,979
	Mossed do. 4,944
	Renewed do. 1,640
	Natural Red 5,328
	Mossed do. 8,985
	Renewed do. 4,093
	Grey Bark 527
	31,495

and that for the current year is estimated at lbs.24,000 of dry bark, viz.:—

Natural Crown 3,000
Mossed do. 5,000
Renewed do. 4,000
Natural Red 3,000
Mossed do. 3,000
Renewed do. 6,000
Total...24,000

The number and description of trees barked in each estate will be noted this season.

47. Moss is obtained from the sholas within the plantation boundary and towards Dunsandal for the Wood Estate, and chiefly from those between the plantation and the Ossington property for the Hooker. The supply is sufficient, but cost of collection, according to Mr. Rowson's returns, is higher here than elsewhere, being As.1-4-03 per lb. of dry bark collected as compared with As.1-0-06 at Neddivattam, or, if we include the barking and mossing the trees, As.2-3-05 per lb. as compared with As.1-7-86 at Neddivattam and As.1-7-33 at Dodabetta. Moss, supply and cost.

48. The bark of the Wood Estate is dried and packed in a small shed erected for the purpose near the lines on the lower portion of the plantation. It has hitherto been dried in the sun, but arrangements for artificial heating have been made this year. The bark is despatched direct to Ootacamund by carts. The Hooker bark has hitherto been taken to Neddivattam to be dried and packed, and has, as a matter of fact, been mixed up with the bark of the latter estate, though certain bales have been marked separately as Pykarra bark. An estimate for the erection of a drying shed on the estate has been framed, amounting to Rs.3,000, without internal fitting or heating appliances, *vide* Chapter III on this subject. I have no information as to details of expenditure in drying the bark on these two estates, nor of the carriage expenditure which must vary considerably, as the Hooker bark has to be taken to Neddivattam, and then carted to Ootacamund. Drying and packing the bark.

49. The total cost of collection, drying, packing, and carriage of the Pykarra bark is given by Mr. Rowson at As.2-9-09 per pound of dry bark. On this estimate it costs Rs.17-13-4½ per lbs.100 or Rs.399-7-10½ per ton at Mettapolliem Railway station. The estimated cost per 100lbs. delivered in London would be Rs.26-8-11 as compared with Dodabetta Rs.20-13-2½ and Neddivattam Rs.23-11-1½. To facilitate comparison I recapitulate, in a tabular form, the cost of collection and mossing, and of collection, mossing, drying, packing and carriage to railway per lbs.100 of dry bark. Cost of collection and carriage.

Plantation.	Cost of collection per 100lbs. of dry bark.	Cost of collection, mossing, drying, packing and carriage to Mettapolliem per 100lbs. of dry bark.	Remarks.
Dodabetta ..	As.1-7-33	Rs.12-1-8	Exclusive of all charges for supervision, office, buildings, &c.
Neddivattam ..	" 1-7-86	" 14-15-6½	
Pykarra (Wood & Hooker).	" 2-3-05	" 17-13-4½	

50. The actual expenditure on the Pykarra plantation for 1877-78 was Rs.10,761-11-1 classed as follows:— Expenditure

Establishment	Rs. 840 0 0
Working charges	" 4,104 9 0
Buildings (Repairs)	" 434 0 9
Do. (New Works)	" 100 0 0
Wire Rope and Cradle	" 235 2 4
Collection of Crop	" 5,047 15 0

GENERAL CONDITION OF THE PLANTATIONS.

51. The trees in the plantations are, on the whole, very healthy, and there is an entire absence of regular disease, such as canker. In the lower portion of the Wood Estate, (Pykarra) I observed a good many trees, crown barks, both barked and unbarked, sickly and dying, and on digging them up by the roots, found rust and a tendency to canker in its milder Trees generally healthy.

form. I ascribe this to the situation being too low, sub-soil unsuitable, being a stiff clay saturated with moisture, and requiring deep narrow drains, and in some instances to a southerly exposure. A comparatively small number of trees were found attacked by a species of borer, but I imagine they were sickly before they were attacked.

Large percentage of renewals in Dodabetta plantation.

52. The detailed statement of enumeration (Appendix A) exhibits also a large percentage of renewals (chiefly in Dodabetta plantation) and failures. The worst subdivisions are in the lower portion of Dodabetta, near the old Jail; on some of the upper portions, grass hills, at Neddivattam; in the Hooker Estate; and in the lower portion of the Wood Estate. A large proportion is apparently due to the original plants having died down, or been nipped by frost and sambur, and existing only in the shape of a shrubby growth from root suckers never likely to grow into trees; insufficient working of the soil, and the effects of a southern exposure appear to me the other causes of failure or poor growth, and these are easily guarded against for the future.

Causes of decay in the *C. Micrantha* and *C. Calisaya*.

53. In the case of the *C. Micrantha* on the Wood Estate I believe they suffer from over much moisture at the roots, caused to some extent, by the leakage from the water channel above, and insufficient drainage. The Chinchona are, it is well known, singularly impatient of damp at the roots. On other hand, I am inclined to agree with the late Superintendent that the cause of non-success with the *C. Calisaya* at Neddivattam is the want of superficial moisture or rainfall all the year round. It is noteworthy that the *Micrantha* and *Calisaya*, even when healthy, assume almost invariably a shrubby form with numerous stems as compared with the *Officinalis* and *Succirubra*. This habit is probably peculiar to them even in their indigenous state. The result of recent sales, even mere loppings, of the *Calisaya* show that this species is well worth renewed careful attempts at acclimatization.

Six feet apart appears most suitable distance to plant.

54. I consider six feet is the maximum distance apart at which the trees, of all descriptions, should be planted out. They appear to grow better when closely planted, and are less liable to be damaged by wind and sun, besides it is easy to thin out and uproot if the trees become too crowded.

Plantation roads.

55. The plantations are very well supplied with roads, which greatly facilitates their subdivision and working. They are throughout in excellent condition, water-courses being, as a rule, provided with culverts, and streams with wooden bridges. A good system of roads and paths is of great importance in plantations, and in this respect, there is nothing to wish for in the Nilgiri Government Chinchona Plantations.

Building.

56. The buildings, consisting of the Assistant Superintendent's bungalow at Neddivattam, drying houses, cooly lines, &c., appear generally in good repair. New lines were being built at Neddivattam and Dodabetta which are doubtless completed ere this. I have already referred (para 18 Chapter II) to the new propagating house at Neddivattam, besides which a grain store was under construction by the P. W. D. The building formerly occupied by Mr. Broughton in the Ootacamund Garden has been handed over to the Superintendent of the Government Botanical Gardens, and Mr. McIvor's bungalow is occupied by the Private Secretary to His Grace the Governor. Mr. Broughton's bungalow at Neddivattam is now used as cooly lines. The situation is said to be unhealthy, and it is in an indifferent state of repair. The old Jails at Neddivattam and Dodabetta form the drying houses. The former is in very bad repair, but the latter appears in good state. The laboratory adjoining the Government Gardens at Ootacamund, is used as a

store for the bark previous to its despatch to Mettapolliem. The Overseers' bungalows on the Wood and Hooker Estates have been allowed to fall into complete disrepair, which is, I think, to be regretted. The condition and requirements of each plantation is dealt with so fully in the remarks in statement of detailed enumeration, and in Chapter III that no further general remarks appear necessary.

SUPERINTENDENCE AND BOOKS.

57. No Superintendent has been appointed since Mr. McIvor's death, and the plantations are under the immediate charge of the Commissioner of the Nilgiris, in whose office one clerk, styled Manager, and two peons form the Cinchona office establishment. The Manager receives Daily Reports of Labor from the Assistant Superintendent and Head Overseer, which he posts in the *Daily Journal*. Early in each month he receives the *Monthly Journals*, and checks entries with those on the *Daily Journal*. The above refer to labor alone. Expenditure is checked and adjusted on receipt of vouchers for payment, except in the case of labor, for which the *Journals*, are accepted as vouchers. The present Manager, (Mr. Hillier) keeps a Cash Book, in which he enters all monies received and paid, and a book showing all expenditure incurred under each budget heading for each plantation, but this is nowhere prescribed. So far as I can gather, no monthly accounts are now submitted to Government or the Accountant General; merely an annual budget estimate and account of expenditure by the Commissioner. Monies for sale of seeds and plants are received by the Assistant Superintendent at Neddivattam and Head Overseer at Dodabetta, and paid into the Treasury by them either direct or through the Manager. The Assistant Superintendent has a permanent advance of Rs.2,500, besides an old unadjusted balance of Rs.1,200 advanced by the late Superintendent on account of labor, and the Head Overseer of Rs.1,300; but the permanent advance system is not clearly understood by either, and inconvenience frequently occurs from their expending the whole amount, and waiting for more funds until their Monthly Journals are submitted and checked, and the amounts refunded to them. Mr. Webster appears to have submitted to the Accountant General in June 1877 a set of new forms of account in accordance with G. O., R. D., No. 1,454, dated 17th April 1877, which that officer has recently submitted to Government for approval, pending which they have been adopted to the extent just stated.

58. The Assistant Superintendent in charge of Neddivattam and Pykarra Estates, and Head Overseer in charge of Dodabetta Estate keep the following books:—1, Check Roll and Labor Account; 2, Daily Journal; 3, Daily Report; 4, Monthly Journal. They submit early each month a copy of Monthly Journal, with vouchers for payments, and a short Progress Report, showing state of the weather, rainfall, and works carried on for the previous month, but no further account of expenditure and receipts, nor statement of cash in hand, advances outstanding, &c. The Assistant Superintendent receives a Daily Report from the Overseer in charge of the Wood and Hooker Estates. No plantation books, nor record of operations, appear at any time to have been kept. The Assistant Superintendent and Head Overseer submit Half-yearly Reports of growth of certain standard trees on the plantations, and Annual Reports on the plantations generally, but the figures and statements in each appear, until quite recently, to have been systematically altered in the Head Office. So much has this been the custom that I feel bound to recommend Government broadly to dismiss from their minds, in considering the subject, almost all that

Office Establishment and system.

Executive officer's books and returns.

Half-yearly reports unreliable.

has been hitherto reported, resting satisfied with the certain and satisfactory results of sales of the past two or three years, and the facts as to number and classification of trees, their condition, &c., recorded in this report, the statements in which, I have endeavoured, by every means in my power, to make thoroughly reliable so far as they go.

Qualifications of Assistant Superintendent, Head Overseer and Office Manager, &c.

59. The Assistant Superintendent and Head Overseer, Mr. Rowson and Narrainsawmy Naidu, appear well qualified for their respective posts, and to possess a good practical knowledge of their duties. Mr. Burrows, the Pykarra Overseer seems hard-working and steady. The present Office Manager, Mr. Hillier, is intelligent and willing, and has acquired a fair knowledge of the history, management, and requirements of the plantations, which is very useful. He has, however, had but little experience, and no one to guide him in official routine, and appears, therefore, wanting in method in the disposal and record of business. The Overseer at Neddivattam gives Mr. Rowson satisfaction, and the Assistant Overseer at Dodabetta is well conversant with his duties and qualified for promotion if he would keep steady.

EXISTING ESTABLISHMENT.

60. The following is a statement of existing sanctioned establishments, as they stood on the 31st March, 1878:—

Name.	Denomination.	Pay.	
<i>Office Establishment.</i>			
Mr. H. Hillier ...	Manager ...	80	
Two Peons ...	Peons ...	16	
<i>Neddivattam.</i>			
Mr. W. Rowson...	Asst. Supt. Neddivattam and Pykarra Estates ...	300	
Mr. W. Wharton ...	Temporary Overseer ...	50	
Mr. J. Bonjour...	Nursery Overseer ...	20	
Two Peons ...	Peons ...	16	
<i>Pykarra.</i>			
Mr. G. Burrows ...	Head Overseer ...	70	
<i>Dodabetta.</i>			
S. Narrainsawmy Naidu ...	Head Overseer ...	100*	Including Rs.30
Mr. A. McDonald ...	Assistant Overseer ...	50	personal allow-
Two Propagators ...	Propagators ...	20	ance.

There was also a clerk attached to the office on Rs.15 per mensem, but as his appointment was not sanctioned by Government, and his pay met from working charges, he has been omitted in the above.

COMPARISON OF THE MOSSING AND COPPICING METHODS OF HARVESTING.

Limited extent of coppicing experiments.

Circumstances under which experiments were carried on.

61. In considering this important question, and comparing the results of harvesting under the stripping and mossing, and coppicing systems, the first point which presents itself is the limited extent on which the latter has been carried on, as compared with the former. 505 trees in all have been subjected to the coppicing system, whilst at least 150,000 have been stripped and mossed. The circumstances under which the trees were coppiced must next be borne in mind. The Superintendent in charge, and Commissioner (Mr. Cockerell) were, I may say,

enthusiasts in favor of the mossing system, and it is only natural to suppose that they would not go out of their way to establish the fallacy of their own views. Mr. Broughton, as a chemist, was thus, it appears to me, placed at a disadvantage in his advocacy of experimental coppicing as a method of harvesting the bark. No professional forester or arboriculturist has hitherto been connected in the matter, and Mr. Broughton had therefore no professional opinion to guide him with regard to the trees to be selected, their situation, or mode of coppicing most likely to prove successful. I visited the Neddivattam Plantation with Mr. Cockerell in 1875, and was shown the coppicing experiments. I was then Acting Inspector of Forests, and, as I had not been officially consulted, refrained from expressing any opinion, merely remarking to Mr. Rohde that no forester, who knew his business, would have coppiced trees in such a manner. I now reiterate that opinion officially. The stools showed that the trees had been carelessly felled with the axe, they were not trimmed by the adze, or similar instrument, so as to present a rounded surface close to the ground, and were, as a rule, left in such a manner as was likely to retain much of the rain in the monsoon and so rot off, and suffer from the powerful rays of the sun in the dry months. Suckers or root shoots were left standing, which, from a forester's point of view, should never have been allowed there at all, and forty of the trees, felled in a single row, were in such dense shade, that it was unreasonable to expect any good coppice growth. Again, no care appeared to have been taken with the coppice shoots after they had commenced to grow; all were left instead of only one or at most two—the most healthy—and it says volumes for the healthy root growth of a tree, and its adaptability to the coppice system, when the stool can support a dozen or twenty coppice shoots as in the Crown bark experiment at Dodabetta. The coppice growth on Mr. Rohde's estate (Balmadies), on Mr. Liddell's and Mr. Grigg's at Ootacamund, and even in the Government plantation at Dobabetta, furnishes abundant proof, if any be required, that the Chinchona tree if fairly treated, will spring very freely from the stool at different elevations on the Nilgiris.

I merely submit these views as a forester, as bearing immediately on the non, or only partial, success of the coppice experiments in the Government plantations. I have no doubt that they were carried out according to Mr. Broughton's wishes, but he was not a forester, and, so far as I am aware, laid claim to no special knowledge of aboriculture. So much for the purely professional point of how the trees were, and ought to have been coppiced.

62. Next as to the outturn of bark (1st crop) Mr. McIvor persistently argued that this was much less under the coppicing than the mossing system, I confess I cannot follow him in this; were it the case, *the part would be greater than the whole*, for he affirms that whereas the yield under the coppicing system was 2.77lbs. of dry red bark, that of Mossed trees in two crops (1st and 2nd strips) was 8.72 lbs per tree of 12 years old. Now, under the coppicing system, the whole bark of the tree is harvested, whilst, under the mossing, only a portion, say on an average 12 feet up the stem, is taken, and, although the 2nd strips of bark may have increased slightly in bulk owing to the application of moss for a year or thereabouts, I cannot believe that this would not only counterbalance the fact of the much smaller surface barked, but give an increased yield in first crop, such as stated above. The yield of inferior trees 8 years old under the coppicing system is given by Mr. McIvor, at only .75lbs. of dry bark, but the comparative yield of 1st and 2nd strips under the mossing system, I do not find on record.

Outturn of bark.

As regards the *total* yield in a period of 8 or 10 years after first cropping, the result is doubtless in favor of the stripping and mossing system, for, supposing that the trees yield on a moderate average 3lbs. of dry bark every 2 years, this will give 15lbs. in 10 years, whilst, under the coppicing system, granting that we get slightly more, say 4lbs. on first harvesting, we cannot, I think, calculate on a larger yield on second crop, which would give 8lbs. in 8 years, or say 10lbs. in ten years against 15lbs. by the mossing system; but on these points we have really no sufficient data, for, as I have said, I cannot accept Mr. McIvor's statements of comparative first yield (although they have Mr. Cockerell's support) and we have nothing to go upon regarding the 2nd yield of coppiced trees, or the period at which it can be harvested.

Percentage
of Alkaloids.

Analyses
and prices
generally in
favor of the
mossing sys-
tem.

Latest
Analyses of
Crown barks

Results
varying and
uncertain.

Dr. Bidie's
suggestion as
to transference
of
Alkaloids.

63. As regards yield in alkaloids and consequent value of the bark under the two systems, we are also, to a great extent, uncertain, owing to the conflicting nature of analyses and prices, and want of careful record of results. On the whole, both analyses and prices are in favor of the mossing system, showing that the yield of alkaloids is greater in *mossed* than *natural* bark, and, still more so in *renewed* bark under moss, whilst a recent analysis by Dr. Paul of coppice red bark from Neddivattam, with which Mr. Rohde has kindly furnished me, shows but a poor yield of quinine (1.10), and Chinchonine (.50) the total alkaloids obtained being 7.50, of which quinidine bears the extraordinarily large proportion of 5.9! On the other hand, the account sales for 1876-77 exhibit *Branch Crown*, which was presumably unmossed, as realising 15s.7d., and *Unmossed Crown* 13s.9d., against *Renewed Crown* 13s.5d., although the highest price 15.8d., was for *Mossed Crown*. For red bark the unmossed (natural?) fetched the highest price 11s., whilst *Branch* realised 9s.3d. and *Renewed* 9s.2d. per pound, whilst in the account sales of Neddivattam red bark for 1877-78 just to hand, *Renewed*, heads the list at 4s. 4d. to 5s. 10d.; next comes *mossed* at 2s. 6d. to 2s. 9d., and *unmossed* (natural) bark last at 1s. 7d. to 1s. 9d. Turning to the latest analyses of Crown barks by Dr. Paul, we find *natural* bark from Dodabetta trees of 13 years old yielding 4.11 of crystallized quinine sulphate, and that of 9 and 10 year-old trees 2.90, whilst *mossed* bark from 10 and 11 year-old trees yields 3.98, and *renewed* bark from trees of same age 4.77 of crystallized quinine sulphate, whilst *unmossed* Crown from Neddivattam yielded 4.24, and *renewed* crown only 3.99, but, as pointed out by Government (G. O., R. D., No.715, dated 8th May 1878) particulars as to the age of the trees, in the latter cases, are not given. The above remarks show the varying and uncertain nature of the results hitherto obtained, which render it almost impossible to arrive at anything approaching accurate conclusions on the subject.

64. Dr. Bidie has suggested that the increased yield of alkaloids in renewed bark, when it occurs, may be obtained at the expense of the original bark remaining on the tree, and Mr. Broughton's analyses supported this view which was, however, disputed by Mr. McIvor. Much depends upon the care with which the experiments were conducted, and whether the bark was really taken at equal heights and under similar conditions as to age, situation, &c., from mossed and unmossed trees. Regarding this, I find great difference of opinion. Mr. McIvor, in his unpublished report (1875) already alluded to, contends that as the second strips under moss contain rather a larger percentage of alkaloids than unmossed bark, the renewal cannot be effected at the expense of the natural bark remaining on the tree, and that when they (the second strips) have been removed there remains no natural mature bark to compare with that of unmossed trees, but this is hardly the question which is whether

the bark in the upper portion of the mossed tree remains unimpaired, and equal to that of an equal age and height of a tree never subjected to the mossing process; the second strips, to which Mr. McIvor alludes, have been under moss for several months, and cannot, therefore, be fairly compared with unmossed bark.

65. The advantages claimed for the mossing system are (1) that a larger harvest of bark can be obtained in a given time, (2) that the bark so obtained is of a better quality. I think there is no doubt on the first point—a larger harvest can be obtained as abundantly proved in the case of the 1,000 experimental trees (*C. Succirubra*) at Neddivattam, which have yielded 14,327lbs. of dry bark in 7 years, a yield which I do not think could be reached under any circumstances by the coppicing system.

On the second point it will be gathered, from what I have already written, that I do not consider we are yet in a position to judge, although so far the results are favorable to an affirmative answer. Mr. Broughton did not consider that the gain in the case of the *Red barks* compensated for the labour and expense of mossing, and Mr. Howard was disappointed with the results in this species.

In 1873 Mr. Broughton wrote highly of the results of mossing in the case of the Crown barks, which had also Mr. Howard's support in 1872. In 1874 Mr. Broughton somewhat modified his opinion, but more with reference to time required for renewal, and consequent bulk of crop than the *quality* of the mossed or renewed crown bark. On the other hand Mr. Markham, with whom I have been in correspondence, considers "that the *red* bark certainly ought not to be treated by coppicing, but by renewing;" but that "this does not apply to all other species."

66. Immediately affecting both points under consideration is the question whether the barking can be carried on without detriment to the tree as a plant. It would naturally be supposed that repeated decortication would materially affect its health and growth, and soon result in death. I have given this point most careful attention, and compared barked and unbarked trees of all ages and in all situations, and, so far as external appearances go, can find no signs of decay or want of health and vigor in the barked trees of either species (Red and Crown). In the oldest plantation (Subdivision I 1862 A) at Neddivattam there are thrice barked and unbarked trees growing side by side, apparently equally healthy and robust. I have not thought it necessary to fell any trees to examine the wood, but have carefully examined sections of the barked trees felled in presence of His Grace the Governor in 1876, and compared them with those of the unbarked trees felled later in the same year in the presence of Captain Aylmer. The former were planted in 1866 (Subdivision XIV, Appendix A. Neddivattam) and the latter in 1864, (Subdivision VIII). Some of the former sections do exhibit decay in the wood, due apparently to careless barking and consequent damage to the cambium layer. This was also Dr. Bidie's opinion when he submitted his report in 1873. When the bark has been carefully removed, and complete renewal has followed, the old wood shows no symptoms of decay, nor is there any apparent arrest in the development of new wood. The sections of unbarked trees, the dimensions of which are much smaller, though taken from a plantation two years older, exhibit in some instances signs of heart or ring shake, and their wood does not appear more healthy than that of the stripped and mossed trees, with the exception noted above.

Advantages
claimed for
the barking
and mossing
system.

Yield.

Quality.

Effects of
barking and
mossing on
growth.

No external
signs of
decay visible

Comparison
of sections of
barked and
unbarked
trees.

Renewal of
the bark.

67. It was in the former Subdivision (XIV) Dr. Bidie and Mr. Broughton stated that they respectively found 83 and 85 per cent of the trees had failed to renew. I have examined a great number of trees, especially in this Subdivision, and can state that, *in no instance* did I find a tree which had entirely failed to renew, although now and then there was a partial failure, evidently in cases where the cambium had been damaged by careless or unskilled barking. Since Mr. Broughton wrote Mr. Rowson has taken 37,000lbs. of green bark from this subdivision, and expects to get 18,000lbs. more this season ! Dr. Bidie reported that the unbarked trees, both *Succirubra* and *Officinalis*, exhibited a much more luxuriant and healthy growth than those which had been stripped and mossed, and that the latter were producing an undue quantity of seed. I have stated that I fail to observe any difference in the outward appearance of the barked and unbarked trees, and Dr. Bidie's measurements shewed that the actual growth was about the same. All the trees, whether barked or unbarked, are seeding much too freely and prematurely, which does not give promise of a long life for them, but I cannot say I observed this more in the former than the latter. The renewal of the bark without the application of moss or some substitute I consider too uncertain to be adopted even in a tentative manner, especially as Mr. Howard found in 1864, on examining a section of a tree treated in this manner that "not only is the woody portion less developed than would normally have been the case, but the wood itself is also partially deprived of its vitality and tending towards decay."

Renewal of
bark with-
out moss,
uncertain.

Objections
to the bark-
ing and
mossing
system.

68. The objections to the mossing system, as fully stated by Dr. King at page 43 of his manual, are briefly (1) the necessity of great care and employment of skilled labor to prevent damage to the cambium and consequent failure to renew the bark; (2) thinness of the renewed bark when richest in alkaloids rendering it necessary to allow it to remain for two or three years till it thickens; (3) diminution in health and vigor in the barked trees, and danger of their premature death; (4) that the bark must be harvested when there is much moisture in the air, (*i.e.*, during the monsoon months) when it is almost impossible to dry it by natural means, and when the bark contains its minimum of alkaloids; and (5) that, even if the difficulty of drying can be got over by local manufacture in its green state, the supplies will be poured into the factory during a limited season of the year only.

Their
considera-
tion.

69. As regards the first objection my observations convince me that our natives can readily be taught to bark without damaging the cambium; as regards the second the thinness of bark, if it be proved, is abundantly compensated by the increased yield of alkaloids, and two crops in every three years can be harvested (*i.e.*, if the first strips be taken this year the second strips will be taken next and then a year of rest allowed), third, I see no signs of "diminution in health and vigor" in the trees which have been repeatedly subjected to decortication. The fourth and fifth objections appear to me the most serious, for Broughton has found by experiment that the bark, if dried at all, is best dried by natural means, and that the yield in alkaloids is lowest in the monsoon months (*vide* Chapter I, paras 36—37). The drying difficulty may be got over by local manufacture from the bark in its green state, the best method of treatment (*vide* Chapter I, para 35), and under any system of harvesting (*e.g.* coppicing), the bark would probably come in at a certain season and not all the year round, but the low yield of alkaloids during the monsoon months, which must be the season of harvesting under the stripping and mossing system, remains, and is likely to remain, a permanent drawback to this method of harvesting. So far as our knowledge extends, however, there are equal

and even greater drawbacks to any other system of harvesting as yet suggested.

70. To sum up, I consider that the stripping and mossing system has, so far, proved eminently successful, and that, at the present time, there is no sign of its having proved detrimental to the health and growth of the trees of either description; as regards the comparative *value* of the barks taken under the two systems, mossing and coppicing, results are in favor of the former, but I consider further careful experiments in coppicing, and analysis and sale of the barks very necessary. I allude to the conditions under which these should be carried on in Chapter III.

FINANCIAL RESULTS.

71. It has been already stated in Chapter I para 11, that in 1862, Sir William Denison estimated the outlay and financial results of the plantations; placing the former at £100 per acre (including interest) in the tenth year, and at £1,000 per acre in the fortieth year when he considered the trees "might arrive at their full growth. He estimated that an acre would then yield lbs.40,000 of bark which he valued at £16,000.

Previous to this the Madras Government in their Order No. 81, dated 7th September, 1861. (Vol. I, page 182, of Blue Book) had estimated the capital outlay at £3,100 for 160 acres containing 650 trees per acre. They placed the annual charges at £1,300 and the yield after ten years at lbs.3,000 per acre, equivalent, at the low rate of six pence per pound, to £75 per acre or £12,000 per annum in all.

72. From what has been already written, it will be seen that it is impossible to frame returns having any claim to accuracy of the yield or return per acre up to the present time. We do not know the number of trees or acres from which bark has been taken annually, nor can we trace its cost till placed in the London Market, or prices realized, separately for each plantation. All we do know is that the plantations, with a total cultivated area of *852.64 acres, have cost, including interest on annual balance of charges, Rs.1,192,128-14-9 up to the 31st March, 1876, the date of closing the capital account, and that the receipts for 1876-77, after deducting cost of establishments, working charges, and interest on capital at 4½ per cent., exhibit a balance of Rs.312,282-12-0 in favor of the plantations representing a further return upwards of 26 per cent. or fully 30 per cent. in all.

73. The Revenue account for 1876-77 is as follows:—

Receipts.		Charges.		Revenue account for 1876-77.
Value of bark sent home and supplied to other Governments and departments	433,746 9 4	Establishments	12,467 7 2	
Amount realised by sale of plants, seeds, &c.	3,058 5 6	Buildings	...	
		Working charges	58,408 14 10	
		Interest on capital, viz. :—		
		Rs.1,192,128-6-5 at 4½ per cent	53,645 12 10	
		Balance in favor of the plantations representing a further return of 26½th per cent. on capital	312,282 12 0	
Total Rs...		436,804 14 10		

The balance to credit of the year may be applied in reduction of capital account, or as Government may direct.

In dealing with the existing circumstances of each plantation, I have given the expenditure for 1877-78, but as these amounts have not been finally audited and passed by the Accountant General, and I cannot state the actual result of bark sales credited during the past official year, I do not attempt to

Early Esti-
mates.
Sir William
Denison's.

The Madras
Govern-
ment's.

Yield per
acre not
known.

*Plantations
848.47
Nurseries 4.17
852.64

Cost.
Return.

Revenue
account for
1876-77.

Revenue
account for
1877-78 not
available.

Comparison of annual receipts and expenditure impossible.

exhibit its actual financial results. In the Administration Report for 1876-77 (G. O., R. D., No. 274, dated 20th February, 1878) Mr. Webster endeavours to compare the revenue and expenditure of the year, but as the receipts are mainly for the crop of the former year, and the expenditure includes no charge for interest on capital, it was clearly impossible to do so. This unsatisfactory state of things will continue until we can arrange for the proceeds of the year's crop being credited within the year, and until we have accurate returns kept of the number of acres or trees from which bark is taken in each plantation.

Estimate of annual yield and value per acre.

74. I think it advisable to submit an estimate of the annual yield and value per acre at present prices, based on the supposition that the trees are ten years' old on the average,—the oldest are fifteen and the youngest, a very small proportion, five—and that we have 450,000 healthy trees standing on 848 acres or about 530 to the acre. Of these we may class 250,000 or 471 acres as the more valuable species, *viz.*, Crown and Yellow barks, and 200,000 or 377 acres as the less valuable, *viz.*, Red and Grey Barks. The former yield $\text{lb.}\frac{3}{4}$ of dry bark per tree two years out of three, or $\text{lb.}\frac{1}{2}$ annually, which has recently realised an average price of 7s. 6d. per pound, making the value per acre $530 \times 3\text{s. } 9\text{d.} = \text{£}99\text{-}10\text{-}5$, or close upon £100 per acre per annum. The Red and Grey barks being larger trees yield $\text{lbs.}2$ of dry bark per tree two years out of three, or $\text{lbs.}1\frac{1}{3}$ per annum which we may safely value at 2s. 6d. per pound making the value per acre of these species $530 \times 3\text{s. } 4\text{d.} = \text{£}58\text{-}8\text{-}4$ per annum. This would make the annual yield and revenue derivable from the plantations as follows :—

Description.	Acreage.	Yield.	Rate per Acre.	Value.
Crown & Yellow barks	471	lbs.125,000	£99 10 5	£46,875 0 0
Red & Grey barks ...	377	lbs.266,666	£88 8 4	£33,333 5 0
Total...	848	lbs.391,666	...	£80,208 5 0

From this amount, pay of establishments, working charges, carriage, freight, insurance, and home charges would, of course, have to be deducted. On such a crop these would not fall short of £20,000, leaving a net annual surplus of £60,000.

Net annual surplus.

I do not say that the plantations could at present yield nearly $\text{lbs.}400,000$ of dry bark per annum, even if we had the labor to collect it, but on the other hand, were the area planted up to an average of 800 trees to the acre, which it could well carry, the yield would be proportionately greater without any corresponding increase in charges.

Comparison with early estimates.

The above estimates may therefore be accepted as shewing the valuable property which Government possess in their Chinchona plantations, and how profitable a field this cultivation on the Nilgiris offers to private enterprise and capital.

75. The results so far obtained compare favourably with the the estimates of 1861 and 1862, although the circumstances connected with chinchona cultivation, prices, &c., have altered so materially that it is almost impossible to institute comparisons. Sir William Denison's estimate of cost, £100 per acre in the tenth year, has proved fairly accurate; the yield per acre under the stripping and mossing system of harvesting falls short of the Madras Government's estimate, especially as the area under cultivation is not fully stocked, but the enhanced prices obtained more than counterbalance the

deficiency in quantity, and the annual yield appears so far likely to prove permanent, or at least to extend over a number of years.

76. Seed and plants are, under the orders of Government, supplied to the public at rates representing the cost of collection or rearing. The existing rate for seed is As.4 per oz. and for plants Rs.10 per 1,000. Government have recently ruled (G.O. R. D. dated 20th February 1878, No.274) that this principle should be maintained, provided always that more important work be not interfered with in order to collect seed or rear plants for sale. The existing rate per ounce of seed appears fully to cover the cost of collection and packing, but I fear that for plants will have to be raised as Mr. Rowson informs me that existing rates, although they appear to be altered according to size of plants, &c., do not cover cost of propagation. If we rear for sale the more valuable species and varieties only, the public will readily pay enhanced rates for well established plants. Rs.7,254-2-4 have been realised by sale of plants and seed and miscellaneous receipts from the commencement of the plantations up to date of closing the capital account, whilst Rs.3,058-5-6 are credited under this head in 1876-77, the first year under the new regime.

Seed and plants supplied to the public at cost price.

Amounts realised

77. Intimately connected with financial results is the labor supply, Labor, which is certainly short at Neddivattam and Pykarra. The Government rate of wage and general treatment of the laborer, compare, I think, favorably with those common in the adjoining planting districts. I am informed that much good labor was lost some years back owing to large reductions in working charges. Such are doubtless bad in many respects, although sometimes unavoidable in all Government undertakings owing to general financial pressure. Permanency of employment, good lines, and fair pay and treatment will, I think, always secure a sufficient supply of labor under existing circumstances in this country, and I consider all these are now guaranteed on the Government Chinchona estates. Special batta or rice money may of course be necessary during periods of scarcity.

CHAPTER III.

FUTURE MANAGEMENT OF THE PLANTATIONS.

CONSIDERATION OF COURSES OPEN TO GOVERNMENT.

1. As regards the future management of these valuable estates, with regard to which I am called on to submit an opinion, there are the proverbial three courses open to Government, viz. :—

- 1st—to dispose of them and trust to private enterprise for the further Disposal development of the Chinchona industry in India;
- 2nd—to retain them, as at present, without any special officer in charge Retention having time or qualifications to carry on experiments and record results under present for the information of Government and the public; resting satisfied system. with the undoubted fact of the acclimatization of known species, and ultimate success of Chinchona cultivation financially and commercially on the Nilgiris; or
- 3rd—to pursue the enterprise as an Imperial undertaking, under the best Further agency available, with the view of carrying out the second part of the develop- original programme; viz., arriving at definite conclusions as to the ment of the descriptions most likely to produce good results under various circum- enterprise. stances of elevation, soil, and climate, and, by promulgating the results, extending the cultivation, and so bringing the remedy or antidote against fever “within reach of frequenters of jungles and of the native population generally.”

2. The first course is eminently matter for the consideration of the Local Considera- Government and the Secretary of State alone, but I may be permitted to record my tion of each opinion decidedly against it at the present time. I consider the Chinchona course. experiment on the Nilgiris as still quite in its infancy. True we have introduced Arguments and established the tree, or at least two species, *Succirubra* and *Officinalis*, on these against Hills, and sufficiently demonstrated the fact that they can be profitably propagated abandoning the enter- and grown, the latter even on the bare grass hills, with comparatively poor soil at prise. high elevations; but even this we have only established by the expenditure of capital far beyond the means of most private enterprises in India; the exertions of the best scientific explorers and collectors available, such as Clements Markham; the services of perhaps the best gardener who ever came to India, the late Mr. Graham McIvor; and the advice of quinologists like Messrs. Howard and DeVriz. Reliable data as to the best descriptions to grow, where and how to propagate and grow them, the best and most economical means of harvesting and drying the bark, and the preparation of a really good and reliable cheap febrifuge are still entirely wanting.

Well may Mr. Howard style the desire of the Government of India that every native druggist's shop should be supplied with a febrifuge remedy at the cost of

Rupees 1 per ounce, "a magnificent conception;" but how is it to be brought about? Certainly not by Government abandoning the experiment in its present state to private enterprise. My bias is altogether in favor of private *versus* Government undertakings as a rule, but twenty years of Indian experience teaches me that an undertaking like this cannot, in this country, be left to private enterprise, which will either rest satisfied with the results already obtained, or, from the absence of competition, take advantage of any special knowledge or discoveries to enhance the price of the product whether in its raw or manufactured state. This is clearly not the intention of Government in introducing and pioneering Chinchona cultivation in India.

Again, I fail to see any force in the argument that, having been successful so far, Government ought to abandon the experiment, as otherwise it will compete with private enterprise. Government, it is almost needless to state, has never evinced any desire to compete in, still less to monopolize, the market for Indian Chinchonas or any other article. It sells the bark produced on its estates through brokers, in the open market, in the ordinary manner, and by so doing doubtless greatly enhances the value of Indian grown Chinchona generally. The Indian Government have furthered many industries and developed many resources of the country, too frequently at a heavy loss. To argue that in this instance, because the undertaking appears likely to prove financially a success, Government are bound to retire from it, leaving the most important questions and objects of their programme unsettled, seems to me unreasonable in the extreme.

Arguments
against
retention
under exist-
ing system.

Adoption
of third
course
recom-
mended.

The arguments which I have just ventured to adduce in favor of the Government retaining the Chinchona plantations, dispose also of the second course to which I have referred, viz., their retention under existing circumstances as regards management, and development of information. The conduct and record of careful experiments as to the best species or varieties to grow, the most favorable conditions under which they may be grown, the most economical means of harvesting the bark and its subsequent treatment, these and the promulgation of the results, and dissemination of knowledge on the subject, must, I consider, be the justification or argument for the Government continuing the enterprise, and it can scarcely be maintained that they will be arrived at under existing arrangements, or any thing short of the third course which I have endeavored to define.

SYSTEM RECOMMENDED.

3. I shall therefore confine my remarks to the means by which it may most efficaciously be carried out.

Mr. Webster's re-
commend-
ations.

The late Acting Commissioner, Mr. McCallum Webster, in paragraph 16c. of his Administration Report for 1876-77 (G.O., R.D., No. 274, dated 20th February 1878) states that the present arrangement is hazardous, as the plantations are not all under one trained Superintendent, and "it is possible that serious damage may result from any defective system of culture and harvesting." He considered that it was not at all necessary to appoint a successor to the late Mr. McIvor, but that Mr. Rowson should be entrusted with the general superintendence of all the plantations, with the title of "Superintendent." This had been already proposed by Mr. Cockerell, but not approved of by Government (G.O., R.D., No. 1,703, dated 17th November 1876). He further suggested that "it would be well if the Conservator of Forests were directed to annually inspect and report upon the

health of the trees in the plantations, and bring to notice any defects in cultivation he observes." I fully agree with Mr. Webster that the present arrangement for the management of the plantations is hazardous, but do not consider that the measures he proposes are adequate. I have recorded my opinion regarding Mr. Rowson, which is favorable; but I cannot consider him qualified for the post of Superintendent at this juncture. He is active, zealous, steady, fairly educated, and conversant with the vernacular, but he lays claim to no special knowledge of Chinchona cultivation beyond what he has acquired during the seven or eight years he has been employed on the plantations, still less to any scientific or general knowledge of arboriculture, or gardening in its highest sense. The Dodabetta Head Overseer, a native, is, I consider, quite as well qualified as regards practical knowledge and has the advantage of a much longer and more intimate connection with the propagation and cultivation of Chinchonas, on which he has been employed from the commencement of operations on these Hills. I do not wish by these remarks in any way to disparage Mr. Rowson's abilities or services. Far from it, but I am bound to record my opinion that he is not at present qualified for the post of Superintendent, who should, I consider, be the best man the Government can get in order to do justice to the plantations.

Mr. Markham wrote in 1861 that the Dutch in Java gave £1,200 a year, with the rank of a Resident, equivalent to our Collectors, to the Superintendent of their plantations (Blue Book, volume I, page 167), evincing thereby their sense of the high qualifications required for the office, its arduous duties and responsibilities. We have now arrived at a stage in the undertaking when the greatest care and forethought is required to maintain and improve the plantations, and, owing to the premature death of the late Superintendent, before he had recorded the results of his labors in hybridization, &c., we have to begin the task of experimenting and recording results almost *ab initio*.

I consider, therefore, that a special officer is required for some years to come, who shall be entirely responsible for the management of the plantations. He may be placed under the orders of the Commissioner or the Conservator of Forests. I consider that the plantations should in any case, sooner or later, be transferred to the charge of the Forest Department, and that after a few years; when they have been planted up, got into really good order, major questions as to cultivation, harvesting and hybridization settled, and the recording of data bearing on minor questions systematized; they should be amalgamated with the Nilgiri Forest Division under the orders of the Deputy Conservator in charge. Mr. Rowson might then, with propriety and advantage, be placed in immediate charge, with a position similar to that of an Assistant Conservator of Forests.

I cannot concur with Mr. Webster in his suggestions regarding a mere annual inspection and report by the Conservator of Forests. Any such course would, I think, place that officer in an invidious position, and lead to no good result. If the plantations are placed under the Forest Department, it will of course be the duty of the Conservator to inspect and report on them, as in the case of any other forest or plantation; but the officer in charge will be his subordinate and subject to his orders, and the Conservator will be responsible to Government and no one else. But if the plantations and officer in charge remain under the Commissioner, which, for some reasons, it may be deemed desirable they should for some time longer, the Conservator would be inspecting and reporting where he had no control, authority or responsibility; the result being too probably either that he would perform the

Qualified
Superin-
tendent
to be
appointed.

Plantations
to be trans-
ferred
eventually
to charge
of Forest
Department

Mere
annual
inspection
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by the Con-
servator
of Forests
unadvis-
able.

duty in a perfunctory manner, or, if he pointed out mistakes or shortcomings, would find himself at variance with the Commissioner and officer in special charge. I do not think Government would wish to place an officer of the Conservator's standing in such a position. The arrangement was tried in the case of the Forest Department when Collectors were made ex-officio Conservators and the Conservator an Inspector and adviser. The result was exactly what I have predicted above, which caused Government to cancel their orders and revert to the old system.

DUTIES OF THE SUPERINTENDENT.

4. Presuming, then, that Government appoint a special officer under the orders of the Commissioner or Conservator, it appears advisable to consider how his services can be utilized to the best advantage. I take it for granted that the object of Government will still be to further the more general introduction and acclimatization of Chinchonas in India, and the production of a cheap and efficacious febrifuge, whether manufactured in India or Europe, rather than a mere direct financial profit on the Government plantations. This must, therefore, be the first consideration steadily held in view, but the economical working and development of the plantations to the best advantage from a purely monetary point, as an inducement to private enterprise to embark in the undertaking on a large scale must, none the less, not be lost sight of. It forms, if nothing more, an important means towards the end contemplated; we have now 848 acres (exclusive of nurseries) under cultivation; of this area 72 acres containing 45,758 trees are on the Wood Estate.

5. I recommend that this estate be sold if a reasonable price can be obtained in order that we may concentrate our attention more on the other plantations. It is situated on the wrong side of the Pykarra river to be efficiently supervised by the Assistant Superintendent at Neddivattam, as he is virtually cut off from it during the south-west monsoon. It is a straggling estate, the distance from the top of the avenue to lowest planting being at least three miles, and being so near to Hooker and Neddivattam in a direct line, and situated at a similar elevation, I do not think we are likely to gain any new or special results other than on those estates.

It would none the less be a valuable small estate to a private proprietor, and should readily find a purchaser at a price representing five or ten years' purchase based on the estimated annual yield and value.

This point being settled, the Superintendent should define clearly the duties and responsibilities of the Assistant Superintendent and Overseers in immediate charge of plantations.

6. I should be inclined to relieve the Assistant Superintendent from all tailed work (such as mustering coolies) and accounts, so as to leave him free to supervise work on the Neddivattam and Hooker Estates, and most important of all, to carry on experiments and carefully record results under the Superintendent's direction.

The existing plantations should be carefully gone over, sub-division by sub-division, number of trees of each species and variety counted, their condition and how often barked noted, and arrangements made to plant up, where required, with well-established plants from the nurseries.

With this in view, I have already suggested to Mr. Rowson the advisability of having an ample supply of well-rooted healthy plants of the rarer varieties of hybrids ready next year, which I recommend should be a year of rest, so to speak, so far as harvesting is concerned, on all the plantations, in order to permit of their being gone over and worked up as suggested above. The supply of labor is not sufficient for this if a full crop of bark be harvested, nor could the necessary supervision be given to each operation. Next season is, as it happens, in any case a year of rest for almost all the Crown barks at Neddivattam, and I should merely take a sufficient crop of Red bark there, and of Crown bark at Dodabetta, to cover working expenses for the year, and rely on a bumper crop in the following year, 1880, by which time the plantations should be divided into three divisions or working compartments of nearly similar area, harvesting in future to be conducted in two out of the three each year.

7. Besides the planting up or stocking fully the existing area under cultivation, it will probably be found advisable to extend cultivation on well digested plans and estimates in order to test new varieties. Cultivation under partial shade, whether of existing forest trees or those specially planted for the purpose, should have further attention, as Mr. Broughton has demonstrated the detrimental effects of strong sun-light on the yield of alkaloids. An important direction in which such efforts should be made has been suggested to me by His Grace the Governor, viz., to endeavor to introduce and popularize the growth of acclimatized species at lower elevations each year. The Red bark grows well in the Wynaad; might it not be tried at a still lower elevation? The hybrid *C. Pubescens*, with the robust habit of the *Succirubra*, and yielding a percentage of alkaloids equal if not superior to the *Officinalis*, flourishes at Neddivattam; might it not succeed in the Wynaad, the Ouchterloney Valley, and similar elevations? With this important object in view, I venture to recommend the experimental planting of Chinchona in other districts of this Presidency, such as the Pulnies, Upper and Lower, in Madura; the Anamullays, Bolamputty and Colegal Hills in Coimbatore; the Shevaroys and Denkenekotta Hills in Salem, &c., &c., in short everywhere where we can command the necessary machinery in the shape of more or less trained Forest Officers to carry out experimental planting under the advice and supervision of the Superintendent of Chinchona. No expensive arrangements are required or should be permitted; the rearing of Chinchona plants from seed is no occult process, as we have been led to believe; all it requires being care to keep the seed-beds uniformly moist. Wherever there is a Forest Department nursery this could be done and the plants put out in the most favorable sites available by the Forest Establishments at but little cost; operations of this description, even on a very limited scale, would do more to popularize and spread the cultivation of Chinchona in India than any amount of extension and high cultivation, however successful, confined to one locality.

I am aware that experiments in Chinchona cultivation have been made in Tinnevely, Madura, South Canara, Salem, and Kurnool with varying results, but I submit that the agency employed was not calculated to ensure successful results. I do not advocate anything like extensive or costly Chinchona planting; merely the introduction and acclimatization of the tree wherever practicable, by the existing Forest Establishments, to be furnished with seed and directions by the Superintendent, who should also periodically visit and report on all the experimental plantations.

PROPAGATION.

Restriction
to more
valuable
varieties
recom-
mended.

8. As regards the propagation and rearing of plants from seed and cuttings, I would not recommend any extension of existing nurseries and propagating-houses, which are more than ample for all estate purposes. I would discontinue the growing of Red and Grey barks *for sale*, as they can be readily reared by any one who chooses to take the trouble, seed being supplied freely from the Government plantations at cost price. Beyond a supply of Red barks for supplies and experimental planting at low elevations, I would devote our whole attention and space at disposal, to the rearing from seed and cuttings of the most valuable varieties of *Officinalis* and *Calisaya* (especially the *Ledgeriana*, with which the Dutch have obtained such good results in Java, and *Sta-Fé* now on its way to us) and hybridization. *C. pubescens* and *C. angustifolia* should certainly be extensively propagated, both for the supply of the Government Estates and sale to the public at cost price; care being taken that the plants are always what they are represented to be, in order that there may be no loss of faith in the reliability of the supply from Government, nor subsequent confusion as to results obtained. An accurate record of all plants propagated and hybridization experiments carried on should be kept, and the eventual disposal of the annual outturn noted, whether the plants be distributed to the public or planted out in the Government plantations.

CULTIVATION AND HARVESTING.

Growth of
root-
suckers
condemned.

9. In the matter of cultivation, a practice has apparently found favor with the late Superintendent of leaving root-suckers to grow alongside of the parent tree; the argument being that, if the latter died from the effects of stripping and mossing, the former would take its place. I think this view erroneous, and the course pursued detrimental. Not only is there no sign of the original trees dying to justify such a measure, but to my mind, the precaution is likely to do more harm to the healthy growth of the tree than the evil against which it is supposed to be an insurance. Moreover, I do not believe that root-suckers could ever take the place of the parent stems; their bark, so far as I can judge, being thin, deficient in cellular tissue, and therefore not likely to yield an average percentage of valuable alkaloids.

Pruning,
lopping,&c.,
to be experi-
mental.

This is matter quite apart from the shrubby or many-stemmed growth observable in some portions of the plantations, with regard to which the Superintendent, if a Forester, must take care not to be empirical, and judge merely from a Forester's ordinary point of view. It may be found that such shrubby growth is favorable, both as regards yield and quality of bark, and the point should therefore form subject of careful experiment. The same may be said with regard to pruning and lopping in general. We are not growing for timber or even firewood, but for the maximum yield of bark of the best quality.

Treatment
of coppiced
trees.

This leads me to the consideration of the treatment of coppiced trees. I would certainly experimentalize with the coppice shoots already growing, by removing all but one or two from a moiety of the stools, and sending the bark so obtained separately for analysis and sale. This will be specially interesting in the case of the experiment of October 1873 at Neddivattam (*Succirubra*), and of the same year at Dodabetta (*Officinalis*), as we know that these must all be coppice shoots, no suckers having been left. The remaining coppice shoots I should leave for two more seasons in order to note the difference in results. As regards further coppicing experiments, whilst convinced that they should take place, I hesitate to recommend the exact form which they should assume. My experience is indeed too limited to

Further
coppicing
experi-
ments
recom-
mended.

justify me in doing so. I think, however, that it will be found possible to carry them out, as well as the uprooting system practised in Bengal, without any detriment to the plantations, by our being prepared to re-plant with the more valuable varieties as required. In this direction I think we may be ready to sacrifice, if necessary, all our Red barks. We know that this species can be grown profitably at low elevations, and that its production is an established fact; that it is deficient in quinine but rich in chinchonidine, which appears to increase rather than diminish under the mossing system.

Chinchonidine appears likely to play an important part as the febrifuge of the future, but the area planted with *Succirubra* in India and Ceylon is sufficient to justify our regarding its gradual disappearance from the Government plantations on the Nilgiris without apprehension. Government have, in short, done their duty in introducing and establishing it on the Hills and the Wynaad, and proving by analyses and sales what it is worth. It may therefore well make way gradually for other species in their Nilgiri plantations. Red bark trees may make way for others.

As bearing on the comparative merits of the mossing and coppicing systems of harvesting, it must be borne in mind that the moss supply is precarious. It is matter for consideration whether it would be good and economical policy to reserve sholas merely for the moss supply of the Government plantations. I think it would certainly not be so. The moss supply from sholas reserved for climatic or other purposes may decrease or not suffice. It becomes therefore important to consider substitutes for moss. I am informed that Captain Cox has made use of leaves and grass with good results, and General Morgan informs me that he is going to try coir-matting or rope. It appears only necessary here to direct attention to this point, which should certainly not be lost sight of by the Superintendent. Moss supply precarious. Substitutes to be tried.

Standard trees for measurement and record of growth should be carefully marked and retained in the older plantations. I have stated in Chapter II, paragraph 58 that the original trees selected for this purpose have been changed, and the half-yearly reports thereby been robbed of their value in this respect. A sufficient number of unbarked trees fortunately still remain in the oldest Neddivattam plantation (1862), a dozen of which should be selected, and retained for comparative periodical measurement with an equal number of stripped and mossed trees adjoining. The same would appear advisable at Dodabetta and Pykarra. Standard trees for measurement to be selected.

In concluding my remarks on the subject of cultivation and harvesting, I would urge the necessity of the Superintendent opening plantation books, in which the progress and operations carried on in each plantation should be carefully recorded; compiling periodical statistics of growth, yield, and condition of trees of the several species; and keeping himself fully acquainted with what is being done elsewhere, and noting the tendency of the home markets, the supply of bark from the indigenous forests, and from trees artificially grown. The Java plantations appear to be very extensive, and to contain a large proportion of the most valuable varieties. It will probably be found advisable that the Superintendent should visit them ere long, in order to compare and report on conditions and results. All the knowledge acquired *and verified*, whether on the Government plantations or from abroad, should, I think, be published periodically for the benefit of those interested in Chinchona cultivation. Results obtained elsewhere and Markets to be studied. Information to be published periodically.

Private planters complain bitterly, and with apparent justice, of the absence of such reliable data from a Government source in the past. Such reticence should, I submit, be guarded against in future.

DRYING AND CARRIAGE OF THE BARK TO MARKET.

The Coimbatore experiment.

10. Government have ordered an experiment in sending green bark to Coimbatore to be dried (G.O., R.D., No. 95, dated 18th January 1878). I am not sanguine of the success of this experiment. As a matter of expense, we shall be carrying three times the weight, *i.e.*, green instead of dry bark, during the most unfavorable time of year, when the road between Neddivattam and Ootacamund is almost impassable for heavily laden carts. The delay in despatching and getting the bark to Coimbatore will be considerable, and I fear that much of the bark will become mildewed and valueless. It is, however, quite worth while making the experiment, although, conducted on a small scale, it may mislead and cause eventual loss.

Estimate for erection of drying-shed and store at Neddivattam.

The estimate for the erection of a drying-shed and store at Neddivattam is certainly heavy. In consultation with Mr. Rowson and the District Engineer, I have managed to reduce it from Rupees 35,000 to Rupees 30,000, but this makes no provision for the drying of the Wood and Hooker bark, and, if such an expenditure be necessary for Neddivattam, similar provision on a smaller scale would appear advisable on the other estates. The question would be greatly simplified if we would have one central drying-shed and store for all the bark, but this is quite out of the question.

Drying-shed on the Hooker Estate.

An ultimate saving might be effected in the carriage of the Hooker bark to Neddivattam, were the road made fit for carts and the Macoorchi stream bridged, but this would entail considerable outlay. At present the proposal is to erect a small drying-shed on the Hooker Estate at a cost of Rupees 3,000 without internal fittings, and if such a building be sufficient, this will probably be the best plan, but the Hooker bark must still go to Neddivattam when dry and thence to Ootacamund. I think that the cost of carriage of the bark on all the plantations to drying-sheds and store might be materially reduced by the introduction of some sort of trolley or hand-cart to be dragged by one or two men. The existing plantation roads are, as a rule, quite broad and good enough for this.

Cost of carriage on the plantations might be reduced.

Carriage to port of shipment.

11. As regards the carriage to port of shipment, it has suggested itself to me that a very large saving could be effected by sending our bark to Beypore or Calicut instead of to Madras—the Neddivattam and Hooker bark to go direct by road—which is the usual route adopted by planters in the Ouchterloney Valley, Gudalur, and the neighborhood. According to calculations which I have made with Mr. Rhode, the cost of carriage by this route would be about Rupees 40 to Rupees 45 per ton (weight), or still less if sent by backwater from Ariacode to Calicut; *via* Ootacamund and Mettapolliem to Madras, the cost is at least Rupees 65 per ton (weight). There are objections to this direct route, especially the fact that the carts would be travelling in the teeth of the south-west monsoon, but I do not think that they are insurmountable, or sufficient to deter us from further enquiry and experiment.

The bark from the Dodabetta and Wood Estates (if the latter be retained) would of course go by the Coonoor Ghât as now, but from Mettapolliem the rail charges to Beypore would be considerably less than to Madras, the respective distances being 326 and 129 miles.

We now pay Rupees 40 freight per ton of 50 cubic feet by P. & O. steamer from Madras to London, and insurance at 1 per cent. on the declared value of bark. Freight for coffee from Calicut to London is £3 10s. to £3 15s. by British India steamers. I am informed that the rate of insurance is somewhat higher than by

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P. & O. The cartage, shipping charges, &c., could scarcely be higher than in Madras, where I calculate that they amount to nearly Rs. 20 per ton; and I believe that if we got all our bark to the coast, so as to go by one steamer, the B. I. S. N. or other Canal Steamship Company would be willing to make special arrangements, and concede lower rates of freight. I consider the point well worthy of further consideration and enquiry if Government is to continue to send the bark to England for manufacture.

LOCAL GOVERNMENT MANUFACTURE AND RE-APPOINTMENT OF QUINOLOGIST.

12. Whilst engaged in this report, I have received the Secretary of State's despatch and communication from the Government of India, recorded with G. O., Revenue Department, No. 830, dated 1st June 1878, regarding the re-employment of a Quinologist and resumption of local manufacture. The Madras Government have appointed a Special Committee to consider these points, but as my report is to be laid before it, I conclude that an expression of my opinion is desired.

If a competent and trustworthy Superintendent be appointed, I see no necessity for the appointment of a Quinologist, and am decidedly opposed to the idea of resuming local manufacture as a *Government undertaking* here, and equally so to sending our bark to Bengal to be manufactured there. Neither considered necessary or advisable.

The Superintendent can do all that is necessary as regards cultivation and carefully recording and publishing results, of which analyses by the best analytical chemists at home, and prices realized at public sales will be the best criterion. Ordinary comparative analyses could probably be undertaken by the Superintendent himself with sufficient accuracy.

Should Government, however, decide to appoint another Quinologist, his duties should be strictly confined to analysing, and, if so decided, superintending the manufacture of the bark, the Superintendent being charged and held responsible for the cultivation and cropping under such instructions as Government may from time to time issue for his guidance. The Quinologist's functions and laboratory should be altogether outside the plantations.

As for Local Government manufacture, I believe I am justified in assuming, on the strength of Dr. Cornish and Mr. Cockerell's report, that Mr. Broughton's operations were, financially at all events, a complete failure, resulting in a loss of from 30 to 40 per cent. of the alkaloids in process of manufacture; and from what I have recently read, Mr. Wood's manufacture in Bengal is little, if at all, superior in this respect, although the febrifuge obtained may be better than the "amorphous quinine." Without laying claim to any special knowledge of the subject, I confess I cannot bring myself to expect satisfactory results in the direction of the production of a cheap febrifuge, containing the alkaloids in a mingled form, through Government agency in India. There are more mysteries in the craft of a manufacturing chemist than perhaps any other; and the best chemist Government could employ would probably be, or soon become, ignorant of at least the latest of them.

Mr. Howard's opinion on this point may be quoted. Writing in 1875, he says, "It has been supposed that the adoption of a cheap process for the extraction and precipitation of the alkaloids in a mingled form would present an efficacious febrifuge at so low a cost before the people of India, that the object above referred to (*viz.*, "the means of combating fever by cultivating for themselves these precious

trees") might in this manner be obtained. It happens, however, that the people of India can be supplied with febrifugal alkaloid of equal power and efficacy at about half the cost of the mere production of the above-mentioned precipitate; so that even if the Government were to give the bark for nothing, they could not, without further sacrifice, meet the competition of European manufacturers." This eminent authority has written much more to the same effect, and I am personally convinced that by sending our bark to England for sale and purchasing sulphate of quinine, chinchonidine, or other febrifuge in the open market, we shall obtain far better results, both from a financial and philanthropic point of view, than by any attempt at local manufacture as a Government undertaking. As regards sending bark to Bengal, it would involve all the trouble and expense of drying, packing, and carriage, without affording any advantage compared with its despatch to England for sale and manufacture there.

Proposal to send bark to Bengal condemned.

SUGGESTIONS AS TO LOCAL MANUFACTURE AS A PRIVATE UNDERTAKING.

Arguments in favor of local manufacture as a private undertaking. 13. The arguments against local manufacture as a Government undertaking do not, however, apply to the establishment of a private manufactory under favorable conditions on these hills. I would strongly advocate the adoption of this course if Mr. Howard or other first-class manufacturing chemist could be induced to undertake it, or send out some duly qualified person to do so as a private venture, and I see no reason why such should not succeed. Government would, according to my view, give land in a convenient situation for the erection of a factory, and afford every facility in its power; agree to give all its bark at average sale rates ruling in London, less charges for drying, packing, carriage, insurance, brokerage, &c.; and to take from the factory, on similar terms, the quinine and other alkaloids produced, if found up to the average quality; thus securing a supply of locally manufactured febrifuge, the produce of their own and private plantations on the Nilgiri Hills, which would without doubt follow suit in sending their bark to the local factory, thereby saving the risk and expense of drying and shipping to England. The bark produced in Northern India would also probably find its way to the Nilgiri factory for manufacture, and an important local industry be developed.

I have stated in Chapter I, paragraph 35, that Mr. Broughton found the manufacture from green bark far more satisfactory and economical than from dry. This would be in favor of the manufacturer, whilst the vexed questions as to the best methods of drying, packing, and despatch of the bark would be set at rest, and high freights, both on the raw-product exported and quinine imported, insurance, brokerage, &c., avoided.

Failure of South American experiment probably due to unhealthy climate and want of labor.

14. I am aware that a private experiment was tried in South America and was not successful. I have no data as to cause of failure, but imagine it was greatly due to unhealthy climate and difficulty in obtaining suitable labor. The climate here is excellent and the native labor, if taught and supervised, second, I believe, to none in the world, whilst the rate of wages is low compared with that ruling in Europe. I am told that the cost of importing the necessary chemicals is heavy, but it cannot be compared with that of the raw produce to England, and its return here in the shape of quinine and other alkaloids. I think the establishment of a local factory for the production of Chinchona alkaloids,

under the auspices of some of the leading European manufacturers, well worthy of the attention of the Special Committee and Government. As observed by the Committee of 1874, "The manufacture of Chinchona alkaloids for the whole civilized world is a monopoly in the hands of about a dozen European firms. It is but reasonable to suppose that years of practice in this particular business has given rise to improvements in method of procedure which to a large extent determine the question of profit or loss. It is understood that the methods of working in quinine factories are secrets guarded with zealous care."

I have little doubt that Government could induce one of the dozen European firms to establish a factory here with every element of success, whereas, if it attempts manufacture itself, I predict nothing but failure. I leave the question for the consideration of the Committee and Government.

CLASSIFICATION OF BARK AND BROKERS' CHARGES.

15. Should Government continue to send bark to England, the subject of its sale according to classification, and the deductions and charges made, merits special attention. As regards the former, I find great discrepancies in rates realized apparently without any cause. As an instance, at some of the latest sales (25th April 1878) Renewed Red bark marked N. (Neddivattam) sold at from 4s. 6d. to 5s. 10d. per pound, whilst some Renewed Red bark marked P. (Pykarra) realized only 3s. per pound. Now the Hooker bark, as has been stated, is dried at Neddivattam, and the bales which fetched only 3s. per pound, although marked P. contained in reality bark from the finest plantation in the Neddivattam Estate, identical with that which realized from 4s. 6d. to 5s. 10d. under a different brand.

Again a deduction of 3 per cent. is made in account sales on account of dust, apparently a tradition from the sales of South American bark rudely prepared and packed; for the said dust from our plantations realized at last sales 2s. 5d. per pound. The brokers' deductions and charges, as set out in the account sales received, are, I confess, inexplicable to me, or to any one connected with the plantations here. The deductions include tare, trett, dust, &c., whilst the general charges, beyond those usual on landing goods, include discount at 2½ per cent. &c., besides brokerage, amounting altogether to a considerable sum. I am informed that in the case of private estates adjoining Neddivattam the brokers charge 3 per cent. in all, plus actual payments for wharfage, but without any deductions such as I have alluded to. Some similar arrangement with regard to the Government bark would appear highly advisable. I do not see why Government, more than any private individual or firm, should leave itself unreservedly in the hands of any brokers, however respectable and above suspicion they may be, and doubtless are.

Loss by erroneous classification.

Deductions, &c.

Uniform rate of brokerage without deductions recommended.

FUTURE PROSPECTS.

16. The prospects of the plantations are, I consider, most encouraging. The financial position is insured, the annual expenditure being moderate and comparing favorably with that of any undertaking of a like nature public or private; the commercial value of the Nilgiri Government bark is fully established, and the impetus already given to private planting of Chinchona on these hills highly satisfactory. The plantations might have been better stocked, operations more carefully recorded, and experiments in hybridization and cultivation of new

Financial position.

species and varieties initiated. Still much has been done, and the way towards further progress is clear.

Results
already
obtained.

17. Eight hundred and fifty acres of land formerly waste and unproductive have been brought under remunerative cultivation, and the enhanced value of the land and permanent buildings erected on it alone fully represent the total capital expended, whilst the value of the annual crop represents an extraordinary high scale of interest. The success of the Government undertaking is well known, and cannot fail to exercise a most favorable effect on the extension of Chinchona cultivation, which means the utilization of Government waste lands, employment of labor, introduction and distribution of capital in the country, and increased supply of the fever-killer. The Madras Government and all concerned may therefore be well satisfied with the result of their endeavors, and encouraged to prosecute them further.

Spelling of
the word
Chinchona.

18. It will be observed that, differing from most modern writers, I have spelt the word or genus "Chinchona" throughout (both the "ch's" being pronounced soft, as in "chin"). I have done so advisedly and after careful consideration. I publish in appendix a monograph with which Mr. Clements Markham has favored me on the subject. His argument for the correct spelling appears to me conclusive, and with him I plead for its general adoption in supersession of the varied and erroneous methods which have crept into general use.

J. CAMPBELL WALKER, CAPTAIN,
Deputy Conservator of Forests.

APPENDICES.

1878.
APPENDIX. A.
Detailed Enumeration and Classification of the Chinchona Trees in the Government Plantations on the Nilgiris.
DODABETTA.

Sub-Divisions.	Areas. Acres.	NUMBER OF TREES AND SPECIES.				REMARKS.
		Red Barks.	Crown Barks.	Yellow Barks.	Grey Barks.	Other Species.
I. 1863 A. ...	2.32	...	1,478	...	...	3
II. 1863 B. ...	1.67	...	1,032	...	...	...
III. 1863 C. ...	3.57	...	1,930	...	...	17
IV. 1863 D. ...	0.98	...	662	...	...	2
V. 1864 A. ...	4.06	...	2,835	...	...	...
VI. 1864 B. ...	7.28	46	5,060	...	...	...
VII. 1865 A. ...	10.20	19	9,112	131	26	1

(i)

Average height and girth. Crown barks 18 feet by 12½ inches. Percentage of renewals 10 per cent. 967 trees barked and mossed 4 times.

Crown barks 18 feet by 12 inches. Percentage of renewals 5 per cent. 737 trees barked and mossed 4 times.

Crown barks 15 feet by 11¼ inches. Percentage of renewals 10 per cent. 1,360 trees barked and mossed 4 times.

Crown barks 14¼ feet by 10½ inches. Percentage of renewals 15 per cent. 556 trees barked and mossed 4 times. High ground: poor soil.

Crown barks 13¾ feet by 9¾ inches. Percentage of renewals 3 per cent. 1,900 trees barked and mossed 3 times.

Crown barks 11½ feet by 8½ inches. Percentage of renewals 5 per cent. 3,283 trees barked and mossed 3 times. Soil poor in upper portion of this lot.

Crown barks 16½ feet by 10½ inches. Sub-division good over all. 15 per cent. renewals, and another 15 per cent. required. Growth good—considering elevation 7,200 feet, and southerly exposure. 6,601 trees barked and mossed thrice, renewed bark appears a little thin.

Detailed Enumeration and Classification of the Chinchona Trees in the Government Plantations on the Nilgiris.
DODABETTA. (Continued.)

Sub-Divisions.	Areas. Acres.	NUMBER OF TREES AND SPECIES.				REMARKS.
		Red Barks.	Crown Barks.	Yellow Barks.	Grey Barks.	Others. Specie
VIII. 1865 B...	17.54	...	11,282	...	...	Crown barks 11 $\frac{1}{10}$ feet by 7 $\frac{1}{10}$ inches. Renewals 10 per cent. Sub-division fair all round but slow growth; 7,567 trees barked 3 times.
IX. 1865 C. ...	13.65	...	12,423	...	...	Crown barks 11 $\frac{1}{10}$ feet by 7 $\frac{1}{10}$ inches. Renewals 15 per cent. Remarks as for 65 B. 7,602 trees barked 3 times.
X. 1866 A. ...	7.44	...	5,176	...	...	Crown barks 6 ft. by 4 $\frac{3}{8}$ inches. Percentage of renewals 10 per cent. 416 trees barked once. Plantation very irregular with poor growth on high ground, but fair in hollows.
XI. 1866 B. ...	12.18	...	11,063	...	...	Crown barks 12 feet by 7 $\frac{1}{8}$ inches. Percentage of renewals 5 per cent. Sub-division fair in lower portion, but poor in upper. 4,627 trees barked and mossed once and a small percentage twice.
XII. 1866 C. ...	11.16	...	11,722	...	...	Crown barks 9 $\frac{3}{8}$ feet by 6 inches. Percentage of renewals 15 per cent. Sub-division very broken and patchy. 3,573 trees barked and mossed once (last year).
XIII. 1866 D...	12.68	...	10,523	...	...	Crown barks 7 $\frac{1}{8}$ feet by 4 $\frac{5}{8}$ inches. Renewals 30 per cent. Sub-division very poor; trees shrubby and requiring a great deal of pruning and lopping. 2,971 trees barked thrice.
XIV. 1866 E...	4.33	...	3,583	...	...	Crown barks 10 $\frac{1}{2}$ feet by 6 $\frac{3}{8}$ inches. 20 per cent. renewals. Poor sub-division 715 trees barked and mossed thrice.
XV. 1866 F. ...	3.24	...	2,922	...	...	Crown barks 10 $\frac{1}{2}$ feet by 6 inches. 15 per cent. renewals; poor sub-division. 1,425 trees barked twice.
XVI. 1866 G. ...	9.57	...	8,072	...	...	Crown barks 12 $\frac{1}{4}$ feet by 8 inches. Sub-division fair compared with former sub-divisions of the year in this locality. Percentage renewals 15 per cent. 3,622 trees barked and mossed twice.
XVII. 1867 A...	5.62	...	4,038	...	...	Crown barks 9 $\frac{1}{2}$ feet by 9 $\frac{1}{2}$ inches. Percentage of renewals 3 per cent. About half of the trees have been barked and mossed once; trees much forked.
XVIII. 1867 B.	6.24	...	5,199	...	...	Crown barks 8 $\frac{3}{8}$ feet by 6 $\frac{3}{8}$ inches. Percentage of renewals 3 per cent. Remarks as for A.
XIX. 1867 C. ...	5.90	...	4,333	...	...	Crown barks 9 $\frac{1}{4}$ feet by 6 $\frac{3}{8}$ inches. Percentage of renewals 3 per cent. Remarks as for A and B.
XX. 1867 D. ...	4.92	...	4,258	...	...	Crown barks 10 feet by 6 $\frac{1}{8}$ inches. Percentage of renewals, nil. 1,457 trees barked and mossed once. Growth good.
XXI. 1868 A...	1.61	...	1,193	...	...	Crown barks 9 $\frac{1}{2}$ feet by 6 inches. Percentage of renewals 30 per cent. Trees unbarked and unmossed.
XXII. 1868 B...	6.04	...	4,739	...	...	Crown barks 8 $\frac{5}{8}$ feet by 5 $\frac{1}{10}$ inches. Ten per cent. renewals. Sub-division poor growth. Trees shrubby but healthy. 706 trees barked and mossed once.
XXIII. 1868 C.	11.76	...	8,595	...	...	Crown barks 8 $\frac{5}{8}$ feet by 5 $\frac{1}{2}$ feet. Remarks as above; trees unbarked.
XXIV. 1868 D.	13.37	...	8,755	...	...	Averages as for 1868 C and remarks as for 1868 B.
XXV. 1869 A...	4.68	...	3,880	...	...	Crown barks 9 $\frac{3}{8}$ feet by 7 $\frac{3}{8}$ inches. Percentage of renewals 10 per cent. 69 trees barked and mossed last November, remainder unbarked and unmossed. Very steep hill-side shown as unplanted on original Survey map.
XXVI. 1869 B.	3.22	...	2,633	...	...	Crown barks 6 $\frac{1}{4}$ feet by 5 $\frac{1}{4}$ inches. Percentage of renewals 30 per cent. Remarks as above. This is lower portion of hill-side, very steep and liable to be washed away; hence large proportion of renewals; trees looking very healthy, unbarked.
XXVII. 1869 C.	14.50	...	10,467	...	...	Crown barks 4 $\frac{3}{8}$ feet by 4 $\frac{1}{8}$ inches. Percentage of renewals, nil. Plantation very poor on high exposed situation, but fair at bottom where it borders on 1865 planting. The boundary of it was not laid down on the ground, but we have ascertained it as nearly as possible by growth and condition of the trees. 157 trees barked once.
XXVIII. 1869 D	15.33	...	11,532	...	...	Crown barks average 8 feet by 4 inches. (Average not taken but carefully estimated.) Percentage of renewals 15 per cent. Growth poor, but trees generally healthy, unbarked.
XXIX. 1869 E.	8.05	...	6,309	...	...	Average as above. Sub-division very patchy; percentage renewals 15 per cent., but in many portions at least 15 per cent. more are required to replace casualties, stunted trees, &c.; trees unbarked.
XXX. 1869 F...	17.62	...	10,184	...	...	Crown barks 8 feet 3 $\frac{1}{2}$ inches. Sub-division patchy and poor. 50 per cent. renewals, and a considerable number still required. Soil poor on rocky ridge; trees unbarked.

Detailed Enumeration and Classification of the Chinchona Trees in the Government Plantations on the Nilgiris.
DODABETTA. (Continued.)

Sub-Divisions.	Areas. Acres.	NUMBER OF TREES AND SPECIES.				REMARKS.
		Red Barks.	Crown Barks.	Yellow Barks.	Grey Barks.	Other Species.
XXXI. 1869 G.	14.08	...	8,485	...	...	...
XXXII. 1889 H.	12.82	...	6,446	...	...	...
XXXIII. 1869 I.	12.33	...	6,754	...	...	...
XXXIV. 1869 J.	7.28	...	4,019	...	...	...
XXXV. 1869 K.	6.40	...	5,102	...	...	...
XXXVI. 1869 L.	2.19	...	1,481	...	...	...
XXXVII. 1870.	8.92	...	4,864	...	...	...
XXXVIII. 1872	8.36	...	3,949	...	...	...
XXXIX. 1873.	1.81	...	557	...	...	44
TEA	5.55					
TOTAL...	320.47	65	226,647	131	26	67

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1878.
APPENDIX A.
Detailed Enumeration and Classification of the Chinchona Trees in the Government Plantations on the Nilgiris.
NEDDIVATAM.

Sub-Divisions.	Areas. Acres.	NUMBER OF TREES AND SPECIES.				REMARKS.
		Red Barks.	Crown Barks.	Yellow Barks.	Grey Barks.	Other Species.
I. 1862 A.	14.12	3,197	2,325	...	...	...
II. 1862 B.	17.06	6,272*	1,984	...	4	...
III. 1863	5.41	3,469	224	...	16	...
IV. 1864 A.	8.86	3,484	1,309	...	...	...
V. 1864 B.	4.46	1,418	640	...	...	...
VI. 1864 C.	7.87	2,849	3,202	...	...	...

Average height and girth. Red barks 24 feet by 17 inches. Crown barks 18½ feet by 11 inches. Percentage of renewals, *nil*, but many self sown trees including a large proportion of the Hybrid *C. Anglica* coming up between the rows. This and 1862 B are the oldest plantings. This sub-division includes 200 trees coppiced in 1873 and 92 remaining out of 115 coppiced subsequently, the former experiment having on the whole succeeded best. The upper portion of this sub-division was originally trenched; the lower portion below the sholah, which is chiefly Crown barks, exhibits a comparatively poor growth, the trees having been much damaged by sambur. It would appear advisable to renew it.

Red barks 24 feet by 17 inches. Crown barks 18½ by 11 inches. A small percentage (say 2 per cent) of renewals above the road in place of the yellow barks which have died out, and a few between the rows below the road. The sub-division includes the 1,000 experimental trees, Red barks (including the 12 now used for standard measurements), which have been barked 6 times, their average yield of green bark last year was 8½ lbs. per tree, one tree having yielded as much as 45 lbs. of green stem bark. It also includes 86 trees remaining out of 115 coppiced in 1875. The other red barks in this sub-division have been barked and mossed 4, and the Crown barks 3 times. The growth on upper portion is very fine but in the lower that of the Crown Barks is indifferent.

*Including 613 plants supposed to be *C. Anglica*, recently planted out in place of the Grey barks *Micrantha* which have died out.

Red barks 14 feet by 11½ inches. Percentage of renewals *nil*, but a good many self sown trees of 4 and 5 years, coming up, chiefly Red barks. Trees barked and mossed, Red barks 5 times. Crown barks 3 times. Appearance generally healthy, bark renewing well.

Red barks 13½ feet by 9½ inches. Remarks as to renewals, barking &c. as above. A portion of this sub-division was manured in 1872 or 1873.

Red barks 12½ feet by 7½ inches. Remarks as to renewals, barking etc, as above; a few Grey barks in this sub-division, but fast dying out.

Red barks 24 feet by 14½ inches. Crown barks 20 feet by 10½ inches. Percentage of renewals, *nil*. Red barks, barked and mossed 3 times. Crown barks 4 times. Sub-division very flourishing.

planted on forest land with favourable exposure—90 per cent of the trees

Detailed Enumeration and Classification of the *Chinchona* Trees in the Government Plantations on the Nilgiris.
NEDDIVATTAM. (Continued.)

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Sub-Divisions.	Areas. Acres.	NUMBER OF TREES AND SPECIES.					REMARKS.
		Red Barks.	Crown Barks.	Yellow Barks.	Grey Barks.	Other Species.	
VII. 1864 D. ...	17-04	7,719	7,400	...	...	...	Remarks as above. 2,833 in C. and D. manured once with cattle dung some twelve months ago with good results.
VIII. 1864 E. ...	11-58	4,707	3,693	...	...	...	Red barks 21 $\frac{3}{4}$ ft. by 12 $\frac{3}{4}$ in. Crown barks 17 $\frac{3}{4}$ ft by 9 $\frac{3}{4}$ in. Percentage of renewals, <i>nil</i> . Red barks unbarked. Crown barks barked and mossed 3 times; growth good and trees as a rule very healthy.
IX. 1864 F. ...	8-58	3,625	3,305	...	164	...	Averages. &c., as above; about 1,000 trees in lower corner of this sub-division have been barked and mossed once, others as above
X. 1865 A. ...	18-32	11,201	1,201	...	...	...	Red barks 18 $\frac{3}{4}$ feet by 10 $\frac{1}{2}$ inches. Percentage of renewals, <i>nil</i> , trees barked and mossed 3 times, bark renewing very well, and trees apparently very healthy all round; an excellent and robust growth altogether.
XI. 1865 B. ...	12-95	9,161	795	...	...	...	Red barks 18 $\frac{3}{4}$ feet by 10 $\frac{1}{2}$ inches. Remarks as above; a fair percentage of Hybrid <i>C. Anglica</i> , in both the above sub-divisions.
XII. 1865 C. ...	12-43	8,802	2,687	...	...	...	Red barks 22 feet by 13 $\frac{5}{8}$ inches. Crown barks 17 $\frac{3}{4}$ feet by 9 inches. Plantation known as the "Markham"; very good all over, percentage renewals, <i>nil</i> , Red barks trees barked and mossed 4 times. Crown barks 3 times.
XIII. 1866 A. ...	4-10	209	2,764	...	...	...	Red barks 14 feet by 8 $\frac{5}{8}$ inches. Percentage of renewals, <i>nil</i> , Crown barks barked and mossed once this year, average growth good over all.
XIV. 1866 B. ...	14-34	9,563	50	5	...	...	Red barks 23 feet by 14 $\frac{3}{8}$ inches. Percentage renewals, <i>nil</i> . The trees in this sub-division are very fine all round; it surrounds the old Jail now drying house for bark and coolly lines to which position probably much is due. Trees barked and mossed 4 times. A good many self sown plants between lines. This sub-division includes the block near Jail referred to by Mr. Broughton, as containing 2,000 (really 5,000) trees of which "85% had failed to renew," I have carefully examined those trees; they are now very healthy and bark well renewed, and have yielded 15,000lbs. of dry bark since Mr. Broughton wrote. This sub-division originally contained about 2,000 Yellow barks which have gradually died out or been cut down; a few still remain, but all being more or less in a dying state, I have not entered them. It appears advisable to plant up the blanks with Crown barks,

XV. 1866 C. ...	12-45	9,347	211	...	...	...	Red barks 20½ feet by 12½ inches. Percentage renewals, <i>nil</i> , but a good many younger trees planted close together near road when new trace made; sub-division fair, self grown trees frequent. Red barks barked and mossed 4 times.
XVI. 1868 A. ...	3-71	1,208	386	...	...	...	Red barks 14½ feet by 9 inches Remarks as to renewals, barking, &c., as above. This Sub-division appears to have been originally planted in 1864, was almost entirely destroyed by fire in 1867 during the late Superintendent's absence in England, replanted in 1868 and classed as that years planting.
XVII. 1868 B. ...	8-13	4,461	1,179	...	...	...	Red barks 19 feet by 10½ inches. Crown barks 17 feet by 10½ inches. Percentage renewals <i>nil</i> , trees unbarked and unmossed. Sub-division generally very healthy but, though classed as 1868, Mr. Rowson believes it was originally planted in 1864 and renewed at intervals, as the land slipped, up to 1868, vide remarks on 1868 A, originally planted in 1864. This sub-division is situated entirely on what was sholah but very steep and subject to land slips.
XVIII. 1869 A. ...	9-96	6,298	772	...	...	...	Red barks 10½ feet by 5½ inches. Percentage of renewals, <i>nil</i> , Trees unbarked and unmossed. Subdivision in good state, growth poor on high lying portion, very good in lower.
XIX. 1869 B. ...	11-83	7,924	350	...	...	...	Red barks 9 feet by 4½ inches. Percentage of renewals, <i>nil</i> . Trees unbarked and unmossed. Growth very poor in upper portion of sub-division and average only maintained by very fair growth below. Mr. Rowson proposes to replant the upper portion entirely, containing 3,257 trees (of which 150 are Crown barks) with Crown barks in lieu of Red barks which would appear advisable It was an open grass hill and the Red barks are likely to do no good.
XX. 1869 C. ...	13-69	10,186	854	25	...	...	Red barks 10½ feet by 6½ inches. Percentage of renewals, <i>nil</i> . 404 Crown barks barked and mossed this year, remainder unbarked and unmossed. General condition of subdivision very good.
XXI. 1869 D. ...	13-26	6,300	52	...	...	...	Red barks 17 feet by 8 inches. Percentage of renewals, <i>nil</i> . Subd ivision generally good with exception of small piece in right hand lower corner; trees unbarked and unmossed.
XXII. 1869 E. ...	12-18	5,904	1,894	4	...	...	Red barks 6 feet by 4 inches; Crown barks 5 feet by 3 inches. Subdivision very poor all over; planted on grass land. Many say 30 per cent.,—renewals with Crown barks and a good many trees now dead or dying. The subdivision originally contained a good many Yellow barks which have all died out.
XXIII. 1869 F. ...	11-54	8,719	374	...	...	...	Red barks 14 feet by 7½ inches. Subdivision fair all over, half averages taken on grass hill where growth is poor, 20 per cent Hybrid. (Broad leaved Condaminia ?) Renewals <i>nil</i> , trees unbarked and unmossed.
XXIV. 1869 G. ...	20-19	13,805	915	...	...	...	Red barks 18½ feet by 9½ inches. Percentage of renewals, <i>nil</i> . A superb sub-division planted on forest land with favourable exposure, 10 per cent of the trees

Detailed Enumeration and Classification of the Chinchona Trees in the Government Plantations on NEDDIVATTAM. (Continued.)

Sub-Divisions.	Areas. Acres.	NUMBER OF TREES AND SPECIES.					REMARKS.
		Red Barks.	Crown Barks.	Yellow Barks.	Grey Barks.	Other Species.	
XXV. 1869 H...	9.20	7,559	823	...	...	...	classed as Red barks are a Hybrid locally known as the broad leaved Condaminia, the analysis of which is not known. It is matter for regret that a larger proportion of this Sub-division is not Crown barks; trees unbarked and unmossed, but ready for harvesting.
XXVI. 1869 L...	2.55	1,099	...	...	25	...	Red barks 16 feet by 1½ inches. Crown barks 11 feet by 6 inches. Remarks generally as for 1869 F. Crown barks barked and mossed once last year; renewing well.
XXVII. 1870 A. 11.52		3,190	3,000	...	...	...	Red barks 15 feet by 9½ inches. Percentage of renewals, nil, trees barked and mossed twice; a small sub-division a part from the rest of the years planting, and including trees planted by Sir W. Dennison in 1862 used originally for standard measurements. The Sub-division was all formerly forest land and is situated in an exceptionally good and sheltered situation.
XXVIII. 1870 B. 16.37		...	...	...	...	...	The major portion of this planting has proved a failure owing to exposure, want of weeding, and intermixture of the Red bark which does not flourish on grass land on which the sub-division is situated. The 3 detached portions below the road (vide map) exhibit a somewhat better growth, but on the whole the trees are so small and scattered, I did not think it necessary to ascertain average height and girth which may be taken at 3 feet by 2 or 3 inches, the Crown barks being the best. Mr. Rowson proposes to replant the whole with Crown barks which, with care, would do fairly well though much cannot be expected on such a situation.
XXIX. 1870 C...	4.30	2,780	1,314	387	...	...	This planting has proved an entire failure, there are very few trees remaining and those of such a poor and stunted growth as renders their enumeration useless and misleading. The sub-division is situated on top of a grass hill, which Mr. Rowson now proposes replanting with <i>Acacia Dealbata</i> for supply of firewood and as a break wind. This would appear advisable; the broad path betwixt the sub-division and that lower down will prevent the wattle spreading and, if kept in order, and properly treated as a coppice firewood plantation it will, I feel sure, prove very valuable.
TOTAL...	318	164,456	43,694	421	193	16	Red barks 16½ feet by 9½ inches. Crown barks 9½ feet by 4½ inches. Red barks very good and regular, planted on forest land and sheltered situation. Crown barks fair, percentage of renewals, nil. Red barks unbarked and unmossed. Crown barks barked and mossed once last year.

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1878.
APPENDIX. A.
Detailed Enumeration and Classification of the Chinchona Trees in the Government Plantations on the Nilgiris.
PYKARRA (WOOD ESTATE.)

Sub-Divisions.	Areas. Acres.	NUMBER OF TREES AND SPECIES.					REMARKS.
		Red Barks.	Crown Barks.	Yellow Barks.	Grey Barks.	Other Species.	
I. 1863	2.55	612	607	...	...	...	Average height and girth. Red barks 15 1/10 feet by 10 inches. Crown barks 14½ feet by 9 inches. Percentage of renewals 10 per cent. General appearance of sub-division very poor. A great many casualties amongst Crown barks, said to be due to careless planting. Trees barked and mossed 3 times.
II. 1864	10.87	6,972	1,682	...	64	...	Red barks 14½ feet by 9¾ inches. Crown barks 12¾ feet by 7 inches. Percentage of renewals 20 per cent. Trees barked and mossed 3 times on average. Sub-division very poor all round, can scarcely believe it to be 1864 planting. A great many casualties and trees just dead and dying, to form matter of further report. N.B.—Some of the dead and dying trees of Red barks and Crown barks have never been barked, so the casualties cannot be entirely due to bad barking. Soil apparently fair, though rocky in lower portion.
III. 1865 A. ...	10.08	4,571	4,094	...	65	...	Red barks 19½ feet by 12½ inches. Crown barks 18½ feet by 8 inches. Percentage of renewals 10 per cent. Trees barked and mossed 3 times on an average. Although the average height and girth of this sub-division and 1865 B compares favorably with that of similar or even older sub-divisions at Neddivattam and still more Dodabetta, the trees have generally a ragged and sickly appearance and are far inferior in habit to those at Neddivattam. Although the percentage of renewals is not high, there are a large number of blank spaces, and a good many trees are dead or dying, attributed to careless barking, but the cause of which should be further investigated. The non-renewal of failures raises the height, &c., but the plantation generally looks as if it had been neglected; much of this appearance is, however, doubtless due to exposed situation and effects of both monsoons.
IV. 1865 B. ...	4.88	2,430	509	...	657	...	Red barks 21¾ feet by 11¼ inches. Grey barks 20½ feet by 8 inches. Percentage of renewals 10 per cent. Trees barked and mossed 3 times on an average; Grey barks not at all. General appearance and growth in sub-division good. Red barks generally, superior to A, more robust and healthy. Grey bark, the best I have yet seen but shrubby and of small girth; the trees of this description are

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Detailed Enumeration and Classification of the Chinchona Trees in the Government Plantations on the Nilgiris.
PYKARRA (WOOD ESTATE.) (Continued.)

Sub-Divisions.	Areas. Acres.	NUMBER OF TREES AND SPECIES.				REMARKS.
		Red Barks.	Crown Barks.	Yellow Barks.	Grey Barks.	Other Species.
V. 1865 C. ...	8.80	4,888	112	...	...	...
VI. 1867 A. ...	8.39	5,687	41	...	...	...
VII. 1867 B. ...	9.62	4,744	117	...	...	...
VIII. 1867 C. ...	10.87	7,208	20	...	...	...
IX. 1868 ...	6.12	667	...	...	...	...
TOTAL...	72.18	37,779	7,182	...	797	...

planted close together in good soil below Mr. Grove's watercourse, but have grown up spindly, and show symptoms of dying at the top. Average of Crown barks not taken as there were comparatively few. Sub-division much more sheltered than above, being the lower portion of the "Avenue," and trees consequently appear more robust and less crooked and weather-beaten.

Red barks 19 feet by 12½ inches. Percentage of renewals 10 per cent. Appearance very healthy in upper portion, but many casualties in lower. Trees barked and mossed 3 times.

Red barks 14½ by 10 inches. Percentage of renewals 20 per cent. Sub-division very poor. A good many blank spaces and casualties ascribed to careless barking. Trees barked and mossed 3 times.

Red barks 16½ feet by 10 inches. Percentage renewals 20 per cent. Trees barked and mossed three times on average. Sub-division generally very poor with a great many casualties.

Red barks 19 feet by 11½ inches. Remarks, &c., as for 1867A; this sub-division being in same block only separated by a road.

This sub-division, with an area by original survey of 4.17 acres, contains only clumps of trees here and there, and should be entirely re-planted if maintained; average height, &c., not taken.

Detailed Enumeration and Classification of the Chinchona Trees in the Government Plantations on the Nilgiris.
PYKARRA (HOOKER ESTATE.)

Sub-Divisions.	Areas. Acres.	NUMBER OF TREES AND SPECIES.				REMARKS.
		Red Barks.	Crown Barks.	Yellow Barks.	Grey Barks.	Other Species.
I. 1866 A ...	10.91	4,789	2,876	...	...	...
II. 1866 B ...	15.09	6,735	2,036	...	...	...
III. 1867 A. ...	14.21	7,539	196	...	...	...
IV. 1867 B. ...	7.02	390	3,357	...	...	...
V. 1867 C. ...	2.71	1,542	207	...	...	...
VI. 1867 D. ...	16.07	5,271	5,520	...	...	...
VII. 1868 A. ...	18.36	4,961	3,910	...	1	...
VIII. 1868 B. ...	23.74	10,569	2,223	...	72	...

Red barks 16½ feet by 11½ inches. Crown bark 13½ feet by 9½ inches. Sub-division good all over, situated on western side of valley. Trees barked and mossed 3 times. Crown barks appear to renew better than Red barks, a portion of which however were barked very late last season.

Red barks 14½ feet by 9½ inches. Crown barks 14½ feet by 8½ inches. The growth of Crown barks is good; also of Red barks on western side of the valley where the average is 17½ by 11½ compared with 12½ by 7½ on east, average of the whole as above. Crown barks and most of the Red barks barked 3 times.

The growth of this sub-division is very poor, quite below average. Trees unmeasured but about 7 feet by 4 inches. The whole requires careful going over and pruning, or renewing with Crown barks.

Crown barks 10½ feet by 7 inches. Growth poor, but sub-division healthy and regular; Crown barks barked twice.

Red barks 12 feet by 7½ inches. Healthy trees barked and mossed twice.

Red barks 7½ feet by 4½ inches. Crown barks 10½ feet by 7 inches. Sub-division generally poor; Crown barks better than Red barks, but all more or less shrubby; Renewals nil, but a great many required in place of trees which will never do any good. Red barks unbarked and unmossed; Crown barks barked and mossed twice.

The growth of Red barks in this sub-division is good, this species having been for the most part planted in the ravine, and in better soil than Crown barks. Crown barks exhibit poor but regular growth, and the trees appear generally healthy. Crown barks and two-thirds Red barks barked and mossed twice.

Red barks 16 feet by 9½ inches. Crown barks 12½ feet by 7½ inches. Sub-division fair but patchy. A good many renewals, and much pruning required; healthy trees barked and mossed twice.

Detailed Enumeration and Classification of the Cinchona Trees in the Government Plantations on the Nilgiris.
PYKARRA (HOOKER ESTATE.) (Continued.)

Sub-Divisions.	Areas. Acres.	NUMBER OF TREES AND SPECIES.					REMARKS.
		Red Barks.	Crown Barks.	Yellow Barks.	Grey Barks.	Other Species.	
IX. 1868 C. ...	16.04	7,448	1,152	...	9	...	Red barks 11 $\frac{1}{10}$ feet by 6 $\frac{3}{4}$ inches. Crown barks 11 feet by 7 $\frac{1}{2}$ inches. Sub-division generally poor and patchy. A few good bits but many hundreds very poor and shrubby with leading shoots gone, and only half a dozen or more suckers left, in fact quite unmeasurable; about quarter of Red barks barked and mossed.
X. 1869 A. ...	3.58	1,320	1,096	...	...	...	Red barks 11 feet by 6 $\frac{7}{10}$ inches. Crown barks 13 $\frac{7}{10}$ feet by 8 $\frac{3}{8}$ inches. A small sub-division, Crown barks fair, barked twice. Red barks very poor, requiring a complete overhauling and numerous supplies or replacing with Crown barks.
XI. 1869 B. ...	9.35	4,225	390	...	777	...	Red barks 12 $\frac{3}{8}$ feet by 8 $\frac{1}{2}$ inches. Grey barks 15 $\frac{1}{2}$ feet by 6 $\frac{7}{10}$ inches. The Red barks exhibit a fair growth and are generally healthy, but require pruning and renewing in patches. The healthy trees have been barked and mossed twice. The growth of Grey barks is good, and trees healthy, they are intermixed with the Red barks and a few have been barked and mossed; pruning of suckers and shoots is much required.
XII. 1869 C. ...	6.52	3,429	446	...	...	...	Red barks 10 $\frac{3}{8}$ feet by 7 $\frac{1}{4}$ inches. The sub-division is patchy, growth fair in places but inferior and shrubby in others; the latter portion should be completely renewed with Crown barks, pruning required in other portions; healthy trees barked and mossed twice.
XIII. 1873 ...	10.59	319	4,500	...	..	253	The average in this sub-division was not taken, the greater portion being beneath average. In upper portion the growth is fair, Crown barks averaging 6 and Red barks 9 feet in height. A good deal of damage done by Sambur, lower portion very poor and mostly failed. A percentage of the trees are varieties, <i>Pidayensis</i> , &c., but are looking sickly and never likely to do good. A fine sholah some 25 acres felled and only 10 $\frac{1}{2}$ acres planted and then neglected.
TOTAL....	154.19	58,537	27,909	...	858	253	

(xii)

1878.

APPENDIX B.

Abstract Statement showing the Number and Description of Trees in the Government Cinchona Plantations, Nilgiri Hills, on the 15th April 1878
and the years in which they were planted.

Year's Planting.	DODABETTA.						NEDDIVATTAM.						WOOD.				HOOKER.						
	Red Barks.	Crown Barks.	Grey Barks.	Yellow Barks.	Other Species.	Total.	Red Barks.	Crown Barks.	Grey Barks.	Yellow Barks.	Other Species.	Total.	Red Barks.	Crown Barks.	Grey Barks.	Other Species.	Total.	Red Barks.	Crown Barks.	Grey Barks.	Other Species.	Total.	
1862...	..	..	..	..	22	5,124	9,469	4,309	4	..	16	13,782	..	612	607	..	..	1,219	..	..	..	..	..
1863...	..	5,102	..	..	..	7,941	3,469	224	..	..	..	3,709	..	607	..	..	..	8,718	..	..	..	..	..
1864...	46	7,895	..	..	..	32,994	23,802	19,540	164	..	..	43,506	..	1,682	64	..	..	17,326	..	..	..	..	..
1865...	19	32,817	26	131	1	53,061	29,164	4,683	..	..	..	33,847	..	4,715	722	..	..	11,889	..	..	..	..	..
1866...	..	53,061	..	..	..	17,828	19,119	3,025	..	5	..	22,149	..	..	..	..	..	11,524	..	4,912	..	..	..
1867...	..	17,828	..	..	..	23,282	5,669	1,565	..	..	..	7,234	..	178	11	..	..	14,742	..	9,280	..	..	16,436
1868...	..	23,282	1868	..	..	77,292	67,794	6,034	25	..	..	73,882	..	..	..	..	..	22,978	..	7,285	81	..	24,022
1869...	..	77,292	..	..	..	4,864	5,970	4,314	..	387	..	10,671	..	..	..	..	..	8,974	..	1,932	777	..	30,344
1870...	..	4,864	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	11,683
1871...	..	..	..	..	..	3,949	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1872...	..	3,949	..	..	..	601	..	..	..	..	..	..	..	..	..	..	..	319	..	4,500	..	..	..
1873...	..	557	..	..	44	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5,072
	65	226,647	26	131	67	226,936	164,456	43,694	193	421	16	208,780	37,779	7,182	797	45,758	58,537	27,909	858	253	..	..	87,557

Dodabetta ... 226,936
Neddivattam ... 208,780
Wood ... 45,758
Hooker ... 87,557

Total... 569,031

(xiii)

1878.
APPENDIX C.

Abstract Statement showing the growth of Trees in the Government Cinchona Plantation, Nilgiri Hills, on the 15th April 1878.

SUB-DIVISIONS.	DODABETTA.				NEDDIVATTAM.				WOOD.				HOOKER.			
	Red barks.		Crown Barks.		Red Barks.		Crown Barks.		Red Barks.		Crown Barks.		Red Barks.		Crown Barks.	
	Height feet.	Girth inches.	Height feet.	Girth inches.	Height feet.	Girth inches.	Height feet.	Girth inches.	Height feet.	Girth inches.	Height feet.	Girth inches.	Height feet.	Girth inches.	Height feet.	Girth inches.
1862 A	...	...	...	...	24	17	18	11	...	...	...	...	...	...	...	...
" 1863 B	...	...	...	...	24	17	18	11	...	...	...	...	...	...	...	...
" " C	...	...	18	12 $\frac{1}{2}$	...	...	...	...	...	...	...	...	...	...	...	...
" " D	...	...	15	11 $\frac{1}{2}$	...	...	...	...	...	...	...	...	...	...	...	...
" 1864 E	...	...	14 $\frac{1}{2}$	10 $\frac{1}{2}$	...	...	...	...	...	...	...	...	...	...	...	...
" " F	...	...	13 $\frac{3}{4}$	9 $\frac{3}{4}$	...	...	...	...	...	...	...	...	...	...	...	...
" " G	...	...	11 $\frac{1}{2}$	7 $\frac{1}{2}$	...	...	...	...	...	...	...	...	...	...	...	...
" " H	...	...	...	...	24	14 $\frac{1}{2}$	20	10 $\frac{3}{4}$	...	...	...	...	...	...	...	...
" " I	...	...	...	...	24	14 $\frac{1}{2}$	20	10 $\frac{3}{4}$	...	...	...	...	...	...	...	...
" " J	...	...	...	...	21 $\frac{3}{4}$	12 $\frac{3}{4}$	17 $\frac{3}{4}$	9 $\frac{3}{4}$	...	...	...	...	...	...	...	...
" " K	...	...	...	...	21 $\frac{3}{4}$	12 $\frac{3}{4}$	17 $\frac{3}{4}$	9 $\frac{3}{4}$	...	...	...	...	...	...	...	...
" 1865 A	...	...	16 $\frac{1}{2}$	10 $\frac{1}{2}$	...	...	...	...	...	...	...	...	...	...	...	...
" " B	...	...	11 $\frac{1}{2}$	7 $\frac{1}{2}$	...	...	...	...	...	...	...	...	...	...	...	...
" " C	...	...	11 $\frac{1}{2}$	7 $\frac{1}{2}$	...	...	...	...	...	...	...	...	...	...	...	...
" " D	...	...	6	4 $\frac{3}{4}$	...	...	...	...	...	...	...	...	...	...	...	...
" " E	...	...	12	7 $\frac{1}{2}$	...	...	...	...	...	...	...	...	...	...	...	...
" " F	...	...	9 $\frac{3}{4}$	6	...	...	...	...	...	...	...	...	...	...	...	...
" " G	...	...	7 $\frac{1}{2}$	4 $\frac{5}{8}$	...	...	...	...	...	...	...	...	...	...	...	...
" " H	...	...	10 $\frac{1}{2}$	6 $\frac{3}{8}$	...	...	...	...	...	...	...	...	...	...	...	...
" " I	...	...	10 $\frac{1}{2}$	6	...	...	...	...	...	...	...	...	...	...	...	...
" " J	...	...	12 $\frac{1}{2}$	8	...	...	...	...	...	...	...	...	...	...	...	...

(xiv)

1867 A	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" C	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" D	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" 1868 A	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" C	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" D	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" 1869 A	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" C	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" D	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" E	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" F	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" G	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" H	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" I	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" J	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" K	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" L	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" 1870 A	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" C	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
" 1872	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1873	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

(xv)

N.B.—Girth taken at about 4 $\frac{1}{2}$ feet from the ground.

APPENDIX D.

NOTE ON THE CORRECT SPELLING

OF THE

CHINCHONA GENUS.

BY

CLEMENTS MARKHAM, Esq., C.B., F.R.S., &c., &c.

The Chinchona genus was named after the Countess of Chinchon, Vice-Queen of Peru, who first introduced the use of Peruvian bark into Europe. Her title is derived from the town of Chinchon, twelve miles from Madrid, a place well-known in history.

Linnaeus was the first botanist who described the new genus, and he had to give it a name. He chose the most appropriate that could have been selected, namely, that of the noble lady who first made its healing virtues known. In 1742 he gave the name of *Chinchona* to the genus; with the intention of thus immortalizing the great and beneficent acts of the Countess of Chinchon. That intention is frustrated by spelling the name wrong.

Unfortunately Linnaeus himself was misinformed as to the name of her whom he desired to honor. This is to be accounted for, by his having received his knowledge of the Countess through a French, and not a Spanish channel. Thus misled, Linnaeus spelt the word *Cinchona* (Gen. Pl. ed. 1742) and *Cinhona* (Gen. Pl. ed. 1767) omitting one and afterwards two important letters.

But a very few years afterwards, the error was corrected by the Spanish botanists Ruiz and Pavon, who not only spelt the name correctly—*Chinchona*,—but strongly advocated the correct spelling of a genus to the study of which they devoted so much time, and exposed themselves to so many dangers and hardships. The botanists Mutis, Zea, Caldas, Cavanilles, Lagasca, and Rodriguez also spelt the name correctly; and the oversight of Linnaeus was thus corrected.

One would have supposed that, when the original error had been corrected by all the authorities who wrote upon the subject immediately after the death of Linnaeus, the honored name of the Countess of Chinchon would have been safe from future mutilation. But unluckily Humbolt, Bonpland, Weddell, and Karsten have since copied the unintentional error of Linnaeus, and thus lent their names to its perpetuation. A host of subsequent writers have continued the ill-omened mutilation of the Countess's name; calling the genus *Cinchona* (*cinchon* means a policeman's belt) instead of *Chinchona* from the Countess of Chinchon. Among modern writers there are, however, several who adopt the correct spelling, including Seemann, Spruce, Markham, and Dr. C. W. Quin, the analytical chemist.

Correct spelling adopted by

1. Pavon
2. Ruiz
3. Tafalla
4. Mutis
5. Cavanilles
6. Lagasca
7. Rodriguez
8. Zea
9. Caldas
10. Seemann
11. Spruce
12. Markham
13. Quin

Incorrect spelling adopted by

1. Humboldt and Bonpland
2. Pœffig
3. Weddell
4. Triana
5. Karsten
6. Delondoe
7. Hanbury
8. Hooker
9. Brandis

Howard wavers, owning that the correct form is best.

Thus the spelling *Chinchona* is beyond any doubt correct, all other forms being wrong; it is adopted by the majority of authorities who have studied the genus in its native habitat, and also in the Blue Books and by the India Office.

Those who advocate the wrong and illiterate spelling *Cinchona*, unanimously allow that *Chinchona* is correct, but they plead that it is impossible to correct an error when it is once adopted, and that it would cause confusion in indexes. These two objections are easily refuted. It is not now impossible to correct an error in spelling the name of a genus, because it has been done before. Linnaeus also inadvertently spelt *Buffonia* wrong, adopting the form *Bufoia*. But the error was subsequently corrected, and the correct spelling is now universally adopted. If *Buffonia* is to be spelt right, most assuredly *Chinchon* ought to be spelt right also. As for the second objection, confusion in an index is readily prevented by a cross reference. Another argument is that the wrong spelling has the priority, because Linnaeus used it. But Linnaeus spelt the genus in two ways—both wrong; and *Cinhona* has just as good a claim to preference, on this ground, as *Cinchona*. Both being wrong, and the claim of each being equal, the propriety of adopting the correct form—*Chinchona*—becomes evident.

By mutilating and rendering unmeaning the name of the Countess of Chinchona, the intention of Linnaeus to do her honor is entirely frustrated. Her memory is treated with disrespect by those who are bound at least to offer that slight tribute of reverence which would be shown by refraining from needlessly spelling her title wrong. To sum up:—

(1.) All authorities agree that *Chinchona* is correct, and that, consequently, *Cinhona*, *Cinchona*, and all other forms are wrong.

(2.) Most botanical names are means not ends, and it does not, therefore, very much matter how they are spelt. But the name for the *Chinchona* genus is an end as well as a means. It was not given merely as a distinguishing label, but was selected for a particular reason closely connected with the history of the genus. If the continuance of established errors in spelling is to be the general rule in botany, no case has a stronger claim to be treated as an exception.

3. The sole ground for adopting the wrong spelling, that of convenience, is untenable. For many of the highest authorities, including Pavon, Ruiz, Mutis, Zea, Caldas, Spruce and Seemann spell the name correctly.

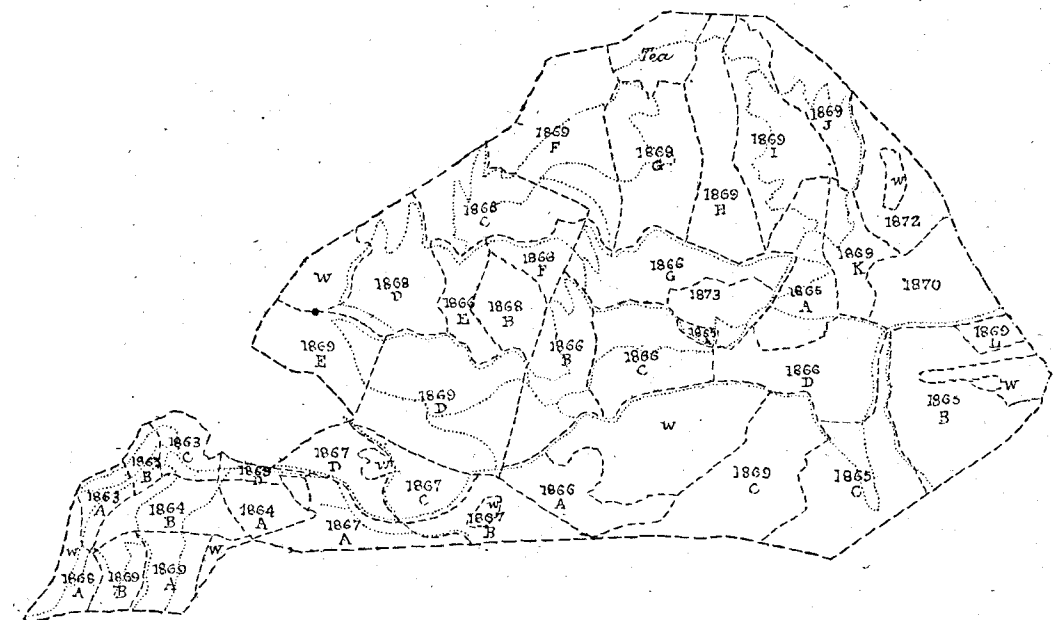
I plead for justice to the memory of the amiable and beautiful Ana de Osorio, Countess of Chinchon, in the name of that great botanist who desired to make it immortal, and who would have been the first to correct his own error had it been pointed out to him before his death; in the names of those zealous Spanish and English explorers of the Chinchona forests, who have earnestly pleaded for the correct spelling; and in the names of millions who should know to whom they are indebted for the priceless febrifuge to which they owe their lives, but who cannot recognize her in the corrupt and mangled form (*Cinchona*) which the advocates of error give to her name. I plead for the correct spelling (*Chinchona*) as the only way by which the memory may be preserved of her who made known to the world the inestimable value of quina bark, who was thus a benefactor to mankind, but whose monument has been destroyed,* and whose place knows her descendants no more—the illustrious and once beloved Ana de Osorio, 4th Countess of Chinchon.

CLEMENTS MARKHAM.

* By the French Marshal Victor on December 27th, 1810, who also burnt the Church at Chinchon. The Church was rebuilt in 1823.

Key Map
of the
Dodabetta chinchona Plantation
Showing area of each years planting
and
Sub-divisions
Scale 4 Inches = 1 Mile

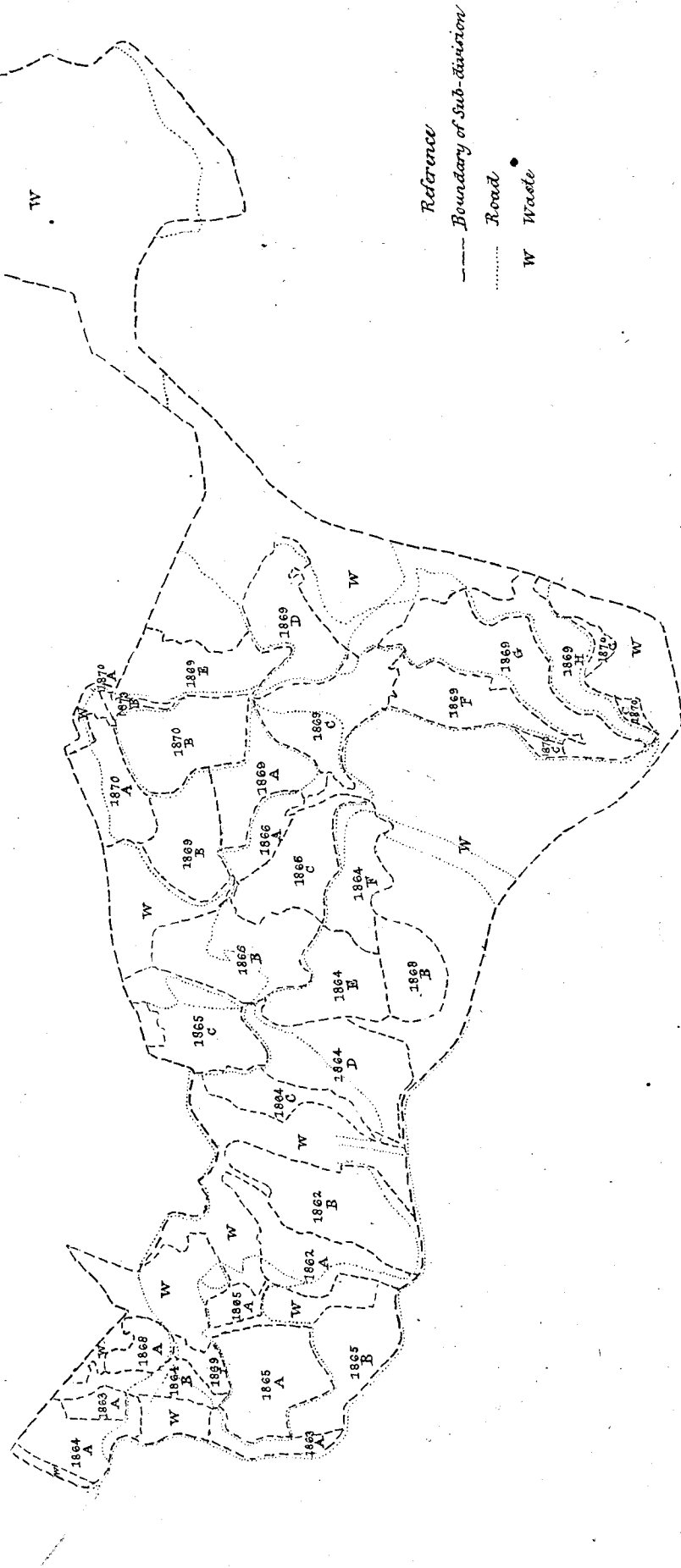
<i>Years</i>	<i>Area Planted Acres</i>
1863	8 . 64
1864	11 . 34
1865	41 . 39
1866	60 . 60
1867	22 . 68
1868	32 . 78
1869	118 . 50
1870	8 . 92
1872	8 . 36
1873	1 . 81
<i>Tea</i>	<i>5 . 55</i>
<i>Total</i>	<i>320 . 47</i>



Reference
 ----- *Boundary of Sub-division*
 *Road*
 W *Waste*

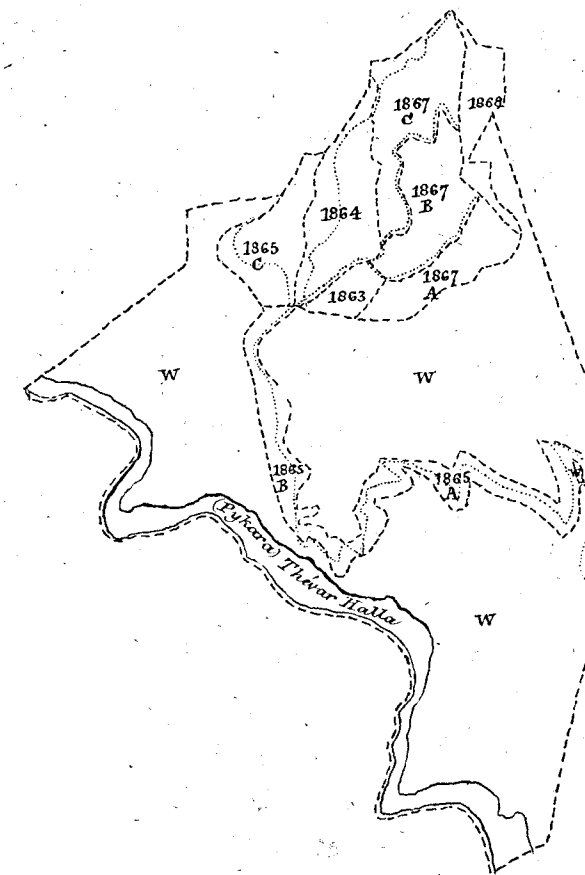
Area Planted
Years Acres
1862 . 31.18
1863 . 5.41
1864 . 58.39
1865 . 43.70
1866 . 30.89
1868 . 11.84
1869 . 104.40
1870 . 32.19
<u>Total 318.00</u>

Key Map
of the
Nedivattam Chindona Plantation
Showing area of each year's planting
and
Sub-divisions
Scale 4 Inches=1 Mile



Key Map
of the
Pykara
Wood Chinchona Plantation
Shewing area of each year's planting
and
Sub-divisions
Scale 4 Inches = 1 Mile

Years	Acres
1863	2.55
1864	10.87
1865	23.76
1867	28.88
1868	6.12
<u>Total</u>	<u>72.18</u>



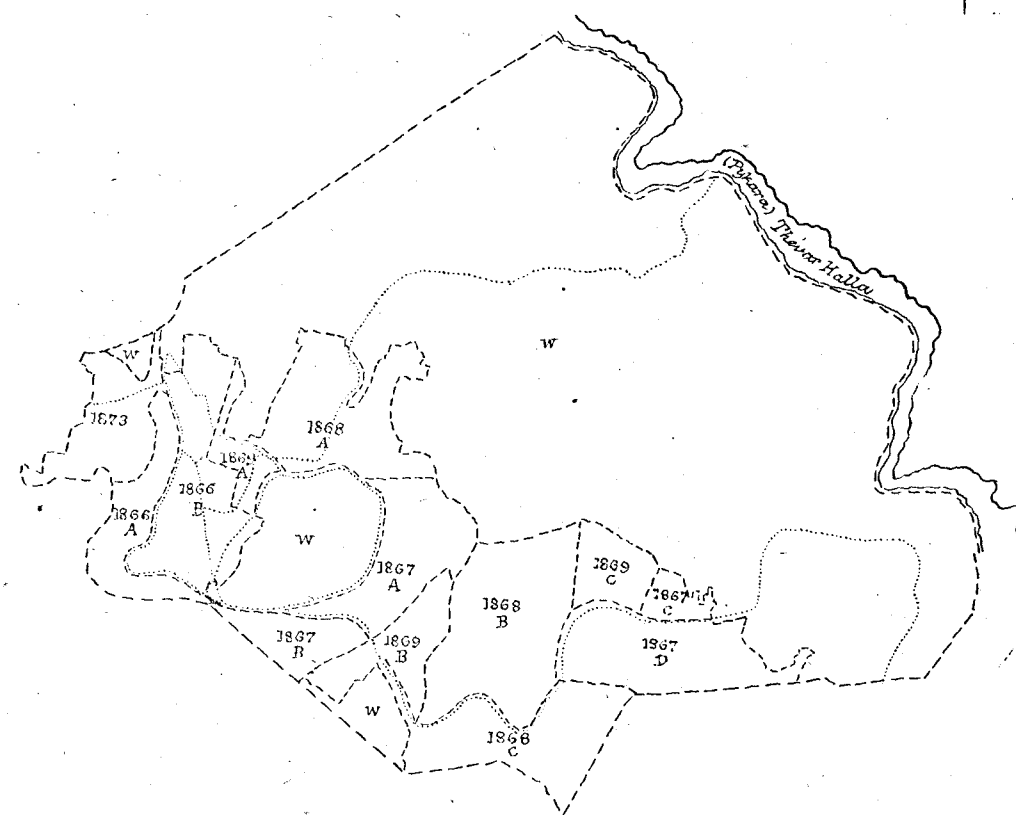
Reference

- Boundary of Sub-divisions
 Road
 W Waste

Key Map
of the
Pykara
Hooker Chinchona Plantation
Shewing area of each years planting
and
Sub-divisions

Scale 4 Inches=1 Mile

<i>Area Planted</i>	
<i>Years</i>	<i>Acres</i>
1866	26.00
1867	40.01
1868	58.14
1869	19.45
1873	10.59
<i>Total 154.19</i>	



Reference

- Boundary of sub-division
 Road
 W Waste

OOTACAMUND,
15th October 1878.

No. 136.

From

R. W. BARLOW, Esq.,
Commissioner, Nilgiris,

To

C. G. MASTER, Esq.,
*Secretary to Government,
Revenue Department,
Ootacamund.*

SIR,

I HAVE the honor to submit by the bearer the report of the Cinchona Committee appointed by G.O., No. 830, of the 1st June last.

I have the honor to be,

Sir,

Your most obedient servant,

(Signed) R. W. BARLOW,
Commissioner, Nilgiris.

SURVEY OFFICE NO. 362

Ootacamund Settlement
NILGIRI HILLS

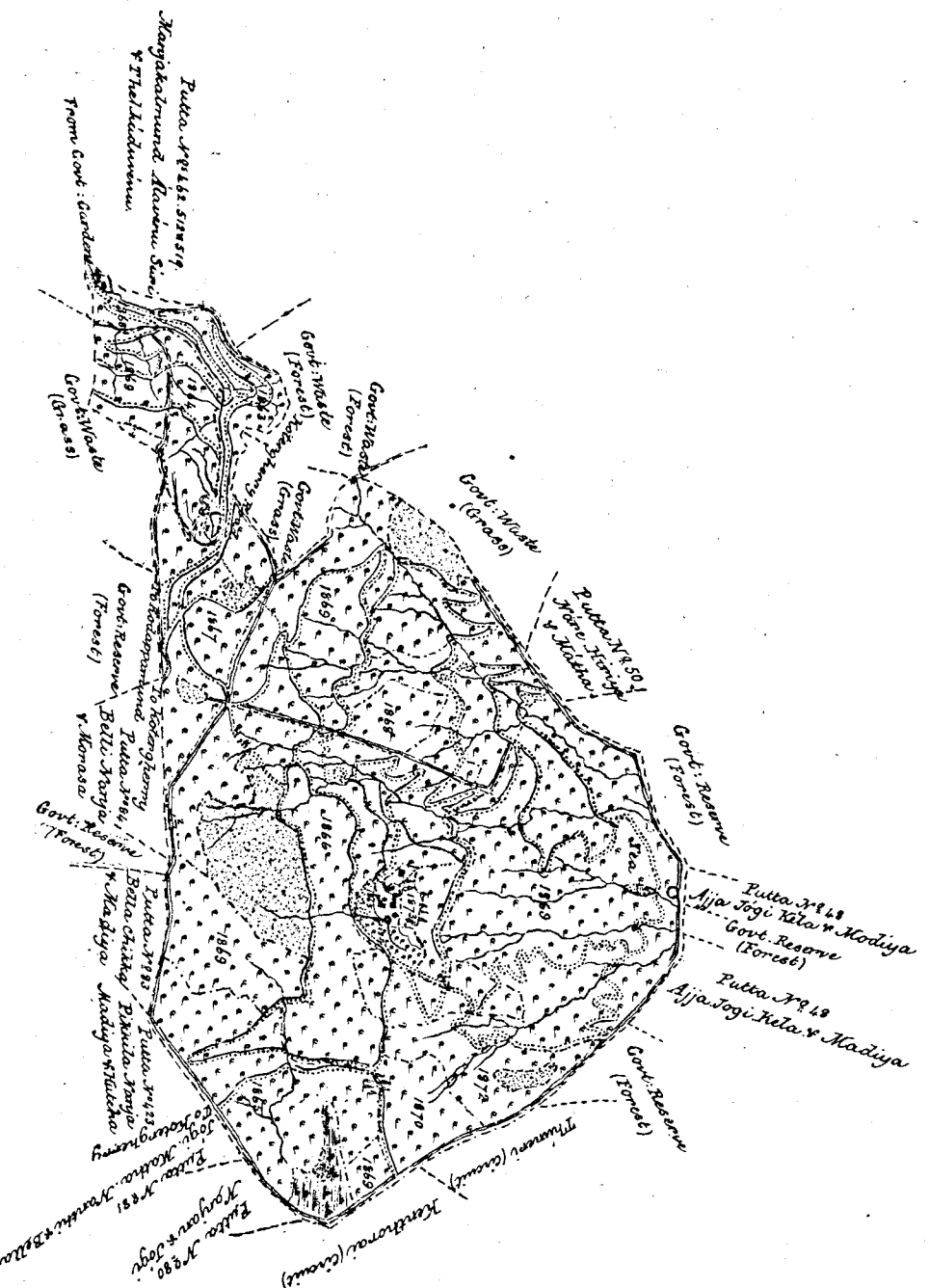
DODABETTA

GOVERNMENT CINCHONA PLANTATION

	Acres.
Planted portion ...	314.92
Tea... ..	5.55
Nursery... ..	2.11
Grass &c. ...	40.58
Area... ..	<u>363.16</u>

SECRET

- | | |
|---|----------------------|
|  | Buildings |
|  | Cinchona & Tea |
|  | Nursery |
|  | Grass |
|  | Scrub |
|  | Pond |
|  | Stream |
|  | Swamp |
|  | Road |
|  | Foot path |
|  | Supply Channel |
|  | Trench & Drain |
|  | Ravine |
|  | Catclapen |
|  | Boundary of Property |
|  | Settlement Boundary |



venue Survey Office
Coimbatore
24th July 1878.

Survey Office
Madras
30th July 1878.

Scale 4 Inches = 1 Mile



(Signed) J. G. CLOETTE *Lieut.-Col.*,
Deputy Superintendent Revenue Survey.

Harry Decker
Lieut.-Col. R. E.,

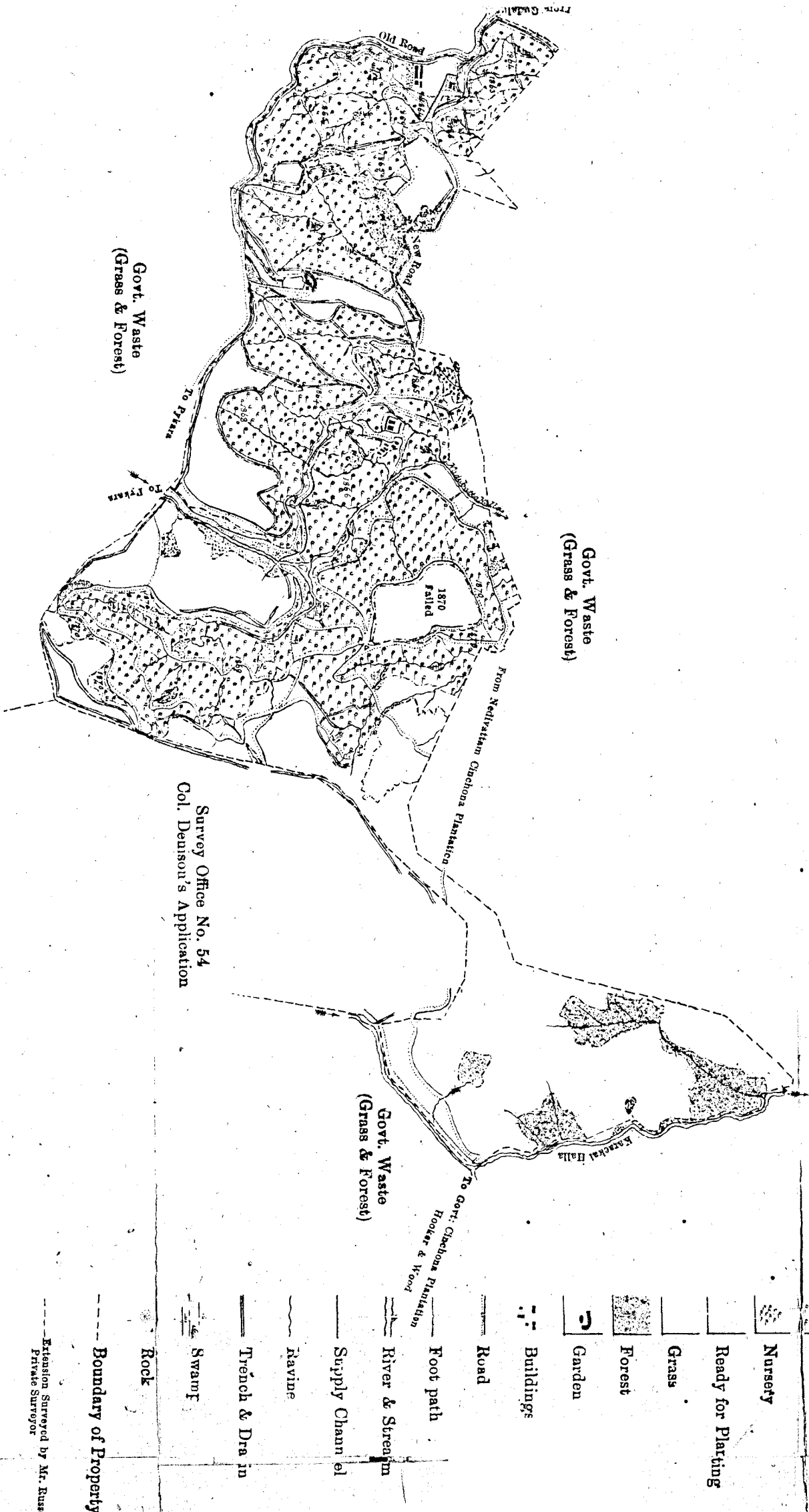
Superintendent Madras Survey.

Ootacamund Settlement
NILGIRI HILLS

NEDIVATTAM

GOVERNMENT CINCHONA PLANTATION

A. acres.	
Planted portion	301.63
Do. Failed	16.37
Nursery	1.26
Forest	43.09
Grass &c.	318.38
Area	680.73



Revenue Survey Office
Coimbatore
24th July 1878.

Survey Office
Madras
30th July 1878.

Scale 4 Inches = 1 Mile
Links 1000 500 0 1 2 3 4 50 Chains

(Signed) J. G. CLOETE Lieut.-Col.,
Deputy Superintendent Revenue Survey.

Baykett Lieut.-Col. R. E.,

Superintendent Madras Survey.

SURVEY OFFICE No. 363 A

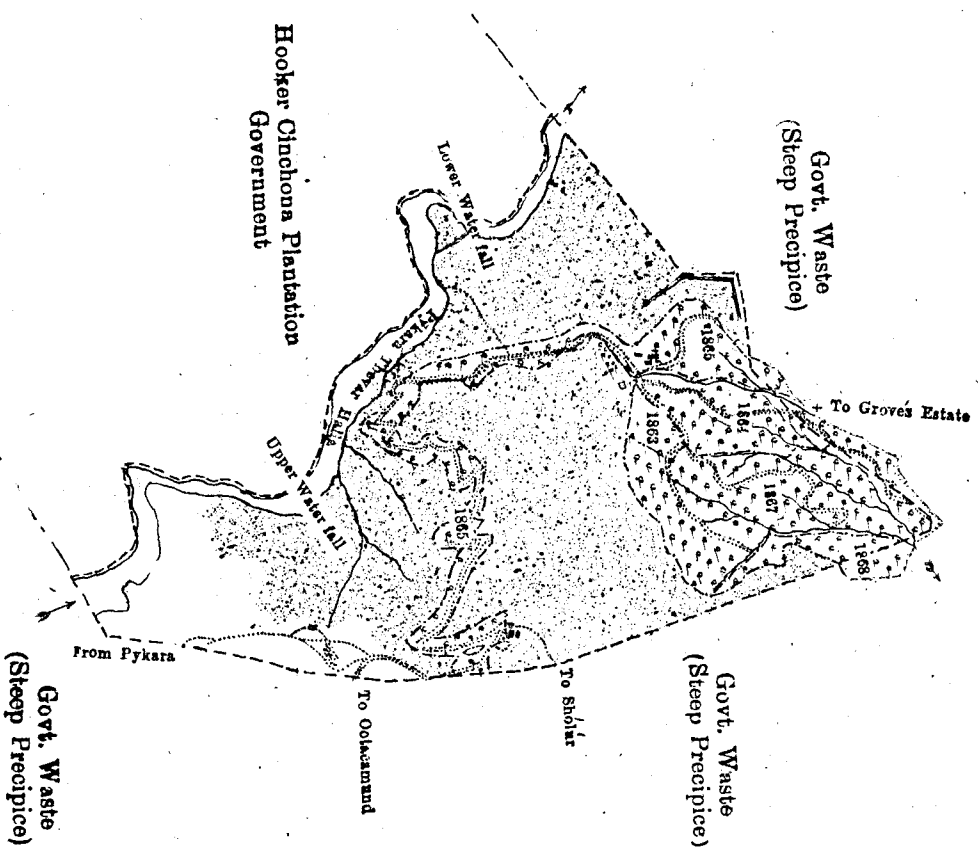
NIGIRI HILLS

PYKARA

WOOD CINCHONA PLANTATION

GOVERNMENT

	A cres.
Planted portion ...	72.18
Nursery ...	0.40
Forest ...	142.02
Grass &c. ...	51.53
Area...	267.02

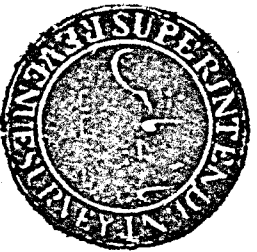


REFERENCE

- Buildings
- Cinchona
- Nursery
- Ready for Planting
- Grass
- Forest
- Garden
- Road
- Foot path
- River & Stream
- Ravine
- Supply Channel
- Trench
- Boundary of Property

{ Right of way Reserve for
Mr. Grove along the Channel

Extension Surveyed by Mr. Russell
Private Surveyor



Revenue Survey Office
Coimbatore
24th July 1878.

Survey Office
Madras
30th July 1878.

Scale 4 Inches = 1 Mile



(Signed) J. G. CLOETTE Lieut.-Col.
Deputy Superintendent Revenue Survey

Robert Lieut.-Col. R.
Superintendent Madras Survey

SURVEY OFFICE No. 363

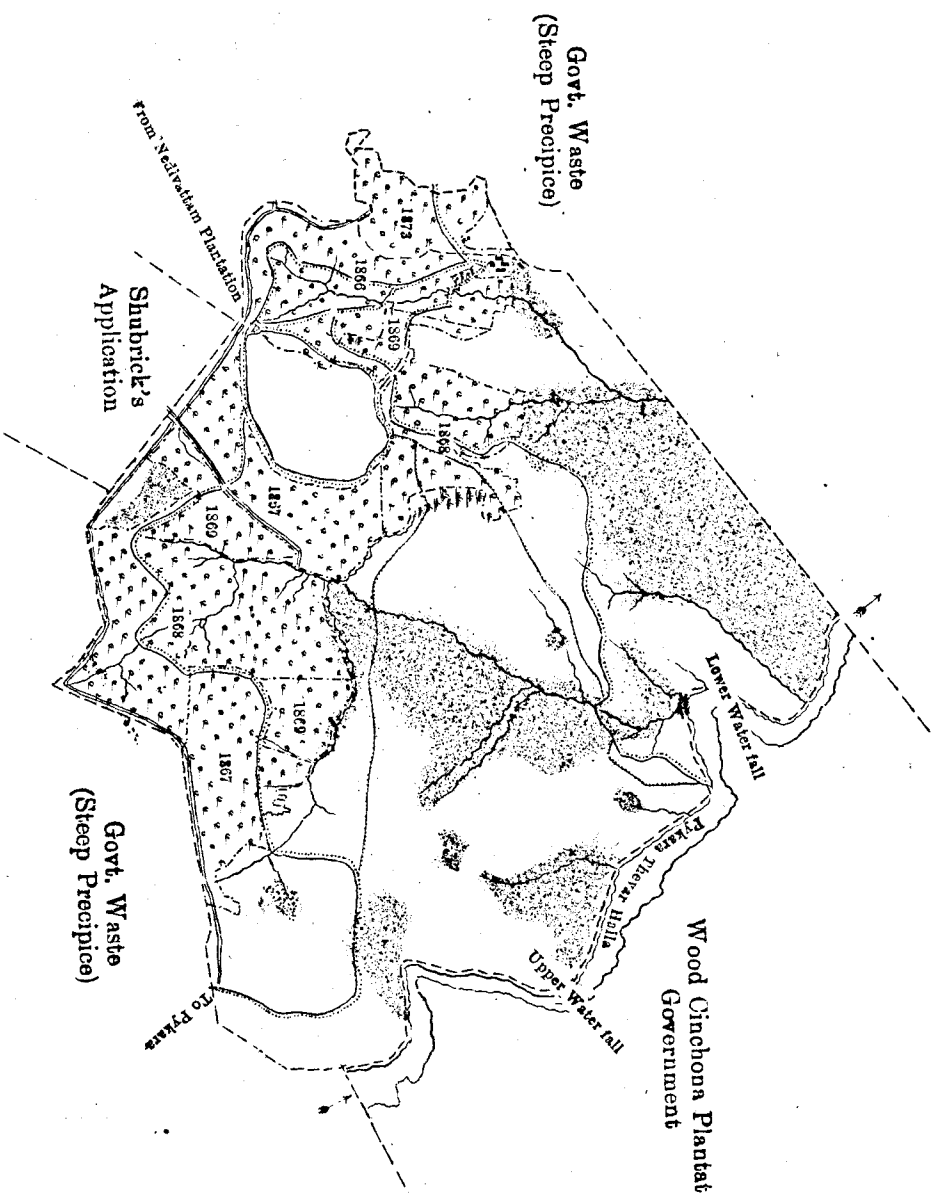
NILGIRI HILLS

PYKARA

HOOKER CINCHONA PLANTATION

GOVERNMENT

	Acres.
Planted portion	154.19
Nursery... ..	0.40
Forest	105.49
Grass &c.	208.89
Area... ..	468.97



Revenue Survey Office
Coimbatore
24th July 1878.

Survey Office
Madras

OOTACAMUND, 31st August 1878.

From

THE PRESIDENT AND MEMBERS OF THE
CINCHONA COMMITTEE,

To

THE SECRETARY TO GOVERNMENT,
Revenue Department,
Ootacamund.

SIR,—We have the honor, in obedience to G.O., No. 830, of 1st June 1878, to report that the subjects referred to us in paragraphs 4, 5, 6, 7 and 8 have been duly considered in Committee.

2. The first meeting of the Committee was held on 24th June, and subsequently the business of the Committee has been discussed in ten meetings. A Sub-Committee inspected the several Government plantations, and also visited the principal private estates on the Nilgiris accompanied by Dr. King.

3. It seemed so important to obtain the evidence of Dr. G. King, Superintendent of the Cinchona cultivation in Darjeeling, in regard to his experience of cultivation and alkaloid manufacture, that at our first meeting we resolved to request that Dr. King might be permitted to attend to give evidence on the subjects necessary to our deliberations. Dr. King arrived at Ootacamund on the 1st August, and his evidence will be found in Appendix A. The Committee desire to acknowledge their obligation to the Bengal Government in placing Dr. King's services temporarily at their disposal, and are much indebted to that gentleman for the valuable information he has communicated to them.

4. As stated by the Government of India, the main object which the Government had in view in the establishment of cinchona plantations in India was to afford the people of the country a cheap febrifuge.

To produce a cheap manufactured article the raw material must, first, be obtainable at a low price; secondly, the process of manufacture must be inexpensive and exhaustive; lastly, the product must be efficient and economical in use.

These elementary facts were clearly seen by Mr. Broughton, but his factory had to be discontinued, for though its amorphous quinine was thoroughly efficient, the bark supplied to it was costly and the method of manufacture did not prove exhaustive in practice.

5. We have now to consider by the light of further experience here and elsewhere whether any of the elementary conditions have so altered as to give a reasonable hope that the philanthropic intentions of Government are likely to meet with their best fulfilment by the resumption of local manufacture.

6. The course of inquiry necessitates our reviewing the condition and prospects of the Government plantations in this Presidency and in that of Bengal, where local manufacture has for some time been practised.

7. In regard to the Nilgiri plantations Captain C. Walker's recent report furnishes for the first time clear statistical details, and we have supplemented these by personal inquiries and inspections.

The materials we have collected are placed as appendices to this report for convenience of reference and the correction of our conclusions.

8. The points in regard to which the Committee is specially desired to offer opinions are—

- (a) The possibility of locally manufacturing a drug that shall be commercially and chemically an economical production, while of such medicinal value as to justify its cost.
- (b) The investigation of other modes of utilising the bark for the use of the population at a reasonable cost.
- (c) The reappointment of a local Quinologist.
- (d) The consideration of Captain Campbell Walker's report on the present condition of the Government cinchona estates on the Nilgiris, and other papers relating to cinchona.

9. It will be convenient to consider the subjects in the order above stated.

(a) "The possibility of locally manufacturing a drug that shall be commercially and chemically an economical production, while of such medicinal value as to justify its cost."

10. At the outset of our inquiry we were met by the statement that the problem put to us had already been solved in Bengal, where "an efficient and very cheap febrifuge" has been prepared and "is sold to the public at Rupees 20 per pound, or about one-fourth of the cost of quinine at the present time."

11. We were therefore forced, as a preliminary step, to investigate the conditions under which this result had been effected, and ascertain whether they afford grounds on which to recommend that the produce of the Government plantations in this Presidency should be converted into a similar febrifuge, either locally or in Bengal.

12. It will be within the recollection of Government that this question, as regards Madras, was somewhat exhaustively dealt with by a Committee appointed under G.O., No. 759, of the 22nd June 1874.

This Committee had the advantage of conferring with Messrs. Broughton and McIvor on the subject of their report, and of examining them in regard to the accuracy of the calculations on which they based their conclusions. The facts brought out in the report of that Committee have never been challenged, nor, so far as we are aware, have they ever been noticed by the Secretary of State in connection with the revival of the question of local manufacture.

It was shown by the Committee that the 445½ lb. of mixed alkaloid produced under Mr. Broughton's superintendence (in 1871-72 and 1872-73) had in the net value of bark and expenses of manufacture (not including any portion of Mr. Broughton's salary) cost the Government £ 3,083-12-0, while the same weight of crystallised sulphate of quinine might have been landed in the Medical Store Department of Madras, all charges included, for £ 2,895-10-0, so that Government was actually paying more for an inferior article than for the most expensive of all the preparations of cinchona bark (paragraphs 18 to 25). It was further demonstrated that the commercial value of the 445½ lb. of mixed alkaloids, as produced by Mr. Broughton, was not more than £ 1,483, while the actual cost of production was not less than £ 3,080 (paragraph 30). It was shown, moreover, that for the actual expenditure in the local production of 445½ lb. of mixed alkaloid, the Government might have purchased in Europe at current prices in the open market, inclusive of all charges of transport, duty, &c., either 1,233 lb. of sulphate of cinchonidine, or 2,055 lb. of sulphate of cinchonine, by which means, for the same money expended in local manufacture, three or four times the bulk of febrifuges of equal value might have been bought and their use extended in this proportion to the poorer population (paragraph 27).

13. The original estimate of the late Mr. McIvor was that red cinchona bark could be produced on the Nilgiri estates at a cost of 6d. (4 Annas) per pound of dry bark; but when examined before the Committee of 1874, Mr. McIvor had to admit (paragraphs 61 to 63) that he was unable to state the cost to Government of the raw material he delivered over to the alkaloid factory, and that his estimate of 6d. per pound referred only to expenses of cultivation and collection.

14. With the subject of local manufacture again re-opened, it seemed to us a point of vital importance to endeavor to ascertain as clearly as possible at what cost the Government has been able to produce bark. Fortunately since the conclusion of the labors of the Committee of 1874, some experience in regard to this matter has been obtained both in the Nilgiri and Darjeeling experimental culture. In both these experiments it must be noted that a Government works with a saving of expense in comparison with ordinary planters, who, in addition to their unremunerative outlay for many years, would have, in the first instance, to pay a price for the land cultivated, the cost of survey and demarcation; and in the case of Nilgiri cultivators, an annual assessment on the entire area after five years' tenure.

15. The method of working the Government estates on the Nilgiris does not permit us to show the cost of production of bark for each variety cultivated, or for bark from trees of different ages. Our only data available are—(1) the yearly expenditure on cultivation and harvesting and (2) the interest on capital account; while on the other side we have the actual weight of bark yielded by the estates.

16. *Cost of Bark on the Nilgiris.*—The capital account of the Nilgiri estates according to a statement furnished to us by the Accountant-General, given in Appendix E, was closed at the end of the official year 1875-76, showing a balance of charges of Rupees 11,22,116-15-6 or an outlay of about Rupees 1,323 per acre of the cultivated area* of the estates. This capital account includes all expenditure on unremunerative experiments, such as the cultivation at Mailkonda, with balance of interest on yearly outlay calculated at 4½ per cent. The following figures show the past cost of bark production:—

Year.	Yearly Charges.	Interest.	Total.	Amount of Bark collected (lb.).	Cost per Pound.
1875-76	44,657	49,018	93,675	65,170	RS. A. P. 1 7 0
1876-77	70,875	50,495	1,21,370	1,03,341	1 2 9
1877-78	68,031	53,645	1,21,676	1,98,807	0 14 0

The estates are probably now in full bearing, and considering the present age of the trees, it seems to us more than doubtful whether the estimated yield, as calculated by Captain C. Walker, of about 400,000 lb. per annum will ever be realized. This certainly will not be the case without more attention to renewals of trees that have failed, and thicker planting of some portions of the estates than has lately been practised. We do not think it probable that the estates will in their present state yield more than 200,000 lb. of bark yearly (unless some radical changes are made in the management of the plantations).

17. If the balance of receipts be applied to the reduction of the capital account, the annual charges for interest will be lessened, and also the proportionate cost of production. If, then, we take the average of the working charges and the interest on Rupees 6,00,000 capital, instead of on the present capital account, and assume that after 1878-79 the yield of the plantations will not be less than 200,000 lb. of bark annually, the cost to Government of producing bark on the Nilgiri estates will in the future be about 7 Annas per lb. These charges will diminish year by year if the principle of setting the profits of each year to the diminution of the capital account be accepted, so that five or six years hence it may be hoped that the capital account will be extinguished, and the yearly charges of cultivation and harvesting would then represent the cost of production. In process of time, therefore, when the capital account † is extinguished, Government Nilgiri bark may be produced and harvested for something like 4 Annas a pound.

* The area under Cinchona according to Captain Campbell Walker's report is 848·4 acres.

† The Accountant-General in his statement (Appendix E) shows net charges against the estates of only Rupees 8,06,683 up to 1876-77. In the following year 1877-78 the proceeds of crop sales was £33,231. Against this will have to be shown the yearly charges for 1877-78, and the balance, upwards of two lakhs, goes as shown above to diminution of capital.

18. We have seen that so far as the Nilgiri estates are concerned, the cost of the dry bark on the spot, excluding all charges for packing and carriage to ports of shipment, has in past years been not less than Rupee 1-2-7 per lb., very different figures from the estimate of Mr. McIvor of 4 Annas per lb., on which the Madras Government hoped to be able to extract the mixed alkaloids at a cost of 1 Rupee per ounce.

19. We wish to note here that cultivation of cinchonas on the Nilgiris being entirely experimental in the first instance, was necessarily more costly than it would have been if there had been any experience to guide the operations. Private individuals have largely availed themselves of the experience acquired by means of the Government experimental culture, and no doubt will be able to produce bark at a lower expenditure of capital in the cultivation. But notwithstanding the costly character of the cultivation, the yield of barks from the Nilgiri estates will, if sent to England for sale, very soon have repaid every rupee expended on the experiment; and the financial results have been such as to lead to a very considerable development of private enterprise in cinchona culture both in Southern India and Ceylon. Costly as the cultivation has been, the realised value of the produce of the estates for the last two years, after deducting all charges and interest on capital outstanding in 1875-76, has been sufficient to return an average annual dividend of twenty-four and half per cent.

20. It seems to be clear from Captain Campbell Walker's report, and from the personal observation of the Committee, that more attention should be given to renewals and replanting on the Government estates, if the annual yield of bark is to be increased. Unless great attention is given to this matter, the amount of febrifuge material available for Government uses will not greatly increase. Trees are constantly dying out, and to keep the estates in fair order they should be promptly replaced, and every vacant spot of ground planted.

21. *Cost of Production of Bark in Sikkim.*—The Sikkim estates up to 1875, according to Dr. King, consisted of 1,762 acres under cultivation. Since then new estates have been planted, making the total area now under cultivation 2,124 acres. The planting operations on a large scale were commenced only in 1867. The capital accounts of the new estates are kept distinct. Up to 1875 the total expenditure, including interest at 4 per cent., had been Rupees 7,62,487, which, spread over 1,762 acres, amounted to Rupees 427 per acre. As, however, in the Madras capital account interest on outlay has been calculated at $4\frac{1}{2}$ per cent., we have thought it right, for purposes of comparison, to make the necessary alterations in Dr. King's figures. In this way we make the total outlay up to 1874-75 Rupees 7,82,217 or 443 per acre.

22. Some portion of the expenditure in Darjeeling, like that of the Nilgiris, was of an experimental nature, and included outlay on abandoned sites; and the Accountant-General of Bengal fixed the capital account of the present estates at the end of the official year 1874-75 at Rupees 3,50,000, but this amount was obviously inaccurate in regard to the actual cost of the experimental culture to Government, and any calculations in regard to the cost of production would be fallacious that did not include total charges and accruing interest. The following statement shows the actual cost of production of bark at Darjeeling:—

Year.	Charges.	Interest of Capital at $4\frac{1}{2}$ per cent.	Total.	Bark Crop.	Cost per Pound.
	RS.	RS.	RS.	LB.	RS. A. P.
1875-76	42,937	35,199	78,136	211,931	0 5 10
1876-77	49,539	37,223	86,762	207,781	0 6 8
1877-78	57,900	39,647	97,547	345,000	0 4 6

23. It will be seen that the cost of production of bark in Darjeeling has been very much less than on the Nilgiris. Nearly the whole of the cultivation in

Darjeeling is of the red bark (*C. cirubra*), which grows very freely there, but contains so small a quantity of quinine that manufacturers do not care to use it. The crown barks (*C. officinalis*) which thrive so well on the Nilgiris, and which yield bark fetching the highest prices, have completely failed there. The only quinine-yielding plants are two or three kinds of *C. calisaya*, which, according to Dr. King, are propagated with difficulty, and a robust hybrid, which promises to be a good quinine yielder.

24. The cultivation of red bark on a large scale at Darjeeling was commenced long after that on the Nilgiris, so that the experience of the earlier experiment no doubt led to more economy in cultivation. Labor, moreover, is abundant and cheap at Darjeeling, whereas on the Nilgiris it is dear and in parts bad. The habit of the red bark is one of rapid growth, while the crown barks, which constitute the more valuable portions of the Nilgiri estates, are slower in arriving at maturity.

25. The greater yield of bark from the Darjeeling estates is due partly to the difference in the methods of cropping and partly to closer planting. At Darjeeling the trees of eight years of age and upwards are entirely uprooted, and the land so cleared planted anew. Coppicing also is resorted to experimentally, and Dr. King in his evidence is inclined to regard this method of cropping as the one that may hereafter yield the best results. There is no experience yet to show how land that has had the trees uprooted will bear a second or third crop. Dr. King states:—

“Replanting the same land with red barks the same year as red barks have been uprooted, results in many death vacancies. I am now trying in Sikkim the results of replanting one, two, and three years after uprootal, but as yet I have no reliable experience to offer.” (Q. 14).

It is evident from this statement that the calculated yield of the yearly bark crop of 366,000 lb. may, after a few years, if the uprooting is practised for the major part of the crop, fail to be realised, except from the continued opening of new estates.

26. On the Nilgiri estates the plan of cropping has hitherto almost exclusively been that of stripping layers of bark from the living trees, and the renewal of the bark under damp moss—a system enthusiastically advocated by the late Mr. McIvor, and practised by him on private estates in which he was interested as well as on the Government plantations. The coppicing system of harvesting the bark has not yet had a fair trial on the Nilgiri estates. Some remarks on these systems of harvesting will be found in Appendix C. Captain Campbell Walker reports that the stripping and mossing system has up to the present time had no injurious effect on the growth and vitality of the trees, but from personal observation we are not prepared to endorse that statement.

27. In regard to local extraction of the bark alkaloids, Mr. Broughton's work on the Nilgiris ceased from the end of 1874, as the Madras Government came to the conclusion that it could not be profitably conducted; but since that date the Bengal plantations have yielded considerable experience which it is necessary to review.

28. Under the direction of Mr. Wood, the Quinologist to the Bengal Government, a temporary manufacturing establishment was organised on the Sikkim plantations in 1875, and from that time to the present nearly the whole of the produce of the estates has been worked up into amorphous alkaloid, which has been issued for hospital use and sold to the public under the name of “Government cinchona febrifuge.” The process adopted by Mr. Wood was not the same as that of Mr. Broughton. Mr. Broughton *boiled* the *fresh* bark in dilute acid, while Mr. Wood adopted a process of *cold* extraction from the *dried* bark. The nature of the product in both cases was essentially the same. In Mr. Broughton's process he failed to recover, on a manufacturing scale, more than 64 per cent. of the total alkaloids. Mr. Wood in his first two years of manufacture did not recover 50 per cent. of the alkaloids present in the bark operated on, but in the third year a return of somewhat above 50 per cent. was obtained. We now learn from Dr. King that in view of these unsatisfactory results proposals were made in 1875 to the Bengal Government to establish a regular factory in Calcutta with steam-power, improved apparatus, and skilled superintendence, as experiments had shown that with proper appliances seven-eighths of the alkaloids present could be obtained on a manufactur-

ing scale. Up to the present time, however, by the process of cold extraction and without a regular plant and skilled labor, these results have not been obtained, and about one-half of the precious constituents of the bark operated on have been lost to the world.

29. The following results have been obtained by Mr. Wood in manufacture from bark calculated to contain 4 per cent. of alkaloid :—

Year.			Bark used.	Outturn of Alkaloid.	Percentage of Alkaloid.
			lb.	lb.	lb.
1875-76	...	...	107,130	1,987	1.85
1876-77	...	...	190,798	3,750	1.91
1877-78	...	...	239,680	5,395½	2.3
Total	...	...	537,608	11,132½	2.0

The actual cost of the febrifuge, according to our calculations of the cost of production of bark, has been as follows :—

Year.			Value of Bark.	Manufacturing Charges.	Total.	Price per Pound of Febrifuge.
			RS. A. P.	RS.	RS. A. P.	RS. A. P.
1875-76	...	...	£9,057 13 0	6,920	45,977 13 0	23 2 3
1876-77	...	...	79,409 2 8	15,234	94,733 2 8	25 4 2
1877-78	...	...	67,410 0 0	19,008	86,418 0 0	16 0 3
Mean cost of manufacturing alkaloid			...			20 6 5

30. A few observations are necessary in regard to these figures. The Bengal experience has entirely confirmed the opinion of the Committee in 1874 as to the unprofitable character of alkaloid manufacture by crude processes and appliances. Mr. Broughton's process was especially designed for doing away with expensive apparatus and skilled labor, and he recovered only 64 per cent. of the total alkaloids. The remaining 36 per cent. was lost in manufacture. Mr. Wood's process, with simpler appliances, has in the three years ending 1877-78 caused a total loss of alkaloid of 50 per cent., or 11,132 lb., which, at Rupees 20 a pound, may be valued at Rupees 2,22,640. On a commercial scale of manufacture probably not more than 85 or 90 per cent. of alkaloid present in bark is recoverable. Taking the lower estimate, the bark used in local manufacture at Sikkim ought to have yielded 18,924 lb. of alkaloid, or 7,792 lb. more than the quantity obtained. The value of this at Rupees 20 per pound would be Rupees 1,55,840. This loss, therefore, has resulted to the Bengal Government from a perseverance in imperfect manufacturing processes.

31. Mr. Wood has come to the conclusion that a full commercial outturn of alkaloid is impracticable without a regular factory establishment. We are entirely of the same opinion. But factory establishments, steam-power, and skilled supervision in India are very costly, and we are very dubious as to the ability of any Government establishment in this respect competing with manufacturers who have made cinchona alkaloid extraction the study and special labor of their lives. It is only fair to Mr. Wood to note that he estimates when the Calcutta factory is in full working order that the cost of production of febrifuge will not be more than Rupees 11-9-0 per pound, but we have to add that in this calculation it is assumed that the bark will not cost more than 3½ Annas per pound to grow and harvest, a rate which further experience in culture may show to be hypothetical in the future as it has been in the past.

32. The product which has been temporarily described as "Government cinchona febrifuge," according to Mr. Wood, is stated to have a tolerably uniform composition of—

Quinine (crystallisable)	...	...	...	...	...	...	15.5
Cinchonine	...	...	...	...	...	...	33.5
Cinchonidine	...	...	...	...	...	...	29.0
Amorphous alkaloid (uncrystallisable)	...	...	...	...	...	...	17.0
Coloring matter, &c.	...	...	...	...	...	...	5.0
							100.0

It is issued in the form of an almost white powder, very light and flocculent, with a somewhat unpleasant aromatic odor and bitter taste. The alkaloids dissolve freely in weak acids, lime-juice, &c., but a small portion of the mixture, consisting of resin or coloring matter, is insoluble in dilute acid, and no doubt the controversy as to the solubility of the drug has arisen from the fact that no amount of acid will make an absolutely clear solution. The Chemical Examiner of Madras, who has, at the request of the Committee, examined a specimen in regard to its solubility, states that—

"Dilute sulphuric acid, prepared according to the instructions on the label, dissolved 98.24 per cent. of the febrifuge, the insoluble matter appearing to be coloring substances."

33. This preparation is packed in 1 lb. tins, and is advertised for public sale at Rupees 20 per lb. We learn from Dr. King's report, No. 84-C, of 15th September 1877, that besides the quantity supplied to the Medical Store Department, 834 lb. were bought by the public from 1st April to the 31st August 1877, and the demand was said to be increasing. In Bengal and Northern India arrangements have been made by the Surgeon-General, Calcutta, to substitute 75 per cent. of the sulphate of quinine formerly supplied to the Native Army and Civil Hospitals by an equivalent amount of the "febrifuge," and suggestions have been made for a similar substitution of the cheaper preparation in the Presidencies of Madras and Bombay.

34. A collection of papers showing the recent results of the trial of Mr. Wood's febrifuge, and of a similar preparation made by an English manufacturer, Mr. Whiffin, and called by him "Quinetum," have recently been printed by the Government of India, and copies have been supplied to us. We have had before us also the elaborate and carefully conducted experiments made in India in 1866-67 in regard to the therapeutic value of the separated alkaloids of cinchona bark, quinine, cinchonine, cinchonidine, and quinidine. It was then proved beyond all question that all these alkaloids in their purified state, and in the form of soluble sulphates, were possessed of febrifuge power; that sulphate of quinidine was quite equal to quinine in therapeutic value, and sulphate of cinchonidine very nearly so; and that sulphate of cinchonine, while possessing valuable febrifuge properties, was in large doses apt to cause nausea, vomiting and derangements of the bowels, and was not quite so speedy in its action in arresting periodic fevers as the other alkaloids.

35. If the separated alkaloids of cinchona have by severe tests been proved to possess the power of curing malarious fevers, and if the cinchona bark itself possesses the same property, it is a natural inference that the associated alkaloids, as they exist in the bark, must have a similar effect. The careful trials given to Mr. Broughton's preparation in this Presidency from 1869 to 1874, left no room for doubt that the mixed alkaloids were useful and efficacious in the treatment of fevers, and as the Bengal preparation is almost identical in composition, the Committee consider that the therapeutical value of Mr. Wood's febrifuge may be assumed as proved, not only by the testimony of numerous reporters of high professional standing, but by the fact that the chemical constituents of the febrifuge are identical with alkaloids which, in their separated condition, have been proved to be good febrifuges.

36. It is a fact not generally known that up to a recent date the medical profession throughout the world had been using not a pure sulphate of quinine, but a sulphate of the several alkaloids, including cinchonine and cinchonidine, as they existed naturally in the various barks used by quinine manufacturers. It was only on the publication of the British Pharmacopœia that the test of the solubility of

quinine in ether was given as the distinctive mark of a pure quinine. As nobody questioned the efficacy of the mixed sulphates of cinchona alkaloids from 1820 to 1865, it is reasonable to conclude that they were practically of equal value with the pure sulphate of quinine enforced on manufacturers by the "purity test" of the Pharmacopœia.

37. But while admitting the medicinal value of amorphous cinchona alkaloids as prepared by Messrs. Broughton and Wood, it is quite certain that there are practical inconveniences in popularising the use of a febrifuge in this form. These are—

- (1) The insolubility of the preparation, except in acids which the people in India are not likely to have at hand.
- (2) The somewhat nauseous taste of the crude alkaloids and frequency with which it causes nausea, or vomiting and purging.
- (3) The appearance of the drug, so different from the commercial quinine to which the Indian public have long been accustomed.

38. The febrifuge powder would be to a certain extent soluble in lime-juice or tamarind, the only acids likely to be found in native bazaars, but owing to the physical properties of the powder it is not easy to mix with fluids, unless there be appliances for rubbing it into a paste, and then gradually diluting with the necessary liquid. Sulphuric acid or hydrochloric acid are not articles commonly at hand in India.

39. The taste and nauseating effects of the remedy probably depend upon the uncrystallisable alkaloid present, which is apparently more irritant and disagreeable than the alkaloids which are convertible into crystalline salts.

40. The Committee appointed by the Bengal Government to consider certain matters connected with the Government cinchona febrifuge, say:—

"We are unanimously of opinion that although the cinchona febrifuge issued by the Government Quinologist is, in its present form, a preparation of great efficacy in the cure of malarious fever, yet it does in certain cases cause some amount of nausea and vomiting. We believe that to a great extent these unpleasant symptoms have arisen from errors in administration. But after allowing for such errors, we believe that the drug contains a nauseating principle from which it ought to be if possible freed." (*Report dated 27th July 1877.*)

41. This Committee apparently agreed in the main with the Nilgiri Committee of 1874, who reported:—

"In our opinion, if local manufacture is to be carried on at all, an attempt should be made to obtain crystalline salts of cinchona alkaloids. * * * We are certain that medical officers would prefer to use mixed sulphates to the present amorphous powder. * * * It would be a work of time to popularise a preparation of cinchona alkaloids which stops short of the crystalline form." (*Paragraphs 57 and 58.*)

42. We note here that Dr. King and Mr. Wood are members of the Calcutta Committee still deliberating on this question, and that the Committee has recommended a trial, by competent observers, of the following mixture of crystalline salts of the alkaloids before determining the ultimate form which local manufacture in Bengal is to assume:—

Sulphate of quinine	...	...	...	...	...	4 parts,
Do. of cinchonidine	...	...	...	...	...	8 "
Do. of cinchonine	...	...	...	...	...	9 "

and we understand that experiments are now in progress with the above mixture. We believe from all antecedent facts in reference to these several preparations that there can be no reasonable doubt as to the efficacy of the mixture, and its entire suitableness either for the medical institutions of the country or for general use by the native public. In appearance and taste such a mixture would be undistinguishable from ordinary quinine as sold in the shops, and as the combination pretty nearly represents the actual proportion of alkaloids in natural red barks, divested of all nauseating principles (unless cinchonine is considered a nauseating component), it should be not only effective, but popular with all classes.

43. We have now to see what the commercial value of such a mixture would be. Prices of quinine have been ranging very high in 1877 owing to the increased

demand caused by the Russo-Turkish war, but these high prices are now falling. The latest prices charged in the Home invoices (1877) to the Madras Government, with 20 per cent. added for freight and "charges," have been taken in the following calculation:—

		RS.	A.	RS.	A.
4 lb. of sulphate of quinine (bleached)	...	79	4	317	0
8 lb. of do. of cinchonidine	...	21	0	168	0
9 lb. of do. of cinchonine	...	6	0	54	0
21 lb. mixed sulphates	...	25	10	539	0

The mixed sulphates thus prepared would last year have cost Rupees 25-10-0 per lb., but as quinine has now fallen considerably in value, and as 20 per cent. is too high a proportion for actual "charges," it is probable that any wholesale manufacturer of alkaloids would undertake to mix and deliver the above preparation at the Indian Presidency towns at a cost of from 20 to 22 Rupees a pound, varying with the market value of quinine. The actual price of such a mixture might be accurately ascertained by calling for tenders for, say, 100 lbs. for experimental use.

44. The cost of mixed sulphates and amorphous alkaloid of European manufacture, in the proportion of the composition of the Bengal Government febrifuge, would be as follows:—

		RS.	A.	P.
15.5 parts of a lb. quinine sulphate	...	12	4	0
33.5 do. cinchonine sulphate	...	2	0	1
29.0 do. cinchonidine sulphate	...	6	1	6
17.0 do. amorphous	...	0	10	10
Total	...	21	0	5

45. From the prices above indicated it is evident that various proportions of the several commercial sulphates can be mixed so as to bring the cost of the mixture to even less than the amorphous febrifuge now manufactured at Sikkim, and we imagine that there can be no two opinions in the medical profession as to the preferential use of crystalline salts of alkaloids for general purposes.

46. In regard to the resumption of local manufacture of a febrifuge similar to Mr. Wood's we see no economy or advantage, while a stable and efficient preparation like the sulphate of cinchonidine can be obtained from the European manufacturers for less than Rupees 20 a pound.

In nine-tenths of the fever cases of India cinchonidine is just as efficient as quinine, while it is barely one-fourth of the cost; and, as a matter of economy, we believe it will be cheaper to sell our Nilgiri barks as heretofore in the open market, and to buy in the same way all the cinchona alkaloids required for the use of the public service and the poor, to whom it may be necessary to issue febrifuges gratuitously.

47. It has been objected that with a steady demand for cinchonidine and cinchonine prices are likely to rise. We do not attach much force to the objection, because, in our opinion, with a steady demand for these alkaloids, manufacturers will utilise barks that produce them, and we have no doubt that the supply will keep pace with the demand. This appears to be the opinion of Mr. Howard also, who, as a practical manufacturer of alkaloids, is entitled to a hearing on this question.

48. The Surgeon-General, Indian Medical Department, Madras, has intimated to us that he is prepared to substitute the sulphates of the cheaper alkaloids, or a mixture of them, to the extent of 75 per cent. of his average issues of quinine, but that he is not prepared to accept the amorphous febrifuge of Bengal to that extent, while the objections to it as shown by experience of its nauseating effects continue.

49. We observe also that the Surgeon-General of British Troops in Bengal is unwilling to press the use of locally prepared alkaloids and cinchonidine on the officers of his department, "until their efficacy has received more complete affirmation." The report on their use in British hospitals was said to be of an "unfavorable character."

50. In regard to the resumption of local manufacture, we have taken into account the fact that while Mr. Broughton was absent on leave in 1874, a considerable quantity of alkaloid was spoilt by unskilful extraction, and that the process is one that cannot apparently be safely left to untrained superintendence. Even in the Sikkim experiment, under Mr. Wood's direction, but with rude apparatus, we have seen that an enormous waste of alkaloid occurs, and the amount of red bark likely to be yielded by the Government plantations would not, in our opinion, justify a considerable expenditure on machinery and skilled supervision.

51. Suggestions are made in letter No. 82 from the Secretary to the Government of India, Department of Revenue, Agriculture and Commerce "whether it would not be feasible to have the Nilgiri *succirubra* bark converted into cinchona febrifuge in Bengal under the supervision of Mr. Wood, whose process, it is understood, is more economical than that followed by Mr. Broughton; * * and also, whether it would not be advisable for Mr. Wood to manufacture quinine itself from the Nilgiri crown bark (*officinalis*), which is understood to be very rich in that alkaloid."

52. In regard to the first suggestion, we are of opinion that Mr. Wood's tentative manufacture at Sikkim is proved not only to be less economical, but more wasteful of alkaloid than Mr. Broughton's; and that as Nilgiri red barks, which are obtained by mossing and renewal, fetch an exceedingly good price in the market, greater economy would result by selling the barks at their market value and buying the necessary alkaloids required by the Madras Government by public tender. The cost of packing, land carriage, and freight of bark to Calcutta would be very nearly equal to the cost of transport to the London market.

53. In regard to the second suggestion that Mr. Wood should prepare quinine from the Nilgiri crown barks, we may remark that until Mr. Wood has had some experience of the production of crystalline salts of cinchona barks in the factory at Calcutta, it is not at all probable that he would be able to utilise economically and profitably the crown barks of the Nilgiri plantations. The preparation of a pure and definite alkaloid, Mr. Wood states, "would be a highly technical and somewhat complicated process, requiring the regular personal supervision of a skilled chemist, having some experience in such operations. A heavy expenditure for apparatus, &c., would be necessary at the outset, and the permanent success of the undertaking would much depend on the power of securing a continuity in the system of supervision and control. * * It may result, therefore, that it would be more practicable to obtain a pure alkaloid of *succirubra* origin, by selling our best bark and utilising the branch bark that would not pay for exportation in the production of the present febrifuge."

54. But our present objection to the manipulation of our crown barks in Bengal is that there is no factory, plant or appliances, available for the production of pure alkaloidal salts, and that working with crude apparatus, as in Sikkim, results in enormous waste of material. It has yet, moreover, to be demonstrated that manufacturing operations, with skilled labor and appliances, can be economically conducted in India. Mr. Wood seems by no means sanguine on this point. Inasmuch as some three-eighths of the constituents of bark have been lost to the world, it has still to be shown that it is possible for Government to work up in India the raw material in an exhaustive manner, and at a proportionately small increase of cost.

55. We are of opinion, therefore, that neither of the suggestions of the Government of India can be at present adopted as regards Nilgiri barks without sacrifice of valuable produce and incommensurate results in outturn, and that the manufacturing operations for the production of crystalline salts can be conducted cheaper and more satisfactorily in England than in India. The Bengal Government are able to produce a considerable harvest of bark of inferior commercial value which it would not be remunerative to send to European markets. The Nilgiri barks, on the other hand, are of high value and remunerative to exporters, and their realised value in the home market would permit Government to purchase largely and economically the febrifuge alkaloids of European manufacture required for use in India.

56. A good deal has been said in regard to the action of Government in disposing of the barks grown on the Nilgiri experimental plantations on ordinary commercial principles. We are disposed to consider this plan of procedure not only free of objection in itself, but as having contributed more than any other circumstance to the embarkation of private enterprise and capital in the cultivation of cinchona in India and Ceylon. The barks produced from the Government estates have been obtained after careful experiment of the advantages of the mossing or renewal process. The reputation of these barks is so well established that they are keenly competed for by the European manufacturers of alkaloids; they have steadily held the first place in the London market; and the Government experience has demonstrated to planters that cultivated bark will fetch a higher price than natural South American bark. The result of the Government sending its best barks into the open market has been to encourage private enterprise on a scale so vast, that in a few years cinchona production will be one of the chief industries of the hilly country of South India and Ceylon.

57. And in connection with this matter we are bound to notice that the Government culture of cinchona in Bengal has had no such beneficial action in developing private enterprise. We regret to learn from Dr. King that private cultivation of cinchonas is, for the time being, practically in abeyance; that the few persons engaged in it availed themselves of the temporary rise in prices in 1876 and 1877 to root up the trees and dispose of their bark; and that no renewal of cultivation on a considerable scale is likely to take place.

In Bengal the whole of the cinchona cultivation bids fair to become a Government monopoly, while in Southern India and Ceylon the extent of cultivation by private enterprise much exceeds the area of the Government estates. It seems to us that in its dealings with the produce of the cinchona estates the Madras Government has followed the established principles of political economy. We do not believe in the ability of any Government to cheapen artificially the production of a commodity of public utility. But in demonstrating that cinchona can be profitably cultivated, the Madras Government has exercised an enormous influence in stimulating production, which in due course will have a decided effect in regulating the supply of bark and reducing the price of alkaloids, not for India only, but for the whole world. We give in Appendix D a statement of bales of bark, South American and Indian, sold by Messrs. Jenkin and Phillips in London during the years 1876 and 1877. This statement shows most conclusively how Indian and Ceylon bark produce is increasing, irrespective of the few hundred bales sent home annually from Government estates at Ootacamund.

58. There is a further objection to the conversion of the produce of the Nilgiri barks into a crude febrifuge for general distribution and sale below its market value, which may be briefly noticed. All the Nilgiri barks are richer in quinine than the Sikkim barks, and during the late demand for quinine, if such a preparation had been made on the Nilgiris from our renewed red barks or from crown barks, it would have paid speculators to buy up the febrifuge and send it home to manufacturers for the extraction of the quinine in it. A procedure of this nature would be of no benefit to the natives of India, for whom a cheap febrifuge is so much desiderated; but it would surely happen if the Government attempted to sell such an article locally at a price below the value of the crystallisable quinine in the mixture of alkaloid. If no such use of the locally prepared alkaloid was made last year in Bengal, it was probably due to the fact that the small quantity of quinine in a pound of the febrifuge was not worth more than Rupees 20 in the market. Dr. King informs us that precautions are taken to prevent such speculative dealings, but in our opinion, if a profit could be made, it would be impracticable to prevent native dealers entering into combinations to collect and export the crude alkaloids.

(b) "Other modes of utilising the bark for the use of the population at a reasonable cost."

59. In regard to this branch of our labors, we are unanimously of opinion that no simple preparation of cinchona bark will ever be attractive to the native population in Southern India who are familiar with the appearance of sulphate of quinine,

nor can such preparations in India be economically substituted for the cheaper cinchona alkaloids of European manufacture. The causes of the unsuitableness of the bark preparations for general use are not far to seek. If the preparations are of a simple character, the bulk of the medicine, as in powder, is objectionable, and infusions and decoctions quickly spoil. If spirituous tinctures or extracts are used, the bulk of spirit is often an objection in a medical point of view. On this subject we append a memorandum (Appendix B) drawn up by our colleague, Surgeon-Major Bidie, in whose conclusions we generally concur.

60. A preparation of bark has recently been advocated by Mr. Money, a cinchona planter on the Nilgiris, which he terms a "decoction," but which is really a "tincture," and a trial has been accorded to it by the Medical Department. The report of Surgeon-General G. Smith, M.D., on this trial is given in Appendix F. The results are not favorable to the use of such a preparation for public purposes. It is well known to chemists that alcohol does not extract the whole of the alkaloids from bark unless the quino-tannates of the bark have been previously decomposed by a strong alkali. Mr. Money's preparation is a simple tincture, and the spirituous solution does not contain the whole of the alkaloids of the bark. The great bulk of the preparation, and cost of carriage, would make its use very expensive. In regard to the economical use of such a preparation Dr. Bidie has made some observations in Appendix B.

(c) "Re-appointment of a Quinologist."

61. As we have given our views adversely to the resumption of local manufacture, we are of opinion that if the superintendence of the cultivation be in future confided to the care of some one of practical and scientific attainments in botany and gardening, there is no necessity for a chemist to reside on the plantations. The superintendent should have full power to communicate with an European chemist of repute in regard to analyses of specimens of bark of various species, or cropped in various ways, and it would be convenient to the superintendent that some gentleman of established reputation, such as Dr. Paul, President of the Pharmaceutical Society, should be appointed by the Home Government as chemical referee in all questions connected with the cinchona culture in India.

(d) "Report of Captain Campbell Walker and other papers."

62. The report prepared by Captain Campbell Walker shows for the first time the actual outcome of the area planted in surviving trees, and these are much fewer than the numbers hitherto estimated as existing. It is quite evident that in the last few years the replanting of vacant ground has not been carried out so actively as it should have been, and to maintain the efficiency of the plantations we are of opinion that a responsible superintendent, thoroughly trained in the theory and practice of scientific gardening, should be at once placed in charge of the whole. We are strongly of opinion that the time has not yet arrived for Government to retire from this great and important experiment, and that there are many things yet to be done, which only a Government anxious to increase the productive resources of its country can undertake. On the Nilgiri plantations two species of cinchona have been successfully introduced, the red and crown barks; but the culture of the yellow barks (*calisayas*) has practically failed on the Government estates, and for this and other species, the proper locality, soil, and climate have yet to be found by actual experiment. Some notes on *C. calisaya* culture will be found in Appendix C.

63. Experience has also shown that certain varieties of the red and crown barks are better growers and freer alkaloid producers than others, and natural hybridisation has produced forms of plants which in habit of growth surpass any of the distinct species, while some of these have proved to be remarkably prolific in alkaloids.

The Committee of 1874, in alluding to this subject, remark:—

"We would advise that the whole question of artificial hybridisation of promising species should be carefully worked out by the superintendent and quinologist in intimate communication."

And in their conclusions, the Committee sum up the question as follows:—

"The hybridisation of species of cinchona is a phenomenon that brings us to the threshold of a new department of enquiry and research, which might be profitably entered upon by the scientific officers entrusted by Government with the progress of the experimental culture of the cinchonas."

64. The late Mr. McIvor in his last communication, No. 91, of 2nd August 1875, made to Government, makes the following statement in regard to the subject of hybridisation:—

"Selection and hybridization has secured for our domestic plants those wonderful improvements which now make it difficult to recognise in our large and prolific grain, in our fine fruits and splendid flowers, their worthless progenitors. Cinchona belongs to a tribe of plants highly susceptible of improvement by these means. * * So soon as our plants flowered, or early in the spring of 1865, I made a vigorous attempt to attain this object. The result was that in 1866 a number of hybrid seedlings were produced. Among these six distinct varieties, possessing remarkable vigor of growth, were selected, and the weakly growing plants destroyed. The selected varieties were planted here and there in every way, soil, exposure, and elevation available. Under all these conditions our new seedlings maintained that remarkable vigor of growth which at first distinguished them. * * Circumstances soon arose which clearly indicated that under certain conditions these seedlings produced a bark of great value. * * Evidence was also clear that in these vigorous growing hybrids we had secured in a marked degree the good qualities of both parents."

65. But it is important to note here that whatever Mr. McIvor did in the way of experiment in hybridisation, not a single line has been recorded to show the results obtained, and we are still left in the dark as to whether the valuable hybrid named "*pubescens*" is the result of artificial crossing or an accident in hybridisation. The omission to keep a record of such important experiments is much to be deplored, and for the future we think Government should insist on all experiments in hybridisation being accurately noted at the time and the results reviewed in the annual report.

66. We are under the conviction that great results may be expected from a steady perseverance in scientific experiment and culture, and that Government alone can afford to work out the problems still unsolved, and with their secured success they can afford to do so without drawing on the public purse. It is on these grounds we advocate the employment of a person of recognized scientific repute in gardening, whose time may chiefly be devoted to the question of improving the various species by cross fertilization and their public distribution, so that we may not rest content until we have varieties that will grow quickly in our different climates and elevations, and at the same time produce such an abundance of alkaloid as to remunerate the cultivators. A memorandum on cultivation and distribution of plants to private individuals will be found in Appendix C.

67. We have in conclusion to suggest that the experimental culture should be systematic, methodical, and prolonged for many years, and that the results obtained, whether successes or failures, should be made public from year to year for the benefit of private cultivators. It is in this direction that we conceive the State may yet accomplish great things in establishing hardy and productive varieties of plants, and thus give a continued impetus to production, so that the desiderata of all interested in the subject may be best attained, a plentiful and moderately cheap febrifuge for India and the world at large.

We have the honor to be,

Sir,

Your most obedient servants,

(Signed) R. W. BARLOW, *President*.

(") W. R. CORNISH, F.R.C.S.,

(") G. BIDIE, M.R.,

(") L. A. CAMPBELL,

} *Members.*

APPENDICES.

APPENDICES.

APPENDIX A.

Questions relating to Cinchona Cultivation put to DR. KING by the Cinchona Committee, and his Replies thereto.

FINANCIAL.

Question.

Answer.

1. What is the approximate area of the cinchona estates in Bengal belonging to Government?

1. The Sikkim plantation was surveyed in 1875 by a Party of the Revenue Survey, and a map of it, on the scale of 16 inches to the mile, was prepared and printed. Of this map a copy shall be sent to the Secretary of the Commission.

	Acres.
In 1875 the absolute area was found	
(base measurement) to be	1,762
During 1876-77 there were planted	110
Do. 1877-78 do. do.	252

Total acreage at 31st March 1878 .. 2,124

A survey of these latter two areas has been applied for by me, but I believe them to be pretty correctly stated as above.

2. It is observed that you had 2,691,600 plants permanently planted out on the 31st March 1877. Has the number of trees been arrived at by actual census, or from annual record of plants taken from the nurseries for the permanent plantations?

2. The number of trees returned at 31st March 1877 as 2,691,600 was not arrived at by actual census. To make such a census annually would cost more than the information elicited would be worth, as the yield of the plantation is estimated by the acre and not by the tree. And for practical purposes the really interesting information is not how many trees stand on an acre, but how much bark can be taken from these trees. With the view of forming a regular working plan for the plantation, I have tried to find out this by uprooting about 120 acres, and by clean coppicing about 20 acres of trees of various ages. But although we work by the acre and not by the tree, every effort is made to secure approximate accuracy in stating the number of trees on the permanent plantations. In first planting out, the land is roughly measured, and the area is checked by counting the number of plants used in planting it, which, since 1872, has invariably been at the rate of 2,722 per acre.

I have claimed above only approximate accuracy, for in dealing with soil so irregular as that of Sikkim and a plant so capricious in growth as cinchona, it would be foolish to pretend to perfect accuracy. The calculations as to number of plants and the rough measurement of the land in planting out are of course by surface measurements. But when surveyed, the acreage is given by base measurement, which in Sikkim averages 15 per cent. less than surface. There is thus always a margin of 15 per cent. against our original calculation and in favor of accuracy.

Question.

3. In Madras experience shows that 50 per cent. of the plants transferred to the permanent plantations fail to reach maturity. Your experience on this point as regards the Bengal plantations will be very valuable to the Committee.

Answer.

3. In Sikkim a percentage (varying with soil, exposure, and season of planting) of newly planted out cinchonas dies. The mortality is heaviest during the first year, and, as a rule, diminishes in proportion as the plants get older. Our practice in Sikkim is to keep filling up death vacancies where they occur in young planting, until it is clear that in such spots cinchona will not grow. As is pointed out in paragraph 2 of my Annual Report for 1874-75, there is every year a large provision of nursery stock for this purpose, and plants so used are not entered in the annual returns as having been planted out during the year. An examination of my last four annual reports shows the quantity of nursery stock available for this purpose during each year. I put the figures in the form of a table:—

Nursery Stock of *Succirubra*, Sikkim Plantation.

Year.	At the beginning of the Year.	Put into permanent Plantation during the Year.	Available for filling vacancies.
1873-74 ..	417,000	247,000	170,000
1874-75 ..	475,000	310,000	165,000
1875-76 ..	235,000	None.	235,000
1876-77 ..	650,000	406,600	243,400

4. In your report for 1875-76 you give the capital account of the Bengal plantations on the 1st April 1875 at Rupees 3,50,000 as settled by the Accountant-General. The Committee will feel obliged by your showing in detail the yearly expenditure from the commencement of the experiment until 1st April 1875, in order that they may be able to understand the system on which the capital account has been made up.

5. The important point in regard to the capital account is to ascertain whether in framing it, the balance of interest on outlying capital has been charged from year to year, as has been done in the case of the Neilgherry plantations. If this has been done, could you, as asked in the preceding question, No. 4, favor the Committee with the rate of yearly expenditure to enable a financial statement to be prepared, as has been done for the Neilgherry plantations, with accumulating interest calculated at $4\frac{1}{2}$ per cent.?

4 and 5. These questions are so closely related that they may be conveniently answered together.

In my report for 1875-76 the capital of the plantation then being worked for crop was put down at Rupees 3,50,000, that being the sum fixed by the Accountant-General for Bengal, after an examination of the accounts, as the proportion of total cinchona expenditure fairly chargeable against that part of the plantation if it was desired to state its crop accounts in profit and loss fashion. At the request of the Commission, I herewith submit a statement of the total expenditure on the Bengal plantations from their commencement to 31st March 1875, in which annual interest on capital is calculated at the rate of 4 per cent. (that being the rate fixed by the Government of Bengal). This statement includes, I believe, every possible charge against cinchona in Bengal, viz., expenditure on abandoned nurseries and propagating-houses, bungalows and roads at Sinchul, Lebong and Rungyroon in Sikkim and at Nunklow in the Khasia Hills, and of course the total expenditure on the existing plantations of Rungbee, Rishap, Mungpoo, and (as far as it was in existence during 1875) also of the Sittong plantation. The latter includes cost of bridges, roads, bungalows, godowns and the like, and also the total expenditure on quinology and factory. The receipts for sale of plants, &c., during the period (amounting to about Rs. 8,000) are not taken credit for in the statement.

Question.

Answer.

Annual Expenditure on Government Cinchona Plantations, Bengal, from the beginning to 31st March 1875. All Charges are included and annual Interest added at 4 per cent. per annum.

Year.	RS.	RS.
1861-62 ..	4,318	
1862-63 ..	10,274	
Previous ..	4,318	14,764
Interest ..	172	
1863-64 ..	12,243	
Previous ..	14,764	27,597
Interest ..	590	
1864-65 ..	31,957	
Previous ..	27,597	60,658
Interest ..	1,104	
1865-66 ..	54,131	
Previous ..	60,658	1,17,215
Interest ..	2,426	
1866-67 ..	50,862	
Previous ..	1,17,215	1,72,765
Interest ..	4,688	
1867-68 ..	58,615	
Previous ..	1,72,765	2,38,290
Interest ..	6,910	
1868-69 ..	71,052	
Previous ..	2,38,290	3,18,873
Interest ..	9,531	
1869-70 ..	50,522	
Previous ..	3,18,873	3,82,149
Interest ..	12,754	
1870-71 ..	53,002	
Previous ..	3,82,149	4,50,436
Interest ..	15,285	
1871-72 ..	51,826	
Previous ..	4,50,435	5,20,278
Interest ..	18,017	
1872-73 ..	50,362	
Previous ..	5,20,278	5,91,451
Interest ..	20,811	
1873-74 ..	60,471	
Previous ..	5,91,451	6,75,580
Interest ..	23,658	
1874-75 ..	60,280	
Previous ..	6,75,580	7,62,487
Interest ..	26,627	

The total expenditure, with interest up to 31st March 1875, was thus in round numbers $7\frac{1}{2}$ lakhs; the area by survey was 1,762 acres, and the cost per acre was therefore, as near as may be, Rs. 433.

6. The object of this enquiry is to ascertain the economy or otherwise of the local manufacture of alkaloids; and, to arrive at any definite conclusion, the actual cost of raw material both in Bengal and Madras must be ascertained as nearly as possible. You will see therefore that there must be uniformity in the mode of preparation of the capital accounts, and in the rates of interest on balance of charges, otherwise the data for the calculation of the cost of production of bark in the two Government experiments are unreliable. A statement prepared by the Accountant-General showing the mode of preparation of the capital accounts of the Neilgherry estates will be placed at your disposal.

6. According to an estimate submitted by Mr. Wood in June 1875, the annual yield of the plantation would thenceforth be 366,000 lb. of dry bark, which, allowing for accumulated interest at 4 per cent. on a capital of $7\frac{1}{2}$ lakhs, and adding annual working expenses, it would cost $3\frac{1}{2}$ Annas per pound to produce. Mr. Wood's estimate of the annual yield of the plantation was arrived at by calculating by the tree; my calculation by the acre came to much the same. The estimated outturn was considered sufficiently large to be worked to advantage, and our proposal was thenceforth to work the plantation annually up to its full producing power, both by taking the full estimated crop and by converting the whole of that crop into cinchona febrifuge by a manufacturing process by which, out of bark containing on an average 4 per cent. of total alkaloids, $3\frac{1}{2}$ per cent. of

Question.

Answer.

febrifuge should be extracted. Mr. Wood estimated that, worked in this way, the annual outturn of febrifuge would be 12,810 lb. and the net cost (including bark at $3\frac{1}{2}$ Annas per lb., quinologist's pay, and all manufacturing charges) would be Rupees 11 As. 9 per lb. We further proposed to divide the total cinchona expenditure into two parts, viz., (a) into charges against capital, which should include the cost of new extensions, additions to permanent buildings, &c., and (b) into working expenses, under which should be included all expenditure on the plantation not debitable to capital, and all expenditure on quinology and factory. It was proposed to add the annual capital charges to the capital account, and to debit the charges under (b) against the annual outturn of the plantation; in other words, to charge them against crop. For reasons which need not be entered on here, the scheme of working up to full power in both ways has not yet been fully carried out, but the mode of dealing with the annual expenditure has been adopted as proposed, and from the year 1875-76 onward the annual expenditure has been divided into capital expenditure and working expenses: the subsequent financial history of the plantation must therefore be viewed in the light of this fact.

The medical profession in Bengal not having made up their minds in 1875 as to whether they were to accept the cinchona febrifuge in lieu of quinine, Government did not feel warranted in committing themselves to the expenditure necessary for the erection of an efficient factory in Calcutta as had been recommended by Mr. Wood and myself. It was therefore decided not to bring into immediate operation the scheme for working the plantation to its full power, but it was decided to continue in its stead and in the meantime, a rough manufacturing process which had been begun on the plantation as a tentative measure, and which could be carried out at a minimum of cost, but by which only about half the alkaloid could be extracted from the bark. Although the demand for febrifuge has steadily increased, this state of things has gone on until now, and we are now working on a large scale a process which was originally suggested as a mere make-shift. It was further decided to regulate the crop of bark to be taken annually, not by the natural capabilities of the plantation, but by the amount which the quinologist might require to use up in order to meet the current demand for febrifuge. During last year the Surgeon-General for Bengal decided on the substitution of cinchona febrifuge to the extent of 75 per cent. on all indents for quinine, and Government are now accordingly taking active steps for the erection of a factory in Calcutta, in which the whole annual crop of the plantation can be worked up by a process by which at least seven-eighths of the contained alkaloid shall be extracted as febrifuge. As soon as this factory is complete, we shall be ready to work the plantation to its full rate of production, which,

Question.

Answer.

7. The statement in paragraph 7 of your report for 1875-76, that the cost of the bark produced in Bengal, including interest at 4 per cent. on the capital account, was only seven pence and one-eighth sterling per pound, will require consideration in reference to the mode of calculation of your capital account, and the Committee will be glad to receive any detailed information from you in regard to this important point.

owing to extension of acreage, has in the meantime increased from 366,000 lb. of dry bark per annum to a considerably larger amount.

7. In my Annual Report for 1875-76 the cost per pound of the bark crop for the year (195,291 lb.) is put down at 3 Annas 6-21 Pies exclusive of interest on capital, and with interest on the Accountant-General's proposed capital of Rupees 3,50,000, at 4 Annas 9 Pies per pound. If however accumulated interest on the whole cinchona expenditure from the beginning be added, the cost of the bark is raised to Annas 6 per pound and the febrifuge to Rupees 23 Annas 11. It must not, however, be forgotten that had the plantation been worked to the full of its producing power, the price of the bark would (including interest) have been only $3\frac{1}{2}$ Annas. As it is evidently the object of this question to elicit the exact cost of raw material on the Sikkim plantation, I shall continue the financial history of the plantation from 1875 to the end of the financial year 1877-78, so as to show the cost per pound of the bark crop of that year.

	RS.	RS.
Year 1875-76, capital expended	9,777	8,02,764
Previous	7,62,487	
Interest	30,500	
Do. 1876-77	16,648	8,51,523
Previous	8,02,764	
Interest	32,111	
Do. 1877-78	10,212	8,95,796
Previous	8,51,523	
Interest	34,061	
The working expenses of the		
Year 1877-78 were ..	57,900	
The interest	34,061	
Rupees ..	91,961	

The crop was 345,000 lb.

345,000 lb. : 92,000 Rs. :: 1 lb. : x =
As. 4 P. 3 per pound.

The net cost, including interest, of last year's crop of bark, was therefore a little over 6d. a pound. If worked by the imperfect process at the plantation, this would give, at 2-25 per cent. (the amount actually obtained last year), 7,762 lb. of febrifuge at a net cost of Rupees 17-4-0 per pound.

Bark	92,000
Working expenses of manu- facture	41,845
	<u>1,33,845</u>

7,762 lb. : 1,33,845 Rs. :: 1 lb. : x = Rs. 17-4.

If worked in the factory in Calcutta, the result would be (at $3\frac{1}{2}$ per cent. of outturn) 12,075 lb. of febrifuge, at a net cost of Rs. 12-12 per pound.

Bark	92,000
Carriage to Calcutta and manufacturing expenses.	64,100
	<u>1,56,100</u>

12,075 lb. : 1,56,000 Rs. :: 1 lb. : x = Rs. 12-12.

Question.

8. In your Annual Report for 1876-77, paragraph 4, there is no reference to charges for interest on capital in the expenses for the year, nor is any allowance made in paragraph 6 for those charges. The Committee will feel obliged by an explanation on this point.

9. The Committee infer that the accounts of your cinchona estates do not include charges on account of price of land, annual rent or assessment, local survey, but will be glad to have specific information on these points.

10. Would you be good enough to furnish a statement showing the prices realized by Bengal Red barks each year that any portion of the crop has been sent home; and also a statement showing the amount that would have been realized by the bark supplied to the quinologist, if sent to England and sold there year by year?

Answer.

8. In estimating the cost of the year's crop in my Annual Report for 1876-77, no charge is made for interest, and the Accountant-General's proposed capital is not referred to for this reason, that, in their Resolution on my report for the previous year, in which I did calculate interest on capital, Government expressly direct that interest shall not in the meantime be debited against the annual crop, but shall be charged to capital account. Accepting the accuracy of the estimate that, when the plantation is brought into full working, the cost per pound of the bark (*including interest from the beginning*) will not exceed $3\frac{1}{2}$ Annas per pound, and unwilling to delay the issue of a febrifuge for the people at the price originally laid down by the Government of India, the Bengal Government decided that until the working plan already alluded to shall be brought into force, the price charged to the quinologist for bark made over to the factory shall not include interest, which shall instead be debited to capital account.

9. The plantation has not been debited with the price of land, which, under Lord Canning's Waste Land Rules in force at the time it was taken up, was Rupees 2-8 per acre in *fee simple*.

There is no annual assessment on *fee simple* land.

The only tax levied in Sikkim is the road-tax, which the plantation pays in cash.

Demarcation and survey charges are, I believe, not included in the statement of expenditure above given. The survey charges would amount to 1 Rupee an acre.

If the Commission desire to include charges under land rent, they ought to allow on the other hand an annual sum for the management of the forest and native cultivation in the cinchona valley.

The cinchona establishment conserves the forest (allowing the Forest Department to remove what timber they want free of charge), and collects and pays into the local treasury the Government land revenue levied on ryots cultivating in the valley. A considerable length of *public* roads is also kept up at the expense of the plantation, and this would require to be allowed for.

10. I am sorry I cannot answer this question, as I have not the figures here showing the prices got for some small consignments of our bark which were sent home some years ago. I may however mention that, as far as I remember, the prices ran from 1s. to 2s. per pound. *No bark has been sent to London since 1872.* Rather than go on under-cropping the plantation, I last year suggested to Government that we should send 50,000 lb. home for sale; but as we soon after extended our temporary febrifuge factory at the plantation, I myself asked Government to cancel my proposal, which they accordingly did. It is in accordance with the reiterated orders of the Secretary of State and Government of India that the object which we have all along kept in view is the issue

Question.

Answer.

of a cheap and efficient febrifuge and not the realization of commercial gain by the sale of raw produce.

11. You are aware of the average proportion of alkaloids in your bark. Have you ever calculated what amount of such alkaloids (preserving the proportion) you could buy in Europe for the money—

(a) that has, at your own valuation, been spent on producing the febrifuge manufactured in any one year?

(b) for the money the bark used in the local manufacture would have fetched in Europe?

The price of each of the cinchona alkaloids varies not only according to the bark market, but also with the demand for each. Until recent years cinchonidine to some extent, and cinchonine to a still greater extent, have had a low value, because they were mere by-products from the manufacture of quinine, and there was little or no market for them except for the purpose of sophisticating quinine. The experience of the Medical Officers of the three Indian Presidencies having established the febrifugal efficacy of the alkaloids other than quinine, these have obtained an increased value.

Cinchonidine and cinchonine are not more abundant in nature, nor are they more easily extracted from bark than quinine; there is therefore no reason why, in the face of an increased demand for them, they should not increase in market-value. It is recorded in the proceedings of the last Madras Cinchona Commission that, after having been induced to use these alkaloids, the Madras Government had to abandon them in favor of quinine, as they were found actually to be invoiced at a higher price than quinine.

I do not see that, under the circumstances, any satisfactory answer can be given to the question contained in *clause (a)*, seeing that it is founded on the assumption that the value of cinchonidine and cinchonine would remain the same in spite of a largely increased demand for these alkaloids. In my opinion, a safer basis for calculation would be afforded by comparing the prices of Sikkim febrifuge and Whiffen's quinetum. Quinetum is a preparation of the same composition as Sikkim febrifuge; it is made from the same kind of bark, and is, in fact, an avowed (see advertisements in newspapers) imitation of the Sikkim product.

During 1867-77 we produced 3,750 lb. (= 60,000 oz.) of febrifuge at a total cost, including interest, of Rupees 92,445. Quinetum would, at the average of market-prices for the year, have cost Rupees 2-8-0 per ounce landed in Calcutta. It would thus have cost Rupees 1,50,000 to land 60,000 oz. of quinetum, and the saving by making febrifuge was therefore Rupees 57,555.

Clause (b). With reference to this clause, I calculate as follows:—

To produce 3,750 lb. of febrifuge, 190,798 lb. of bark were used. It costs 6d. to 8d. sterling to land bark in London. A fair average selling price to allow for the Sikkim bark, consisting so largely as it does of quill and root bark, would be 2s. a pound. Allowing on the one hand for expenses of landing in London, and on the other for the gain by exchange, I think it would be fair to put down As. 12 per pound as the net average that might have been obtained by

Question.

Answer.

selling our bark in London. That would give a sum total *net* of Rupees 1,43,099.

(The accuracy of this calculation may be tested by considering what the maker of quinetum could have afforded to pay for our bark. At the above rate 100 lb. of it would have cost him £10; and, as its average yield of alkaloid is 4 per cent., he could have extracted from this at most 4 lb. (64 oz.) of quinetum, which (charging nothing against manufacturing expenses) would, at 4s. an ounce, have brought him £12-16-0.)

We should therefore have netted Rupees 1,43,099 for our bark, and could not have bought an equivalent in quinetum under Rupees 1,50,000.

But it must not be forgotten that in the foregoing calculation I have pitted a presumably perfect method of extraction of quinetum against an avowedly imperfect method of extraction of Sikkim cinchona febrifuge, and that, with our factory in operation, we should have obtained (at 3½ per cent. of yield) 6,624 lb. of febrifuge instead of only 3,750 lb. Had the factory been in operation, the comparison would therefore have been between the cost of production of 6,624 lb. of febrifuge and the net sum obtainable in the London market for 190,798 lb. of mixed Red bark.

GENERAL.

Question.

Answer.

1. What species of cinchona are cultivated on the Bengal Government estates, and what number is there of each species?

1. At 31st March 1877 the plants on the Sikkim plantation were estimated as follows. Only plants permanently planted out are given; nursery stock is excluded.

Cin. <i>succirubra</i> ..	3,286,000	} These are the only species actually cultivated.
„ <i>calisaya</i> ..	* 354,500	
„ an unnamed hybrid ..	21,000	

„ <i>officinalis</i> ..	25,000	} These are mere relics of past cultivation : none of these three species is being propagated now.
„ <i>micrantha</i> ..	20,000	
„ <i>pahudiana</i> ..	5,092	

2. Have you any experience of hybrids, and if so, what is your opinion as to their productive qualities in respect to alkaloids?

2. There is in our plantation both amongst *officinalis* and *calisaya*, and to a less degree amongst *succirubra*, a great variety of forms; to what extent these are the result of sporting, and to what extent the result of hybridization, I am not prepared to say. I do not myself know of a single form of cinchona of which the exact parentage is really known. Many forms are set down as crosses between such and such variations or species; but the absolute origin of any such has not, as far as I know, ever been demonstrated.

As *officinalis* (*condaminea*) has been a failure with us, I need say nothing about the value of the barks of any of the varieties. The variations of *succirubra* are found to be associated

* Since 31st March a number of the varieties of *calisaya*, which analysis showed to yield poor bark, have been uprooted. These will be deducted in next annual return.

Question.

Answer.

more with differences in growth than with differences in value of bark.

Of various forms of *calisaya* we have had considerable experience in Sikkim.

Our *calisayas* were originally raised from a portion of Ledger's seed collected in Bolivia, and from seeds obtained from Java. Our *calisayas* were all planted in a patch by themselves, and amongst them are recognisable about fourteen distinct forms. Some of these vary quite as much in appearance from each other as does *condaminea* from *succirubra*. The bark of each form has been analysed, with the result of showing that only three kinds have good bark: one of these three is the celebrated variety known as *Ledgeriana* by the Dutch.

The only form of cinchona in the plantation which we recognise as a hybrid and which we have found on analysis worthy of attention, is one which sprung up at a place where *officinalis* and *succirubra* are planted near each other. This partakes of the appearance of both these species, and is presumed to be a cross between them. On analysis its bark was found to be rich both in total alkaloid and in quinine. It is, moreover, a free grower, and affects higher altitudes than *succirubra*. We are therefore propagating it as fast as we can. It appears in most of our returns as an unnamed hybrid, and in some returns as cinchona *sp. ignota*.

3. Are you of opinion that valuable varieties may be produced by careful hybridization?

3. In selecting forms for cultivation we guide ourselves by analysis of bark and by habit of growth. We have never practised hybridization. The recent observations of a German botanist (Herr Kuntze), who visited lately both the Java and the Sikkim plantations, lead me however to believe that carefully conducted experiments in hybridization might lead to valuable results. Such experiments would necessarily extend over many years, and would require to be conducted by a person of scientific training thoroughly conversant with the practice of the higher kinds of gardening, and to whom almost no other duty should be entrusted.

4. Have any analyses been carried out with the view of ascertaining the influence of

- | | |
|----------------|------------------|
| (a) Elevation, | (c) Light, |
| (b) Exposure, | (d) Temperature, |

on the production of alkaloids in the bark of the cinchona under your charge? If so, will you kindly favor the Committee with the available information?

5. Can you furnish the Committee with the results of any analysis showing the changes which take place in the amount and relative proportions of the alkaloids in the cinchona barks according to the ages of the trees?

6. Have you any facts to show that, after a certain age, a certain waste or degradation of the alkaloids takes place, as pointed out by Mr. Broughton, and if so, at what period of the life of the tree does this process commence?

4—6. I have no information on these points beyond what may be contained in Mr. Wood's published reports, which are no doubt in possession of the Commission. From 4 to 8 years, age has very little influence on the alkaloidal constituents of bark either as regards total contents or composition.

Question.

7. What is the average percentage of alkaloids in the Bengal Red and Crown barks respectively, viz.,

- | | |
|-------------------|----------------------|
| (a) Red stem bark | (b) Crown stem bark. |
| " root " | " root " |
| " branch " | " branch " |

8. What are the relative proportions of the several alkaloids in the Red and Crown root barks under your charge?

9. Does your experience lead you to presume that manuring and careful cultivation generally will have any influence in increasing the amount or altering the kinds of alkaloids produced by a cinchona bark? For instance, do you deem it possible to increase the amount of alkaloids generally or of quinine specially in Red barks by such expedients?

10. What are the respective ages at which you have found it most economical to harvest the bark of your trees?

- | | |
|---------------|-----------------|
| (a) Red bark. | (c) Crown bark. |
| (b) Yellow " | (d) Grey " |

11. What is the average yield of bark per tree of

- | | | | |
|--------|---|-------------------|-------------------|
| Red | { | (a) by coppicing? | |
| Yellow | | | |
| Crown | | | (b) by uprooting? |
| Grey | | | |

Also what is the average yield per tree of stem, root, and branch bark by the uprooting system?

12. Of the two systems of harvesting bark in Bengal, viz., coppicing and uprooting, which do you consider the most economical?

13. With reference to coppicing, what experience have you—

(a) Of the frequency of a crop under this system?

(b) Of the quantity of bark that can be thus obtained as compared with that from land planted with seedlings?

Answer.

7. I have no figures for Crown bark, which has been a failure with us.

For *succirubra* the question is answered in the tables given as a foot-note on page 48 of my Cinchona Manual.

8. Beyond the fact that Red root bark is rather richer in total alkaloids than stem bark, and that it contains rather a larger percentage of the alkaloids other than quinine, I have no figures to enable me to answer this question.

9. Manuring does not appear from our experience to increase the amount of alkaloids in Red bark, but it improves the health and increases the growth of the trees. And analysis proves that the bark of quickly growing healthy trees is always richer in alkaloid than that of stunted or sickly trees. The effect of manure is therefore to increase the alkaloid yielded by an acre of trees. The good effects of high cultivation other than manuring are undoubted.

10. I can answer the question only for Red barks. After various cropping experiments, and after considering the information afforded by analysis, I have come to the conclusion that Red bark should be treated as an eight or nine years' crop, and on that principle the Sikkim plantation is now being worked. Analysis shows that up to eight years Red bark does not deteriorate; it also goes to show that after that it does not improve, and not improbably does deteriorate. By their eighth year, Red bark trees in Sikkim appear to have reached their full growth. After that their growth on the whole begins to flag, and not unfrequently they die. On the whole, therefore, I conclude that eight, or in some situations nine, years is, for Sikkim, the safest age to take as the basis of a working plan.

11. I regret that I cannot answer this question, as we do not work by the tree but by the acre. In the appendix on page 6 of my Annual Report for 1876-77 will be found the yields per acre of root, stem, and twig bark on both coppicing and uprooting systems. And on page 8 of the report for 1875-76 will be found similar figures for that year.

12. My experience is not yet sufficient to enable me to offer an absolute opinion as to the relative merits of the two systems of coppicing and uprooting. I am, however, rather inclined to believe that complete coppicing will ultimately prove the more advantageous.

13. With reference to coppicing, I am not yet prepared to say (a) how often a tree may be coppiced: I know of no experience as to how the coppice of Red barks itself bears coppicing. (b) There is no actual experience as to the yield of coppice stools of any given age as compared with the yield of uncoppiced trees of a like age. But we know by experience that a coppiced stool bears shoots varying in number from two to ten, and that each of these shoots is when one, two,

Question.

Answer.

or three years old, as large as or often larger than a seedling tree of equal age. My own belief is that the yield obtainable by working an acre of stools by coppice over eight years will far exceed the yield of an acre of trees remaining non-coppiced and finally uprooted at the end of their eighth year. The reasonableness of this is at once apparent when it is recollected that a coppiced stool is provided with the root system of a tree, and that the shoots have a correspondingly large supply of nourishment brought to them. A seedling, on the other hand, has to make its root system for itself *pari passu* with its general growth.

No kind of partial coppice is, in my experience, of any use. Coppicing must be complete, or at most only a few standard trees per acre may be left. The shoots must be treated as seedlings, and the land must be kept as clean as for new planting. All vacancies can be made up with every condition of success. The bark of coppice shoots is quite as rich as, and often richer than, that of young trees of the same age as the coppice.

14. What experience have you of replanting land on which a crop has been taken by uprooting the trees?

14. Replanting the same land with Red barks the same year as Red barks have been uprooted, results at first in many death vacancies. I am now trying in Sikkim the results of replanting one, two, and three years after uprootal, but as yet I have no reliable experience to offer.

15. In your "Manual of Cinchona Cultivation," it is stated that the average yield of the Red barks at Darjeeling is of root bark from 7 to 8 per cent., stem bark from 5 to 6 per cent., and branch bark 2 to 4 per. cent. of alkaloids. It is observed that your cropping is principally the result of entire uprootal, by which you get a normal proportion of root, stem, and branch bark, the average yield of which, by your own calculation, should not be less than from 4 to 5 per cent. of total alkaloids. The Committee will feel obliged by your explaining how it is that in practical manufacture your quinologist appears to recover only something less than 2 per cent. of febrifuge, a portion of which being insoluble in acids can scarcely be reckoned as alkaloids?

15. It is quite true that the proportions of alkaloids in root, stem and twig bark have been found on analysis as stated. But it must not be forgotten that in laboratory analyses perfectly clean, and above all, quite dry samples are used. In collecting bark on a large scale perfect purity is impossible; root bark, for example, carries some soil on it; twig bark has often to be sliced off (as it cannot be peeled), and therefore carries some wood with it. Pieces of dead and diseased bark are moreover included by the bark collectors and dead bark contains no alkaloid, while diseased bark contains very little. Moreover, bark is very hygrometric, and, in a moist climate like that of Sikkim, always contains, even when nominally "dry," a considerable percentage of moisture. The average yield of the mixed bark, as it is issued to the factory, is therefore believed to be correctly stated at about 4 per cent. Actual analysis has indeed given that result. During the first years of the factory, the actual outturn of febrifuge was a little under 2 per cent.; during 1877-78 it was 2.24 per cent.

16. The Committee appointed by the Madras Government in 1874 to report on alkaloid manufacture, showed that Mr. Broughton recovered on a manufacturing scale about two-thirds of the total alkaloids present in the bark. The details of his process were known to Mr. Wood, who has apparently adopted a process which Mr. Broughton definitely rejected after experiment as causing great waste of alkaloid. The Committee will be glad to learn from you how it is that a process which practi-

16. The reason for the smallness of the outturn is, as has been already explained, that the plantation factory is worked on a process avowedly imperfect, from which no better result was ever expected, and which, originally proposed as a make-shift, has come to be worked on an unexpectedly large scale. The process is not considered satisfactory as worked at the plantation. The present product (cinchona febrifuge) is by no means considered a final one. Mr. Wood's first object was to pro-

Question.

cally loses from 50 to 60 per cent. of the alkaloid present in the bark, can be considered satisfactory; and also how, in your opinion, the great waste in manufacture during 1875-76 and 1876-77 could have been obviated?

Answer.

duce an efficient febrifuge as cheaply as possible, utilising all the small unmarketable bark, and adopting no refinements of manufacture. But it is intended to improve the febrifuge, and possibly to turn out another product. The waste that has hitherto occurred would have been obviated had the full working scheme proposed in 1875 been adopted then. Part of that scheme was that a steam manufacturing process, on the same principle as that carried on at the plantation, should be conducted in Calcutta, by which it had been actually demonstrated that $3\frac{1}{2}$ per cent. of febrifuge could be extracted from bark containing 4 per cent. of alkaloid. As regards the principle of the manufacture, I can only say that Mr. Wood's experiments showed it to be better than Mr. Broughton's, as involving less machinery and giving an outturn about equally good. Mr. Wood's is the process of DeVrij with modifications, and is not claimed as original by Mr. Wood.

17. If the money which the bark used in the manufacture of the Bengal febrifuge would have fetched by sale in Europe, would have purchased a larger amount of alkaloids there than the returns by Mr. Wood's process, are you prepared to admit that the latter is not an economical process?

17. As the premises cannot be proved, I can hardly answer the question that follows from them. I have always understood that the main object of Government in carrying on the Sikkim plantation is to supply its own hospitals and the people at large with a cheap and efficient febrifuge, which shall always be obtainable free from adulteration and at an unvarying price. I have not understood that their object is, by the sale of bark in England, to raise money with which to buy quinine or other medicines. If raising money were the object, it would be more readily attained by growing cocoa or areca nuts, or some other product for which there is a steady local demand.

18. It is proposed to substitute Mr. Wood's febrifuge for quinine to the extent of 75 per cent. in the hospitals in Bengal. Can you give any information as to the extent to which the cinchona alkaloids other than quinine have of late years been used in these hospitals?

18. In Appendix B of my Cinchona Manual will be found details of the quantity of cinchona alkaloids supplied to the Government Medical Departments for the Presidencies of Madras, Bombay, and Bengal from 1867 to 1875, together with, in some cases, the prices paid for them. Sikkim cinchona febrifuge at Rupees 16-8-0 per pound has been supplied to the Bengal Medical Department as follows:—

	lb.	oz.
During 1875-76	1,607	14
1876-77	1,942	14
1877-78	3,011	0
From 1st April to 22nd July 1878	2,180	0
	8,741	12

To Bombay during the same period 600 or 800 lb. have been sent.

19. Have you any recent analysis to show the average chemical composition of Mr. Wood's febrifuge?

19. I have no recent analysis of Mr. Wood's febrifuge. It is believed not to vary to any great extent in chemical composition, and its therapeutic effects are always the same.

Further Questions submitted to DR. KING.

Question.

1. Will you kindly favor the Committee with such information as you possess in regard to—

- (1) The extent of private cinchona culture in Sikkim?
- (2) The present condition of private enterprise?
- (3) Your opinion in regard to the future extension of private cultivation?

Answer.

1. There was never more than one private plantation in Sikkim entirely devoted to the growth of cinchona, and that was and is still owned by the Darjeeling Cinchona Association. But in several tea gardens in the district, patches of cinchona (chiefly *succirubra*) were put out some years ago. And in these and other gardens avenues of *succirubra* trees were planted along roads. The Cinchona Association's plantation was brought up to 1,000 acres, but the patches in private gardens nowhere extended to more than 30 acres, and that area was probably reached only on the Tukvar Company's estate. In the other gardens I should estimate the average number of plants at probably 20,000 each. Some two years ago, the Cinchona Association decided to abandon the cultivation in favor of tea, and with that object about 200 acres of red barks were uprooted and tea was planted instead. The bark from these 200 acres having reached the market at a favorable time, brought a good price,* and this apparently induced the majority of the managers of tea gardens on which there were any cinchona trees to uproot their trees and send the bark home. To such an extent was this done, that in only two or three out of about ten or twelve gardens that carried any cinchona trees, do any trees now remain. (2) I do not know of a single garden in Sikkim (except the Government plantation) on which cinchona has been planted for several years. The feeling in the district is all in favor of tea and against any other kind of cultivation, and I do not believe (3) that cinchona is at all likely to be planted anew on any private garden in the district. In my own opinion the price of red bark—the only species easy of cultivation in Sikkim—is certain to fall when the large number of red bark trees planted in Ceylon and elsewhere come into bearing, and it is too late in the day now for private planters to plant red barks with the hope of good financial results. The case is different with crown and yellow barks, which have nowhere been largely planted and which are in steady demand as sources of quinine, whereas red barks are for the most part used for the manufacture of pharmaceutical preparations and not as sources of quinine. I think the Sikkim planters are probably right in their determination not to extend the cultivation of red bark.

2. Will you kindly give us the data on which Mr. Wood estimates the cost of manufactured alkaloid in Calcutta at Rupees 11-9-0 per pound?

2. The data of Mr. Wood's calculation are as follows:—

He estimates the annual bark crop at 366,000 lb. of dry bark, which shall cost, and shall be made over to the factory, at $3\frac{1}{2}$ Annas per pound.

* We note that Darjeeling barks of fair quality fetched in the London market in 1877 from 2s. 3d. to 4s. per pound.

Question.

Answer.

The total cost of the bark is thus put down at 80,000 Rupees. To convey this to Calcutta and there to manufacture it into cinchona febrifuge he estimates will cost Rupees 68,000. This latter item includes carriage to Calcutta, the cost of chemicals, fuel, rent, quinologist's pay, labor (including European foreman), repairs, and cost of machinery.

The bark is estimated (and the estimate is founded on analyses) to contain 4 per cent. of alkaloids, of which seven-eighths ($3\frac{1}{2}$ per cent.) can be extracted in the factory. The outturn is therefore 12,810 lb. of febrifuge at a net cost of Rupees 11-9-0 per pound.

3. In the event of the Madras Government resuming manufacture with its red barks and selling alkaloid at cost price to the public, would there not be a possibility of the mixed alkaloids being bought and sold for the extraction of quinine?

3. If the Madras Government resumed the local manufacture of a febrifuge, the presumption is that it would first supply its own hospitals, dispensaries and officers, and that only such febrifuge as remained would be available to the general public by purchase. This is the plan followed in Bengal, but in that Presidency, while public institutions buy the febrifuge at Rupees 16-8-0 per pound, the general public pay Rupees 20 per pound for any quantity under 20 lb. Both Rupees 16-8-0 and Rupees 20 are prices a good deal above the estimated actual cost when the factory shall be in operation.

For Bengal the whole of the febrifuge is disposed of by a single officer, viz., myself, and, acting on the principle that the febrifuge is intended by Government for use only in India, I would decline to sell it for export. And at present it is only by exporting it that febrifuge could be profitably used as a source of the manufacture of quinine. It would, under present arrangements, be practically impossible for any one to purchase febrifuge in sufficient quantity to make it worth while to export it to Europe for such a purpose. And I do not see any difficulty in thus preventing exportation, even were the manufacture and sale of febrifuge to assume much larger proportions than at present. An arrangement of a like sort could readily, I presume, be made in Madras.

4. Will you kindly give us your views as to the possible economical use of our red barks in the local production of alkaloid, bearing in mind the value of such barks in the market, and the amount of bark likely to be harvested annually from about 350 acres?

4. Red bark grown on the Nilgiris—and especially bark of the first renewal under moss—differs considerably in the proportion of contained alkaloids from Sikkim-grown bark, and as our calculations for the utilization of our Sikkim produce are founded entirely on the composition of our own barks, I am not prepared at present to answer this question as far as red barks are concerned. The matter would require some consideration. As for the Nilgiri crown barks, it would be easy to extract from them the quinine they contain in a form as pure, and as efficient therapeutically, as Howard's well known sulphate. This could be done in this country at a cost less than that at which cinchona febrifuge is extracted from red bark in Sikkim. If the Committee like to send a hundred pounds of Nilgiri *condaminea* (crown) bark to me, it can be manufactured by Mr. Wood, and the quinine obtained can be sent to the

Question.

Answer.

Committee. By this means the feasibility and advantage of the local manufacture of quinine can be put to a practical test. I should not think there would be any difficulty in working the Nilgiri crown barks for quinine, and (should the Committee so desire) in working the red barks for cinchona febrifuge in Madras, where I understand there are two Government laboratories and two Professors of Chemistry.

It is impossible for me estimate with any degree of accuracy the probable yield of the 350 acres under red bark in the Government plantations on the Nilgiris. Such an estimate, to be of any value, would require to be founded on a detailed acquaintance with every part of the area under these barks, and such an acquaintance I do not possess.

5. The Committee will be glad to receive your opinion in regard to the general condition of the Government estates as to—

(1) The system of cultivation followed;

(2) The present condition and future prospects of the estates;

(3) The system of harvesting bark;

and any other points of importance noticed by you in your recent visit to the estates, which the Committee may have to notice in their report to Government.

5. (1) The present system of cultivation seems to me to be very good. The estates are on the whole quite as free from weeds as it is necessary for cinchona plantations to be, and the weeds present are for the most part annuals that are easily uprooted. Some parts of the Dodabetta estate are in my opinion too clean, as on such steep slopes the continual removal of weeds cannot fail to encourage loss of surface soil by wash. In a few spots on all the plantations there is a deep-rooting perennial grass as a weed: this should be dug out, as it visibly affects the health of the trees.

(2) The present condition and future prospects of the plantation are very far from uniform. Some pieces both of red and crown planting appear to me to look very well indeed; the trees are in good leaf, are comparatively free from flower and seed, have stems that girth fairly well, and stand regularly and close together. I have seen nothing in any private cinchona plantation better than a large patch of *succirubra* in the Napier estate or than the fine piece of the same species near the Neddiumattam jail. Some patches of crown bark on Dodabetta are also very good indeed, and the only bit I have seen to beat them is a corner of crown bark planting near the writer's house on the Welbeck estate.

On the other hand, there are some very poor pieces both of red and crown planting on all the Government estates, and here and there, even in the good patches, there are scattered a good many weak, sickly, and stunted plants.

Patches both of crown and red barks stand on land which should never have been planted. It had originally been grass-land, and, although not by any means devoid of humus, the surface soil is infertile stuff. Moreover many of the bad patches are much exposed to wind. In all cases when exposure to wind and poor soil are associated, the trees—both red and crown—are in my opinion in a hopeless condition, and the best thing to be done with them would, I think, be to root them out so as to secure, without further loss of time and money, what bark they now carry; and having done this, I would let the land for native cultivation (if any body will take it) or allow it to revert to waste.

Question.

Answer.

There are several such patches on Dodabetta and on the upper parts of the Neddiwattum and Hooker estates. It is perfectly clear that red bark trees cannot, even when planted in good soil, stand wind, and this should be borne in mind in all future planting. Crown barks, though much more tolerant of wind, should not, in my opinion, be planted in windy spots. Crown barks get on fairly well on grass-land if it be sheltered, but red barks do badly on grass-land in any situation.

Besides these hopeless patches, there are a good many bits in the Neddiwattum, Hooker, and Pykarah estates planted with red barks, where the trees are doing badly simply because the elevation is too great for this species. On such spots the red bark should, I think, be uprooted, and crown barks should be planted in their place.

There are, as I have said, besides these patches, scattered trees all over the plantation which are clearly in bad health, and, bearing in mind that in proportion to the vigor of a tree is the alkaloidal richness of its bark and that the bark of a dead tree contains absolutely no alkaloid, I would, without further delay, uproot all such trees. I would, moreover, suggest that it be made a standing rule on the plantations that as soon as trees show any signs of dying they should be uprooted forthwith.

So much for the bad bits of the plantations and for the unhealthy trees in the good bits. But if the good bits be looked at carefully—and especially from a little distance with a glass—there will be perceived in many parts of them an evident deficiency in health, as indicated by the enormous amount of flower and seed carried by the trees, by the scantiness of their foliage and by its pale green and often almost yellowish tint. The heads of a number of trees, moreover, are seen to carry many dead twigs, while the tops of some are entirely dead. These appearances for the most part coincide with the areas of the plantation where the trees have been barked, and they are most marked where barking has been done oftenest. There are on the Neddiwattum plantation a good many trees which have not been barked: these stand for the most part separate from the barked trees, and the appearance of barked and unbarked trees cannot be compared so well as on the neighbouring private estate of Balmadies where there is a fine bit of red bark planting, on which three-fourths of the trees were coppiced from three to five years ago, while the remaining fourth were once partially barked and mossed. On Balmadies it is easy to distinguish at a distance, and by a single glance, the old and barked trees,—the heads of the coppiced shoots being densely covered with leaves of a good healthy green, and carrying no dead twigs and but little flower and seed.

• These appearances, together with general physiological considerations, led me to the conclusion that, although the barking process

Question.

Answer.

advocated by the late Mr. McIvor may be practised to the extent of removing the entire bark of a tree once, or one and a half times, or in some cases even twice, yet that it does in the end begin to tell on the general health and vigor of the tree, and, if pursued long enough, will most undoubtedly kill it. In order to test the general truth of this conclusion, Dr. Bidie and I had three crown bark trees uprooted on Dodabetta. The first was a tree that had been once barked, and that was evidently much affected in health; the second was a tree that had been barked once, but which appeared as healthy and vigorous as any of its fellows that had received exactly similar treatment as regards barking, and which might in every respect be taken as an average healthy mossed tree; the third was a tree that had been coppiced at Mr. Broughton's instance five years ago.

The roots of the first two trees were as regards extent and healthiness much the same, the wood and bark of the root in both cases appeared to be healthy; but the extent of the roots and especially of the root fibrils was small. The root of the coppiced tree was almost twice as large, and the root fibrils were greatly more abundant, and there is no doubt that in general health and vigor the root of the coppiced tree was far superior to that of the two mossed trees. Barking thus appears to affect the entire tree. Judging from the appearance of the roots of these two barked trees, there was nothing to prevent good coppice shoots to be thrown from their stools had they been cut down, and *pari passu* with the growth of such shoots, the roots would probably have increased in size and vigor.

With reference to the future working of the plantation, I think it of the greatest importance to put to a practical test on a sufficiently large scale, the behaviour under coppicing treatment of trees that have been frequently barked, and which (presumably from that cause) have become clearly deficient in health and vigor. Coppicing has never had a fair trial on any part of the Nilgiri plantations. It has hitherto been done in a rude unworkmanlike manner, and on by far too small a scale. In Sikkim I find that only clean coppicing is of any use, partial coppice being, on account of drip and shade from the standing trees, an utter failure. I am not prepared to say (without experience) that a similar plan will answer quite as well in the Nilgiris which have a drier and by far more windy climate than Sikkim. But I am quite sure that the large proportion of failures in the few coppiced trees to be seen on the Nilgiris is due to the stools and young shoots having been exposed to dense shade and much drip, as well as to the trees having been cut at a bad season and too high from the ground. In future experiments coppicing should be done at the season when the trees are most at rest, the surface of the stool should not be much above the level of the soil,

Question.

Answer.

and at least 5 acres should be done in one place. After coppicing, all vacancies should be filled up with seedlings and the ground should be cultivated as highly as if it were planted entirely with seedlings. When the coppice shoots have begun to appear they should, if too numerous, be thinned out, and, as they grow, a little earth should be gently heaped round the collar of the stool, so that the young shoots may root into it and be supported against the wind. There is enough coppice at Neddiwat-tum and on the Balmedies estate to show that red bark trees, if cut while yet healthy, will coppice freely on the Nilgiris, and on Dodabetta the few crown bark trees that were coppiced prior to barking have done well. I think it may therefore be assumed that healthy red and crown barks can be coppiced successfully. I am also of opinion that trees of both species may also be coppiced successfully, although they have had the whole of the original bark previously taken by McIvor's process, or even though they have also had some of their renewed bark so taken, provided they are not visibly in bad health from that or any other cause. The only doubt is in the case of trees where, as above described, the general health appears to have been weakened by barking and mossing. And this doubt should be set at rest by experiment without further delay. If it turns out that such weakly trees do not coppice well, I would uproot them and thus secure all the bark they now bear, for I feel pretty sure they have already begun to die, and after they get into hopelessly bad condition their bark will be useless.

(3) As to harvesting the bark, the mossing process does not appear to affect the health of the trees, for a time at least, and as renewed bark brings a very high price, I do not see why the two plans of mossing and coppicing should not be combined, trees being barked, say, to the extent of their original bark and clean coppiced when the latest taken half has been completely renewed. At present the plantation is worked purely on the mossing system, which appears to me to have the disadvantage of affecting the health and (as I fear) of ultimately killing the trees, besides which bark of the second and third renewal is thinner and less rich in alkaloid than that of the first renewal and than original bark: moreover, cases of failure to renew are by no means unfrequent. The system also appears to me to have the very serious objection that by it one works in the dark. To be cropped regularly and at the same time to be maintained in efficiency, every plantation must be worked with some kind of idea, however rough, of the real amount of its mean annual yield. Of the actual mean annual capacity of yield of the Nilgiri plantations, under the present system, absolutely nothing is known. The Superintendent estimates the Dodabetta crop this year at 35,000 lb. of dry bark, but he does not know how or why he has arrived at these figures. The real yield may be 45,000 lb., and if so, he

Question.

Answer.

is omitting to draw a dividend which has fallen due, or the real yield may be only 25,000 lb., in which case he is really encroaching on his capital under the belief that he is drawing fairly earned dividend. Part of this uncertainty is no doubt due to the plan of calculating by the tree. I think a larger unit would give more manageable basis, and I would suggest an acre of trees as the unit instead of one tree.

If it be decided to introduce coppicing as the complement to the barking and mossing system, the first step will be to convert the area that has been longest under the latter into coppice. This will require to be done judiciously, the most sickly pieces being taken in hand first. The uprooting of the thoroughly bad patches treated of in the early part of this memorandum might, if there be scarcity of labor, be deferred until the most sickly patches of barked trees have been coppiced. The conversion into coppice of the barked areas will be a work of time, and during the time the change in the working of the plantation is being carried through, the annual yield of bark will vary in amount; but this is unavoidable. After the conversion has been effected, the plantation should be worked on a regular plan, and for this purpose it should be divided into blocks. I would suggest that the operations of each year should be marked in color on a map—it would be a good thing to have duplicate maps for the Commissioner's Office and Secretariat;—each year's map should be kept in the office, so that a glance at these maps will at once show the exact history of each block. At present the past history of many most interesting and important points connected with these plantations is unknown from the absence of records.

(Signed) GEORGE KING.

NOTE BY DR. KING.

In compliance with the invitation of the Committee, I append a few notes on points not asked in the preceding question.

1. It should be borne in mind that *C. succirubra* is to all appearance a short-lived tree, and the trees that remain unbarked on the Napier estate and elsewhere should not be looked on as good for many years. Coppicing or mossing, or a combination of both, should not therefore, I think, be too long deferred for these trees.

2. In all future planting a closer planting distance should be adopted. I find 4×4 feet (giving 2,722 trees per acre) the best distance for Sikkim. Closely planted cinchonas grow much faster during the first three or four years than widely planted trees, mainly from the mutual shade and protection which they afford each other. As soon as the plants appear to be too crowded alternate lines can be rooted out (coppicing so close is useless), and at a later date alternate trees in the same line can be taken, leaving the plantation 8×8 feet.

3. In order to secure good unhybridised seed, patches of selected trees should be planted at a distance from the plantation—on the west side of the hills for example—and from each other. These should be well cultivated and cared for, and should be kept as seed trees.

4. It is well known that cinchonas are prolific in varieties which vary greatly in appearance and in quality of bark. The plantation should be carefully gone over, and botanical specimens and

samples of bark should be collected from each variety. Each tree thus collected from should bear an indelible number fixed to it. A list of such numbered trees should be made, and their positions should be indicated on a map. The botanical specimens from each of these trees should bear the same number as the tree itself and so should the sample of the bark. The latter should be carefully analysed. Varieties that prove to have bad bark should be ruthlessly uprooted, and the cultivation of varieties that prove on analysis to have really good barks should be most energetically carried on. All future replanting and extension of the plantations should be made to as large an extent as possible with such varieties only.

5. I think *calisaya* is worthy of more attention than it has hitherto received on these plantations. The little field of *calisayas* at Neddiwattum contains 14 varieties. Some of these I know to have poor bark. Analyses should, I think, be made of bark of all 14 species. The bad should be uprooted, the good propagated; and a well sheltered piece of shola land should be selected a good deal lower than Neddiwattum and *calisaya* should be tried there. It is a species which affects warmer spots than *succirubra*, and which requires a climate not only warm but moist all the year round.

G.K.

APPENDIX B.

Memorandum on the various modes of utilising Cinchona Bark and its Preparations as Febrifuges, with a Statement of their Comparative Cost.

CINCHONA bark has been known and used as a febrifuge in English medical practice for upwards of 200 years. For a long period after its introduction it was sold under the name of "Jesuit's Powder" or "Peruvian Bark," and it continued to be known under one or other of these names until a comparatively recent period in England. Prior to the discovery of quinine in 1820, by Pelletier and Caventou, bark was administered as a medicine in the form of powder, infusion, or decoction, and there can be no doubt that periodical fevers were and can be successfully treated by these simple preparations of the drug. At the same time the experience of over 50 years in the use of alkaloid constituents of bark shows, that there are certain advantages—therapeutical and economical—attending their use, which have led to their almost exclusive employment in preference to the cruder preparations. It now remains for me, therefore, to notice briefly the comparative merits of the several preparations of cinchona bark.

Powder of Bark.—This preparation of course contains all the active principles of the drug, but as these are not in a very soluble state, only a small proportion of them is extracted by the gastric juice. A full dose of, say, sulphate of quinine ranges from 10 to 12 grains, and to obtain the same therapeutical effect with bark-powder it would be necessary to give a dose of from $\frac{3}{4}$ to 1 oz. Such a quantity of the powder would be objectionable not only on account of its bulk, but also because of the quantity of indigestible woody tissue administered, which would induce irritation of the stomach and bowels. Crude bark also contains astringent principles, which from a medical point of view are sometimes of advantage, and sometimes the opposite. As a rule, bark-powder cannot be administered in doses exceeding 60 grains without causing nausea, vomiting, or diarrhoea, and its disagreeable taste proves a further objection. On the other hand, as 60 grains would represent less than 2 grains of the sulphate of one of the cinchona alkaloids, it will be seen how impotent we would be to deal with severe forms of fever if restricted to this preparation of bark. At the same time, it must be allowed that in simple forms of malarial fever bark-powder is often very useful, more especially when it is necessary to husband the stock of quinine. I will now glance briefly at the economical aspect of the question. Say a case of fever is being treated with 60-grain doses of bark, of which four are given daily, and that the value of the bark is Rupees 2 per lb.* On an average it takes three days to check even a mild attack of fever with bark-powder, so that the total value of bark necessary to effect a cure would be Annas 3-3†.

Decoction of Bark.—In preparing the decoction, bruised bark is boiled in water, and the resulting liquor strained and kept. While hot the decoction is clear, but gets turbid as it cools, partly owing to the deposit of tannate of starch, and partly to that of cinchona-red, which is more soluble in hot than in cold water. The decoction contains rather more of the alkaloid principles of the bark than the infusion, and also more of the astringent properties and coloring matter. Its efficacy would be considerably increased by using acidulated instead of simple water, as the acid would assist in the decomposition of the combination in which the alkaloids exist in the bark, and promote their solution in the liquor. Both the decoction and infusion are apt to undergo decomposition, more especially in a hot climate, and must be administered fresh. According to Soubeiran bark loses two-thirds of its weight by decoction and about one-third by infusion. The decoction is a more active preparation than either the infusion or powder, but like these has a nauseating taste, and is objectionable on account of the bulk of the dose. At times when given in full doses it produces vomiting and purging, and in some cases it induces constipation. The strength of the officinal decoction is 1 in 16. Say four doses of 2 oz. each are given daily in a case of fever, thus the patient will consume per diem about $\frac{1}{2}$ oz. of bark of the value of 1 Anna. As in the case of the powder, it will usually take three days to check the fever, and therefore the total value of the drug, including cost of preparation, will be about 3 Annas 3 Pies. As regards the therapeutical aspect of the question, it may be remarked that 8 oz. of decoction of bark per diem would represent somewhat less than 6 grains of the sulphate of quinine.

Infusion of Bark.—In preparing the infusion the bark is reduced to coarse powder, boiling water poured over it, and the mixture allowed to macerate and then strained. The result is a coloured fluid containing a very weak solution of the alkaloids, the greater portion of which is left in the marc. The infusion of cinchona therefore possesses little or no febrifuge properties, but is a very good tonic.

* The price of the bark at present in stock in the Medical Store Depot is Rupees 2-3-10 per lb.

† In every case fractions have been omitted in these calculations.

Extract of Cinchona Bark.—This, like the decoction and powder, is an old preparation. The London form of extract was a watery, and the Edinburgh a spirituous one and therefore more active. Brande states that pale bark yields 30 per cent. of watery extract. The extract of the British Pharmacopoeia is a fluid watery one, spirit being added, in due proportion, to prevent decomposition; it is a good preparation, and one part of it is equal, in medicinal value, to four of bark. During the past year a quantity of extract of Nilgiri red bark was prepared by the Medical Department according to the Edinburgh formula, and distributed for trial as a febrifuge in the form of pills. By the Edinburgh process more than 30 per cent. of extract is got from bark, and as it contains a considerable amount of the alkaloids, it must possess active febrifuge powers. The results of this practical trial of it are not yet available, but it is probable that they will show that it is more effectual than powder or decoction. The best mode of administering the spirituous extract is in the shape of pills, but these unfortunately are rather difficult to make, and when made liable to become hard. A pound of bark will yield 2,100 grains of extract at a cost of Rupees 7-4-0, and there will be 140 doses in that quantity. Supposing, then, that four doses are given per diem to a patient suffering from fever and that it takes two days to check the attack, the cost of treatment by this remedy will be Annas 6-7.

Tincture of Bark.—This preparation, of which Mr. Money's so-called "decoction" is an imitation, has long been known to the profession, but it is rarely used except as a tonic in conjunction with other remedies, as the large amount of spirit which it contains renders its employment as a febrifuge objectionable. The tincture is prepared by percolating proof spirit through bark-powder. The spirit extracts a considerable portion of the bitter and astringent principles of the bark, and the tincture is theoretically supposed to contain from 3 to 4 grains of the cinchona alkaloids per ounce. Some further remarks regarding this form of preparation will be offered when speaking of Mr. Money's "decoction."

Money's "Decoction of Bark."—This article, which is referred to in the orders of Government marginally noted as a "decoction," is a tincture, and is said to be prepared by boiling 5 oz. of bark in a quart bottle full, say 24 oz., of spirit. It is therefore slightly stronger than the official tincture, which contains one part of bark in five of spirit. Say that the Nilgiri cinchona barks yield on an average 5 per cent. of alkaloids, then 1 oz. of Mr. Money's tincture would theoretically represent from 4 to 5 grains of the alkaloid principles of the bark. To give a patient a full febrifuge dose therefore, it would be necessary to administer from 2 to 4 oz. of the "decoction"—a quantity which, on account of the amount of alcohol, would generally be highly objectionable. The results of the practical trial of this preparation by the Medical Department are not favorable, and do not require further notice here as they have been specially alluded to in the body of the report. It may be mentioned, however, that the bulk of the "decoction" rendering it difficult of transport, as well as the liability to loss from breakage of bottles in transit would, apart from all other considerations, prove serious objections to its general use as a febrifuge. Mr. Money offers to supply the decoction at 1 Rupee per quart bottle, provided the Government make over their gardens on the Nilgiris to him to apply their bark to this purpose. At the present time the intrinsic value of Government bark is about 1 Rupee per pound, so that the total cost of a quart bottle of the "decoction" under such an arrangement would be about Rupees 1-5-0. Say that in a case of fever 6 oz. of the "decoction" are given daily in three doses of 2 oz. each, and that the fever is checked in two days, thus the total cost of treatment will be Annas 10-6. It will thus be seen that Mr. Money's proposal would, if accepted, prove a rather expensive one to Government.

Cinchona Alkaloids.—The preparations of these most commonly used in medical practice are as follows:—

Sulphate of quinine
Do. of quinidine.
Do. of cinchonidine.
Do. of cinchonine.

Since the discovery of quinine in 1820, that principle has gradually taken the place of the cruder preparations, but there can be no doubt that up to a comparatively recent date commercial sulphate of quinine contained more or less of the other alkaloids, as the old official tests for sulphate of quinine were not such as to preclude their presence. By the tests prescribed in the British Pharmacopoeia such admixture is rendered impossible, and as the other alkaloids are not included in the category of official drugs, these valuable preparations are thereby practically excluded from English practice. When the culture of cinchonas was introduced in India, it became of great importance to ascertain the therapeutical value of substances which formed so large a portion of the alkaloid constituents of Indian grown barks. Accordingly in 1866, under the order of Her Majesty's Secretary of State for India, extensive trials in the treatment of fevers were made with chemically pure sulphates of the several alkaloids in some of the more malarious districts of the Madras Presidency. The total number of fever cases treated was 2,472, the number of cures 2,445, and the number of failures 27. The ratio of failures per 1,000 cases treated was, in the case of each alkaloid, as follows:—

Sulphate of quinidine	..	..	..	..	..	6-024
Do. of quinine	..	..	..	..	..	7-062
Do. of cinchonidine	..	..	..	..	..	9-925
Do. of cinchonine	..	..	..	..	..	23-255

These results are of great interest and importance to India, inasmuch as the red bark, the kind most easily grown and most productive, is rich in the other alkaloids, although ordinarily containing but little quinine. The prices of the supplies of the several alkaloids at present in stock in the Medical Store Depot, Madras, are, in round numbers as follows, including 20 per cent. for freight, insurance and all other charges:—

					RS.	A.	P.
Sulphate of quinine	..	..	..	..	79	0	0 per lb.
Do. of cinchonine	..	..	..	..	6	0	0 "
Do. of cinchonidine	..	..	..	..	21	0	0 "
Do. of quinidine	..	..	..	..	36	0	0 "

According to the figures just given, the efficiency of these alkaloids in curing fever is very nearly equal, except in the case of cinchonine, which is somewhat less energetic than the others. Say that it takes five doses, viz., four per diem of 5 grains each, of either quinine, cinchonidine or quinidine to check an attack of fever, then the cost of the drug in each instance will be as follows, and the time occupied in effecting a cure a little over one day:—

						A.	P.
Sulphate of quinine, five doses of 5 grains each	..	..	..	..	..	4	6
Do. of cinchonidine	do.	do.	..	..	..	1	2
Do. of quinidine	do.	do.	..	..	..	2	0

In the case of sulphate of cinchonine, if eight doses of 5 grains each at the rate of four doses per diem are required, then the cost of the drug will be a little over 6 Pies, and the time occupied in checking the fever two days.

Broughton's Amorphous Quinine.—This preparation received careful trials in Madras hospitals, and it was found that it effected a cure in nearly the same time as that required when using the European made alkaloids, but with a somewhat larger expenditure of the drug. The selling price of the article was latterly Rupees 1-8-0 per ounce. Say that in a case of fever it took six doses of 10 grains each to check the attack, then the total cost of the drug would be Annas 3-3.

Mr. Wood's Febrifuge.—The selling price of this article is Rupees 20 per lb., and the Bengal authorities now state that the proper dose is from 3 to 5 grains. Say, then, as in the case of Mr. Broughton's preparation, that six doses and two days are required to cure an attack of fever. The cost of six doses of 5 grains each will be Annas 1-4. From our experience of Mr. Broughton's kindred preparation, however, I am inclined to think that six doses of 5 grains each (= 30 grains) of the Sikkim drug would not by any means have the same efficacy as 60 grains of the former.

Comparative Cost of Treatment.—The comparative cost of treating cases of fever with the several preparations of cinchona bark will therefore be as follows:—

						A.	P.
Sulphate of cinchonine	..	..	..	..	..	0	6
Do. of cinchonidine	..	..	..	..	..	1	2
Bengal febrifuge	..	..	..	..	..	1	4
Sulphate of quinidine	..	..	..	..	..	2	0
Powder of bark	..	..	..	..	..	3	3
Decoction of bark	..	..	..	..	..	3	3
Broughton's amorphous quinine	..	..	..	..	..	3	3
Sulphate of quinine	..	..	..	..	..	4	6
Extract of cinchona	..	..	..	..	..	6	7
Money's decoction	..	..	..	..	..	10	6

In the foregoing remarks I have tried to express in hypothetical cases the relative therapeutical value, and the cost of the ten preparations mentioned. As regards the cruder substances, viz., the powder, decoction and extract, I believe that the periods required to effect a cure under their use are rather under-estimated than otherwise. There is, therefore, no pecuniary gain by using such articles so far as the cost of the drug is concerned, while, on the other hand, the patient must be detained for a longer period under treatment than if the alkaloids had been administered. Such detention of course means a loss of pay to the bread-winner if the person belongs to the laboring classes, and increased cost of dieting and other charges to the hospital if he or she is an in-patient.

(Signed) G. BIDIE, M.D.

APPENDIX C.

DURING the progress of the investigations of the Committee, they expressed a wish that Dr. King and myself should visit the several Government cinchona estates, and while thus engaged we embraced the opportunity of seeing the chief private plantations on the Nilgiris. The following notes were made during these visits, and all the important parts of them were read to Dr. King, who agreed generally in my conclusions. I have omitted such points as are specially noticed in the general report. While at Neddiwattum we were in constant communication with Mr. Rowson, the Assistant Superintendent, and were very favorably impressed with the knowledge which he possesses of everything connected with his charge, and the interest which he displays in his work. The Head Overseer at Dodabetta is also a careful and intelligent subordinate. The subjects noticed in these notes are as follows:—

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NEDDIWATTUM.

The trees on this property consist practically of red and crown barks, the grey and yellow barks having for the most part died out. Of the red barks there are several varieties, the most notable and common of which are the ordinary form and another with somewhat more pubescent and less corrugated leaves. The latter seems to be a very vigorous growing and hardy variety, and we noticed that it has been extensively cultivated on the Devashola estate. The red barks planted in 1862 are on the whole healthy. Most of them are flowering and seeding very profusely, and as even their leading shoots are bearing fruit, I think it probable that they are not likely to grow taller. Some of them have been barked six times, which shows how tolerant this species is of the operation; but from the present appearance of the trees I deem it certain that this system of cropping can scarcely be continued longer with safety as regards most of the trees.* The red barks of 1863, 64, 65, and 66 planting are mostly all good, and those on the lower parts of the property, especially near the jail, very luxuriant. I again examined the 2,000 trees near the jail, amongst which Mr. Broughton and myself reported a good many failures in the renewal of the bark. They have been barked four times, and are in beautiful luxuriance as to foliage; but even now old failures in renewing may be detected. Some of the later plantings of red bark, such as those in the ravines of the Napier estate, are very flourishing, and as yet do not show that tendency to run to seed and the decline in the foliage which is observable in the older trees after repeated barking. On the No. 2 Dennison, the more westerly part of the property, the red barks are much exposed and have not done well, the trees being small in size and showing a great many blanks. Even the crown barks on the upper portion are dwarfed, weather-beaten, covered with lichens, and have a thick outer coating of dry cracked bark. The red barks on this site might be uprooted and crown barks substituted. On the grass-land on the Napier estate too the red bark trees have proved a failure, and my recommendation is that they be rooted up and crown barks planted closely, say, at the distance of $4 \times 3\frac{1}{2}$ or 4×4 feet. Speaking generally the crown barks on all the higher and more sheltered parts of the Neddiwattum property have done well, but from inacquaintance with their habit of growth when first introduced, they have been planted too far apart. In most cases we might have had nearly double the number of trees on the ground. I will allude to the yellow and grey barks, and also specially to the mossing and coppicing systems and their effects on the trees further on.

* As my views regarding the appearance of the trees differ somewhat from those of Captain Campbell Walker, this may be due to the fact that we inspected them at a different period of the year, and that I have seen them oftener and probably watched their appearance more critically than he has done. I may also mention that the views of Dr. King as to the appearance of the older mossed red barks are identical with my own.

PYKARAH ESTATES.

WOOD ESTATE.

The trees along the "avenue," which leads from the upper part of the property to the lower sections, are mostly red and crown barks. Those at the upper end of the avenue evidently suffer greatly from the wind, especially the red barks. They are also densely covered with lichens, which generally happens when the trees are much exposed to the south-west monsoon, and are not thriving. The trees along the middle and lower parts of the "avenue" are larger and more vigorous, from being in a less exposed situation. Many of them, however, have failed to renew their bark properly under the mossing system. This may possibly be due in part to improper manipulation, as the estate is so distant from the Assistant Superintendent who lives at Neddiwattum, rendering it quite impossible for him to exercise the necessary personal supervision. At the bottom of the "avenue" we saw red bark trees being re-barked, and noticed that the renewed bark, although three years old, is remarkably thin. The specimens we saw could not be more than one-twelfth of an inch in thickness. It will therefore when dried be very light, and the crop will likely come short of estimate. In some instances the denuded surfaces left by the previous barking had failed to renew. Trees in this condition, when deprived of the remaining strips of bark, must inevitably perish. They should therefore either be left intact till covered with a complete coating of bark, or coppiced. We saw some grey barks at the lower part of the avenue, but they did not seem very flourishing. There are also a few yellow barks planted along the edge of the avenue road. They have all assumed a bushy habit and are dying back at the end of the young shoots. Time did not permit of our taking more than a bird's-eye view of the lower portion of the Wood estate, which is planted with red barks, but it appeared very *patchy*. Some portions contained trees of fair size, but large numbers are shrubby and miserable, and there are numerous blanks. It is possible that better drainage or more shelter is required in this situation, and if the latter, it might be afforded by planting some of the species of the eucalyptus. The store for the dried bark on this estate is in dangerous proximity to the drying-house.

HOOKER ESTATE.

The land in this property is all somewhat high and exposed, and as a rule the red barks have not done well. In some ravines they are vigorous and well grown, but there are large blocks in which they are either stunted or have assumed a bushy habit. Here, in some cases, as at Neddiwattum, the trees show a great tendency to run to seed. Large numbers of the stunted and bushy red barks might be uprooted and crown barks, thickly planted, substituted with advantage. The crown barks thrive here better than the red, but, as in the other plantations, have been planted too far apart. This could only be remedied now by coppicing and planting between the rows, as young trees planted under the shade and drip of the older ones never thrive. I consider the site of this plantation too high and exposed for red barks. The grey barks in shady ravines have grown better and look more healthy than on any of the other estates, so far as I have seen.

DODABETTA.

As this property was inspected by the Committee in their official capacity, my remarks will be brief. The trees on this estate may be said to be all crown barks, as the other species are few in number. On some of the higher and more exposed parts the cinchonas have assumed a bushy habit, and are not likely to increase in value. To save further expense in culture the plants in these patches should be uprooted and the ground allowed to revert to grass. Some of the older trees which have been repeatedly barked, as well as others with a southerly exposure, are beginning to flag and exhibit a somewhat sickly appearance. The remedy for these would be to coppice, and when this is done to plant young crown barks between the rows of stools, as the ground could carry twice as many trees as now exist. From the appended notes* regarding a series of trees carefully examined by Dr. King and myself, it will be seen that one of these semi-sickly trees, No. 1, A., had a perfectly healthy root, and would probably have yielded good coppice shoots. We also re-coppiced 3 of the 50 trees coppiced in 1878 with the view of ascertaining the yield of bark, and the tolerance of the stools as regards a repetition of the operation. Detailed information regarding our observations will be found in the annexed notes under No. 1, No. 2 and No. 3, and the stools should be marked with permanent labels bearing these numbers and their future progress carefully watched. It is perhaps scarcely fair to draw rigid conclusions from the results of this experiment, as the trees were originally badly coppiced and cut down at a wrong season; but so far as I am able to judge, crown bark coppice shoots on Dodabetta will require from 7 to 8 years to reach the stage at which they can be economically re-coppiced. The average yield of green bark per stool in this case was $5\frac{1}{2}$ lb.† In appended notes, under No. 4, there will be found remarks regarding a tree coppiced in 1873, which we uprooted with the

* See page 45.

† The whole of the figures in this paragraph refer, of course, to green bark.

object of ascertaining the influence of coppicing on root development. The results of our examination were so far satisfactory, as they show that when coppicing is successful it induces a remarkable increase in the size and number of the roots of the plant. The root development in the case of this stool was much in excess of that observed in No. 1A, a semi-sickly tree, and even of that of No. 5, a healthy tree of the same age growing in close proximity to the coppice stool. The yield of bark from this tree was coppice shoots 6 lb., roots 5 lb., total 11 lb. The uncoppiced tree referred to as No. 5 in appendix, was uprooted partly with the aim of ascertaining the yield of bark from a healthy well grown tree as contrasted with the return from the semi-sickly tree No. 1A, and partly with the view of being able to compare its root-system with that of the coppiced tree of the same age, growing under precisely the same conditions. As already stated its roots were inferior in size and number to those of the coppiced tree. Both this tree and that referred to as No. 1A were planted in 1863, and each had been barked once. Their yield of bark was as follow when uprooted :—

	No. 1A, a semi-sickly tree.	No. 5, a healthy well grown tree.
	lb.	lb.
Boot bark	4	4
Stem	7	10
Branch	4	9
Total lb. ..	15	23

It will be observed that in both instances the weight of the root-bark was the same, but that the healthy tree gave eight pounds more of stem and branch bark than the sickly one. The yield of stem and branch bark of each tree examined was per annum of its age as follows :—

Coppice shoots (of Nos. 1, 2, 3, and 4) 5 years old (average) ..	1.100
Semi-sickly tree, No. 1A, 15 do. ..	.733
Healthy tree, No. 5, 15 do. ..	1.266

The following figures give the yield of root-bark in each case per annum of age of the tree, viz., 15 years in each case :—

Coppiced root	.333
Semi-sickly tree, No. 1A	.266
Healthy tree, No. 5	.266

For further particulars, see notes on page 18.

YELLOW BARKS (*Cinchona calisaya*).—The number of trees of this species now growing on the estates is stated in Captain Campbell Walker's report to be 552, but I am inclined to think that he has under-estimated the number. *C. calisaya* embraces a great many varieties, and it is possible that he has classed some of these as hybrids allied to other species. In one corner of the Napier estate, on a sheltered dry slope, Dr. King and myself found no less than 14 varieties of the yellow bark, some of which are very different in appearance from the typical forms of the species. In the absence of flower and fruit, therefore, it is not at all surprising that Captain Campbell Walker should have regarded some of these as varieties or hybrids belonging to other species. There can be no doubt, however, that the mortality amongst the yellow barks has been very great, and that most of those remaining are in a more or less sickly state. On a private property in the neighborhood of Coonoor I saw one or two trees of this species in a much more vigorous condition than any on the Government estates, and another planter in that quarter is about to give the yellow barks a trial on a limited scale. It appears to me, therefore, that further experiments should be made in the culture of this very valuable species, under conditions different from those to which they have hitherto been subjected on the Government property. For instance, a small plot might be planted in some part of "Sim's Park" at Coonoor, where they could be carefully watched by Mr. Jamieson. I would also suggest a small experiment in forest-land, in a sheltered ravine at an elevation of from 3,500 to 4,000 feet, in the neighborhood of Neddiwattum. These trials, together with our past experience, would settle the question as to whether or not *C. calisaya* can be successfully cultivated in this part of India. It is reported that one or more plants of this species are thriving in or near the Devala district of Wynaad, but time did not permit of our inspecting them.

GREY BARKS (*Cinchona micrantha*, *C. nitida*, &c.)—The grey barks grow fairly up to a certain age, and then gradually die down. Mr. Rowson stated that, according to his experience, they are intolerant of barking and mossing, but we saw some on a private estate on the eastern side of the hills which had borne the operation fairly. This bark is not much valued as a commercial product, as it contains chiefly cinchonine. The principal consumption of grey bark is on the continent of Europe. It does not seem necessary, therefore, to continue the culture of species yielding grey bark.

SUPPLY OF SEEDS AND PLANTS TO PLANTERS.—The demands for these, both in India and Ceylon, are very large and rapidly increasing. At Dodabetta and Neddiwattum seeds are collected and the propagation of young plants carried on to meet those demands. The price of seeds is at present As. 4 per ounce, and of plants Rs. 10 per thousand, these rates being considered sufficient to cover the expense of collecting and packing the seeds, and of raising and packing the seedlings. I question, however, if Rs. 10 per thousand covers the expense of propagating plants raised under glass from cuttings, and it seems desirable therefore that the charge for these should be revised. Considering the activity with which cinchona culture is now being carried on by private individuals in India and Ceylon, and that they chiefly depend on the Government plantations for supplies of seeds and plants, it seems necessary that more special arrangements should be made to meet such demands, as the encouragement of cinchona culture will indirectly promote the object which the Government had in view in starting their plantations, viz., the provision of a cheap febrifuge for the people of India. Every additional acre of land brought under cinchona culture will increase the supply of bark, and thereby reduce its price and that of its products. As matters now stand seeds and plants are reared and distributed under the restriction, that this task is not

to interfere with more important work.* This order, it appears to me, should be modified, and a special establishment provided for the supply of plants and seeds; the charge for issues being sufficient to cover actual cost to Government. With regard to the culture of seeds there are some suggestions which I have to offer, with the view of maintaining the vigor and purity of species. As is well known, cinchonas have a great tendency to cross-breeding, and from past experience it may be regarded as an established fact, that purity of stock cannot be secured when different species are cultivated in the same neighbourhood. At present too the supplies of seeds are chiefly collected from trees which have been subjected for a series of years to barking and mossing, by which their natural vigor has been more or less impaired. To secure supplies of absolutely true and healthy seed it would be desirable to have small preserves of standard trees left intact as seed-producers, and grown in isolated spots so as to be beyond the risk of hybridisation. Regarding cinchonas under culture, Weddell, the great French authority on the botany of the family, says that, admitting their tendency to produce cross-breeds, "if we attach any importance to the preservation of purity of race, it is principally to slips that we must have recourse for the purpose of propagation." There can be no doubt, however, that plants raised from seeds in the manner suggested, would be quite true to species and preferable in every respect, while their propagation would involve less trouble and expense.

COPPICING AND MOSSING.—The bark crop has hitherto been, I may say, exclusively harvested by Mr. McIvor's mossing process. Some of the older crown bark trees have been barked and mossed four times, and some of the older red barks six times. Both species have shown a wonderful tolerance of the operation, but there are now obvious symptoms of the process having affected the vigor of the older trees. At the present time some of the trees which have been frequently barked evince various signs of declining vitality, such as less luxuriant foliage, great tendency to flower and seed even on the top and upper side shoots, tardy renewal of bark, and renewed bark comparatively thin. The original estimate of the average time required for the renewal of bark on mossed trees was 22 months, but at present renewed bark on the older trees is rarely fit for lifting under three years, and even then it is often as thin or thinner than natural bark. This slow rate of renewal and the thin condition of the bark of course affect considerably the yield from trees cropped under this system. One marked characteristic of the older mossed trees is the comparatively small amount of branches and leaves which they bear—a deprivation which must of necessity diminish the vigor and arrest the development of the plant. Repeated observation also demonstrates that the mossing process necessitates constant and intelligent supervision of the labourers, and the results of careless manipulation are evident in some of the less accessible estates on which it was impossible for the superior officers to give the barking the necessary attention. I am now of opinion, however, that the mossing system is a good and economical one up to a certain stage of the life of the tree. I would therefore in the case of both red and crown barks propose to bark and moss four times, which would secure one crop of natural bark, one of mossed natural bark, and two of renewed bark. On the completion of the fourth stripping moss should again be applied, and kept on till complete renewal takes place. At this stage, that is before the trees begin to flag, I would propose to coppice. This would bring in a third and large crop of renewed stem bark, as well as some natural stem and branch bark. As yet we have had little or no experience of the ability of a mossed tree to throw up coppice shoots, but, provided the mossing system is not pursued too long, there can be no doubt that the stool of the cut tree will retain its vitality and produce vigorous shoots. In the case of the red barks too it is highly probable that it will be found practicable to subject their larger coppice shoots to the mossing process, and thus again secure further harvests of mossed and renewed barks. It seems to me that this combination of the two systems of harvesting deserves serious attention, and that a coppicing experiment on a block of the older mossed trees should be carried out next dry season, when the trees are at rest and not likely to bleed.*

* This portion of my notes was read to Dr. King and he quite agreed with me in my views as to the present state of the older mossed trees, and the propriety of combining the mossing and coppicing systems.

As has been repeatedly pointed out by others as well as myself, the trees hitherto coppiced have been felled at a wrong season, and the operation improperly done. The only approach to a fair trial of the coppicing system was in the experiment carried out on the Dennison estate in 1871. Two hundred trees were operated on, and notwithstanding various defects, all the stools with one exception survived. The shoots on these are now vigorous and strong, and one of the largest, measured by Dr. King and myself, was about 20 feet high, and girthed $15\frac{1}{2}$ inches at the height of $4\frac{1}{2}$ feet above the level of the ground. Nearly every stool in this plot carries two or more shoots, and in most instances they are so well developed at their lower ends, that nearly every trace of the old stumps has disappeared. These shoots are, as a rule, much larger than trees of the same age raised from seedlings would have been. I am of opinion that the time has now arrived when these stools ought to be recoppiced, and, as the experiment will be one of much interest and importance, it should be conducted with the greatest care. It is further desirable that a sample of the coppice bark should be sent home for analysis. The opportunity might also be taken to spare some of the larger shoots and subject them to the mossing system. From an examination of the root of a coppiced tree, referred to in the notes on the Dodabetta estate, it is evident that root development is increased by the operation of coppicing. While at Neddiwattum we had the privilege of seeing Mr. Rhode's experiment in coppicing red barks, on his estate at the upper end of the Ouchterlony Valley. Shoots have sprung very freely from the stools in this case, and nothing could be more satisfactory than their size and vigor at the present time. Intermixed with the coppiced trees there are numbers which have been barked and mossed, and looking from the opposite side of the valley the coppice shoots can at once be recognised by the richer green and greater luxuriance of their foliage.

HYBRIDISATION.—As this subject is specially referred to in the general report of the Committee, my remarks will be brief. The tendency to cross breeding in cinchonas, as elsewhere remarked, is so strong, that no contrivance can prevent it if different species are grown near each other. In the various reports of the late Superintendent repeated allusion is made to hybrids possessing valuable qualities, but as he left no special record of his experiments and observations, it is now very difficult to ascertain the plants referred to, and the results of much valuable experience have been lost. At the present day there are numbers of hybrids on the estates, but as a rule their origin and qualities are unknown. One of these, a very hardy, smooth-leaved, quick-growing tree, belonging to the red bark family, is said to be worthless as an alkaloid producer, but it is desirable that further specimens of its bark should be subjected to analysis. Again there is a hybrid called *C. pubescens* of vigorous growth and hardy constitution, from the bark of which Dr. DeVrij obtained 10.67 per cent. of total alkaloids, of which 4.72 per cent. was crystallised sulphate of quinine. Mr. Howard also analysed a specimen of the same bark at a later date, and got a total of 12.20 per cent. of the sulphates of the alkaloids, of which 6.00 per cent. was sulphate of quinine and 5.00 sulphate of cinchonidine. Mr. Howard speaks of this as a variety of *officinalis*, but the specimens submitted to Dr. King and myself from the same tree show, that it is a hybrid with a strong strain of the *officinalis* family, and apparently a cross between *C. officinalis* and *C. succirubra*. The specific name of *pubescens* which has been applied to it is unfortunate, as it has already been given to a distinct species, viz., *C. pubescens*, Vahl. There seems to be some further confusion regarding this Nilgiri hybrid known as *pubescens*, as on a private estate I found the owner diligently propagating a kind quite different from the tree pointed out by Mr. Rowson as the true *pubescens* of Messrs. McIvor and Howard, which yielded such remarkable results on analysis. The plants referred to on the private property seem more allied to the red than the crown barks, but this may be due to their having been raised from seed and thus partly reverted to the type of one of the parents. This confusion and uncertainty indicates how much has yet to be done in the matter of hybridisation, and how necessary it is that all such experiments should be conducted with the utmost care, and the results recorded with mathematical precision. It also seems desirable that a typical tree of each hybrid and variety should be labelled, so as to prevent confusion and to admit of ready reference. Accurate records of their history and qualities should also be kept up, and be accessible to individuals engaged in or interested in cinchona culture.

VALUABLE SPECIES OR VARIETIES OF CINCHONA.—On certain estates belonging to private owners there is a variety, locally termed *C. lanosa*, being largely propagated, but as nearly all the plants are still young, it was only after a prolonged search on several of these estates that satisfactory specimens in flower and from a well grown tree were secured. These specimens are now before me, and indicate that *C. lanosa* is nearly allied to the "strong growing" crown bark of the Government estates. Its obvious good qualities are its vigorous growth and hardy constitution, which permit of its being successfully cultivated under widely different conditions, as to elevation, temperature and moisture. No very definite information could be obtained as to its alkaloid yielding qualities, but as the late Mr. McIvor was interested in the estates on which it is being planted, it is probable that he selected it partly on account of the value of its bark. It is said to come true from seed—a circumstance which, if correct, supports the view that it is a variety and

not a hybrid. None of the officials on the Government estates could afford any reliable information as to its origin and history, and so far as could be ascertained there is not a tree in the Government plantations which agrees exactly with this *C. lanosa*. The specific name *lanosa* which has been given to it is inappropriate, as the leaves of the typical trees seen in two different localities are smooth and not woolly. In vigor of growth and size of stem it is more like a red than a crown bark tree, and promises to be a very valuable acquisition to the owners.

On the Dodabetta plantations there is a variety of crown bark called "strong growing" by the late Superintendent which is deserving of notice. It is at once distinguishable amongst other crown barks by its more robust habit and larger leaves. It is said to be very quick-growing, especially hardy, and to yield a rich bark. I was also informed by the Overseer Narrainsawmy, who is very observant and has a very retentive memory for facts connected with his charge, that it renews its bark quickly and that the renewed bark is thick and good. Owing to the superior size of its stem too it will yield a larger amount of bark than the ordinary varieties of crown bark trees. It is very desirable therefore that this "strong growing" variety should be largely propagated.

There are at Neddiwattum two very distinct varieties of red bark, viz., one with the ordinary leaves, smooth above and slightly pubescent below, and the other with leaves slightly pubescent on the upper and very pubescent on the lower surface. The latter is more robust and hardier than the smooth-leaved variety, and is said to yield superior bark. We found the pubescent kind much more common on private estates than on the Government plantations. I would recommend that special analyses be obtained of the bark of the pubescent and ordinary variety of red bark, from trees of the same age and growing under precisely the same conditions. This would settle the question as to the comparative merits of their bark; but even if they should be found equal in alkaloid-yielding properties, it would be desirable to encourage the culture of the hardier and more robust pubescent variety.

DECLINE IN THE AMOUNT OF ALKALOIDS IN NILAGIRI BARKS.—The most recent analyses of Madras barks by Dr. Paul and Mr. Howard show a very marked decline in their total yield of alkaloids. Eleven samples of crown barks from Neddiwattum, Dodabetta and Pykarah were submitted to Dr. Paul, and the results of his investigations show a great deterioration in the quality of mossed, unmossed and renewed bark. For the actual figures see G.O., Revenue Department, No. 715, of 8th May 1878. In the report by Mr. Howard he does not give the percentage of alkaloids found by him, but states generally that "the *officinalis* of each plantation shews a deficiency in alkaloid of each of the three sorts, the renewed and unmossed shewing it the most: the quinine is deficient on the average 10 per cent. compared with last year." He further states "I have found a similar deficiency in the *officinalis* from another private plantation, the crops of which I could compare in a similar way." "The renewed *succirubra* bark shews an even more marked inferiority, the average of this year's crop is about 25 per cent. deficient in quinine, and though the total alkaloids is less, the deficiency is in the quinine, the cinchonidine being more than last year." Unfortunately the ages of the trees from which the barks submitted for analyses were taken are not given. It is therefore impossible to say exactly whether this deterioration may not have been partly due to the age of the bark, Mr. Broughton having pointed out that certain changes take place in the alkaloid constituents of cinchona bark according to age. On the whole, however, as the inferiority is so general and not confined to one species, I am rather inclined to believe that the decline both in the quantity and quality of the alkaloids was due to climatic influences, the two past seasons having been particularly trying to all kinds of cultivated plants. The occurrence of such deterioration in bark shows how essential it is, that there should be a scientific officer in charge of the estates able to watch and investigate such changes, and, with the aid of the chemist, to seek out their causes.

OOTACAMUND,
31st August 1878.

G. BIDIE, M.B.

APPENDIX TO NOTES ON DODABETTA ESTATE.

(See Page 41).

Memorandum as to *Cinchona officinalis* trees on the Dodabetta Plantation, examined and barked by Drs. King and Bidie on the 14th August 1878.

No. 1A.

A specimen of *C. officinalis*, planted in 1863, growing in splendid black soil on the slope of the ravine within a quarter mile of the entrance to the estate, proceeding from the garden. This

tree was not in a very healthy state, and was a fair sample of many such on the plantations. It was barked once in 1877, and being then in a semi-sickly state, the bark did not rise freely. The bark also renewed slowly and imperfectly. It was uprooted in our presence and yielded as follows:—

						lb.
Root-bark	..	..	..	..	..	4 very thin.
Stem-bark	..	..	..	..	..	7
Branch-bark	..	..	..	..	..	4
						—
Total	..	..	..	..	..	15 lb. of green bark.
						—

The stem was cut across at the crown of the root, as if for coppicing, and showed fine healthy tissues. The roots were also healthy, and it is fair to presume that if this tree had been carefully coppiced at the proper season, it would have given off healthy shoots. The stem was not in a healthy condition, and would probably have died in course of time.

No. 1.

One of the fifty trees of *C. officinalis* planted in 1863 and coppiced in 1873. I saw these trees in September 1873, and they were then bleeding most profusely. The coppicing had also been done in such a manner that it is simply wonderful that they survived the operation. The stem had been coppiced in 1873 about one foot above the surface of the ground, and bore nine sturdy shoots. These were carefully removed with a saw and the cut surfaces dressed. The nine shoots yielded of green bark somewhat thin in character, as follows:—

Bark	..	..	..	..	..	..	..	8 lb.
------	----	----	----	----	----	----	----	-------

We left on this stool some twelve small side-shoots, all small, coming off below the coppiced surface and not true coppice-shoots.

No. 2.

Also one of the fifty *C. officinalis* trees planted in 1863 and coppiced in 1873. This stool bore six coppice shoots, which were removed together with about three inches of the old stool, which left a fine surface of living wood and healthy bark. The surface of the stool having been dressed, the bark of the coppice shoots was removed. It was thin, as in No. 1, and weighed 5 lb. in the green state.

No. 3.

Another of the fifty *C. officinalis* trees planted in 1863 and coppiced in 1873. This stool bore three large and three small shoots, which were removed along with about two inches of the stool so as to get rid of the dead and reach the living wood. Cut surface having been dressed, the bark was removed from the shoots and found to weigh 3 lb.

The total yield of green bark from the three coppiced trees was therefore as follows:—

						lb.
No. 1 Stool Coppice Bark	..	..	..	..	..	8
„ 2 do. do. do.	..	..	..	..	..	5
„ 3 do. do. do.	..	..	..	..	..	3
						—
Total	..	..	..	..	..	16
						—

Average yield of bark per tree $5\frac{1}{3}$ lb. As the coppice shoots are five years old, the produce of green bark has been at the rate of about 1 lb. per annum. I requested the Overseer to mark the stools Nos. 1, 2 and 3 with permanent wooden labels, so that their future progress may be carefully watched.

No. 4.

This was also one of the trees of *C. officinalis* planted in 1863 and coppiced in 1873. It being of great importance to ascertain the state of the roots in coppiced trees, this stool was uprooted and a vertical section made down the centre of the stool. Both in number and in size the roots greatly exceeded those of tree No. 1A, also uprooted, and with few exceptions were healthy. Judging from this specimen, coppicing, when shoots come off freely, seems to have the effect of increasing the root development. Owing to the number and tangled nature of the roots the removal of their bark was attended with some difficulty and not very perfectly performed, but it was considered preferable to sacrifice a little bark rather than to cut up the roots and so destroy the distinctive characteristics of the specimen. The green bark weighed as follows:—

						lb.
Bark of coppice shoots	..	..	..	..	..	6
Do. of roots	..	..	..	..	..	5
						—
Total	..	..	..	..	..	11
						—

The sections of this stool, marked No. 4, are herewith forwarded. It will be observed that the wood is generally sound, except small portions on the upper coppiced surface and on one side. Considering that this tree was coppiced at a wrong season and carelessly handled, the results show how tolerant this species is of the operation of coppicing.

No. 5.

This tree, an uncoppiced one, was selected as a contrast to No. 1A, it being in a healthy state. It was growing immediately below the patch of fifty trees coppiced in 1873. It was planted in 1863 and had been barked once in 1877. It was of good size and looked, as already stated, quite healthy. It was uprooted, and on examination the roots were found very much on a par as to size and number with those of No. 1A. The roots, marked No. 5, are forwarded for examination and comparison with those of No. 4 belonging to a coppiced tree. It will be observed that they are much less developed than those of the latter. The stem bark did not rise very freely and the renewed portions, one year old, are rather thin. As in No. 4, it was found impossible to remove the root-bark quite perfectly without injuring the roots and so damaging the specimen. The yield of bark was as follows:—

						lb.
Root-bark	..	..	..	..	..	4
Stem-bark	..	..	..	..	..	10
Branch-bark	..	..	..	..	..	9
						—
Total	..	..	..	..	..	23
						—

It will be observed that the above yield from a healthy tree contrasts very favorably with the return from the semi-sickly tree No. 1A, the total harvest in that case having amounted to only 15 lb. The whole of the bark referred to in these notes has been handed over to Mr. Lorne A. Campbell, to be reweighed when dry.

G. BIDIE, M.B.

OOTACAMUND,
15th August 1878.

APPENDIX D.

London Bark Sales—Jenkin and Phillips.

Date.		South American Barks.						East Indian Barks.					All other Barks.
		Calisayas.	Carthagena.	Columbian.	New Granadian.	Other American Varieties.	Total American Barks.	Madras and Nilgiri.	Darjeeling.	Ceylon.	Unspecified.	Total East Indian Barks.	
1876.													
February	10th and 15th ...	391	143	...	...	121	655	...	...	...	14	14	98
April	6th and 11th ...	659	...	515	...	99	1,273	...	...	...	170	170	251
	25th ...	313	...	1,495	56	331	2,195	...	...	...	9	9	69
May	4th and 9th ...	231	...	54	34	...	319	636	...	29	25	690	164
June	16th and 20th ...	342	...	448	93	66	949	...	...	...	31	31	38
July	13th and 18th ...	220	7	925	58	47	1,257	...	...	...	15	15	54
	27th and 1st August ...	184	...	690	39	156	1,069	...	...	47	6	53	97
August	10th and 15th ...	182	...	557	335	7	1,081	...	...	99	...	99	97
	24th and 29th ...	406	186	850	163	107	1,712	...	...	...	14	14	167
September	21st and 26th ...	261	200	760	...	118	1,339	...	...	...	49	49	200
October	5th and 10th ...	349	...	141	93	550	1,133	...	...	...	25	25	90
Total ...		3,538	536	6,435	871	1,602	12,982	636	...	175	358	1,169	1,428
1877.													
January	11th and 16th ...	297	20	388	71	155	931	...	...	36	87	123	152
	25th and 30th ...	217	45	66	18	259	605	...	...	2	49	51	14
February	12th and 13th ...	561	25	264	67	209	1,126	...	...	10	17	27	86
	22nd and 27th ...	522	12	...	...	357	891	...	...	24	12	36	172
March	8th and 18th ...	601	44	352	114	111	1,222	12	55	...	132	199	499
	22nd and 27th ...	334	226	263	175	52	1,050	...	83	...	42	125	226
April	5th and 10th ...	307	103	203	107	346	1,066	159	100	...	81	340	9
May	5th and 8th ...	571	4	307	64	120	1,066	20	260	...	39	319	182
	17th and 24th ...	576	207	404	...	559	1,746	...	32	...	75	107	181
June	14th and 19th ...	216	140	679	15	118	1,168	...	108	76	108	292	72
	28th and July 3rd ...	710	12	...	74	83	879	...	85	1	78	164	15
July	12th and 17th ...	246	...	1,128	...	57	1,431	...	...	3	27	30	19
	26th and 31st ...	277	110	1,370	...	125	682	134	115	...	49	298	99
August	9th and 14th ...	291	38	1,195	...	54	1,578	...	93	43	...	136	2
	23rd and 28th ...	361	300	1,230	86	140	2,117	26	204	45	72	347	104
September	6th and 11th ...	286	172	1,460	...	81	1,999	104	...	7	13	124	95
October	4th and 9th ...	215	60	285	...	112	772	34	...	4	47	85	94
November	15th and 20th ...	212	172	1,157	340	96	1,977	...	...	8	7	15	273
	29th and Dec. 4th ...	254	21	936	163	185	1,559	29	74	590	...	693	161
December	13th and 18th ...	311	104	944	130	58	1,547	85	...	16	...	101	240
Total ...		7,365	1,815	12,631	1,424	3,277	26,512	603	1,209	865	935	3,612	2,595

The figures refer to "bales," "packages," or "serons."

APPENDIX E.

Account of Receipts and Expenditure on account of the Cinchona Plantations from the commencement up to the close of 1875-76 taken from the Accountant-General's Books, Returns of Sale from India Office, and other sources.

Years.	Receipts.				Charges.			
	Value of Bark supplied to the Quinologist.	Value of Bark sent to England.	Value of Bark supplied to other Governments and Cash Receipts.	Total.	Establishment including Superintendent's Salary.	Buildings and Plant.	Other Charges.	Total.
1860-61	...	...	...	...	...	...	...	...
1861-62	...	...	...	...	...	...	...	...
1862-63	...	...	...	...	...	...	...	...
1863-64	...	...	...	...	...	...	...	...
1864-65	...	...	...	...	...	...	...	...
1865-66	...	...	...	...	...	...	...	...
1866-67	...	...	...	...	...	...	...	...
1867-68	...	...	...	...	...	...	...	...
1868-69	...	...	...	...	...	...	...	...
1869-70	...	...	...	...	...	...	...	...
1870-71	...	...	...	...	...	...	...	...
1871-72	...	...	...	...	...	...	...	...
1872-73	...	...	...	...	...	...	...	...
1873-74	...	...	...	...	...	...	...	...
1874-75	...	...	...	...	...	...	...	...
1875-76	...	...	...	...	...	...	...	...
1876-77	...	...	...	...	...	...	...	...

Net Results.	RS.	A.	P.
Total charges up to 1875-76	...	...	12,96,287 15 11
Total receipts do.	...	...	1,74,171 0 5
Net charges	...	...	11,22,116 15 6
Add charges of 1876-77	...	...	1,21,371 10 3
Deduct receipts of 1876-77	...	...	12,43,488 9 9
Net charges up to 1876-77	...	...	4,36,804 14 10
	...	...	8,06,683 10 11

APPENDIX F.

GOVERNMENT OF MADRAS.

REVENUE DEPARTMENT.

27th June 1877, No. 2,129.

Read the following paper :—

From J. W. B. MONEY, Esq., to the Hon. D. F. CARMICHAEL, Chief Secretary to Government, Fort St. George, dated Ootacamund, 4th June 1877.

I HAVE the honor to acknowledge the receipt of your letter of the 22nd ultimo, informing me, by order of His Grace in Council, that the whole of my correspondence relating to the Government Cinchona Gardens on the Nilgiris is under the consideration of His Grace.

2. I am aware of the difficulty felt by Government in the matter. They have, of course, no wish to injure me by the continued infringement of their promises, but at the same time they see no practicable mode of making their bark available for the troops and the people of India without a large expense, and the establishment of a Quinine Manufactory with doubtful success as to the results.

3. It was with a view to meet this difficulty that, in my letter to the Secretary of State of June 1875, I proposed, as an alternative, to buy the Government Gardens. But, as I told you in my interview in Madras on the 21st ultimo, my real object is to avoid the loss in Europe caused me by the competition of the Government bark in the European markets. It occurs to me that another solution is open which might, perhaps, meet the views of Government.

4. It was only in about 1825 that the febrifuge alkaloids and the mode of extracting them from the bark were discovered. For the previous two centuries mankind had been contented and derived inestimable benefits from mere decoctions, so well known to our ancestors as Jesuit's Bark.

5. For the troops and the people of India it will surely be sufficient to give them what sufficed our ancestors for two centuries without resorting to the more complex and delicate machinery required to extract the alkaloids from the bark, and to exhibit each alkaloid separately.

6. Should Government agree with me in this, I would offer to convert the bark of their gardens into a most efficacious decoction at no cost to Government, but that of buying the decoction ready made at the moderate rate of one rupee (Rupee 1) per quart bottle.

7. We have now for some years been making a similar decoction for the use of our own people with eminent success. The late Mr. Samuel Wauchope, a Bengal Civilian, my partner, took several bottles of this decoction with him to Hoogly in Bengal and administered it gratuitously, as far as it went, to the fever-stricken population of that district. It acquired so instantaneous a reputation that he was besieged by crowds who had walked over 50 or 60 miles to get a drink of it.

8. If the Government would make over their gardens on the Nilgiris to me to apply their bark to this purpose, I would undertake to supply them with any quantity of this decoction, which they please to take, up to the full bark produce of the gardens, at one rupee (Rupee 1) quart bottle delivered at the garden, each bottle of which should contain a $\frac{1}{4}$ lb. of dry bark pounded and the remainder pure alcohol. This rupee per bottle would give a small profit, from which at the same time I would cultivate and carry on the gardens at my own expense.

9. This solution would enable the Madras Government to apply their gardens to the noble purpose for which they were first established, to supply a cheap febrifuge to the people of India, and would at the same time achieve my object in relieving me from the competition of the Government bark in the European market.

10. Should His Grace in Council be willing to entertain this proposal, I would afford full information as to the preparation of this decoction, and supply samples of it for the testing and report of the Government medical authorities.

11. This decoction has none of the objectionable qualities which have made Mr. Broughton's preparations and those of the Bengal Government of so little practical use. It is nothing but pounded bark and alcohol, the original Jesuit's Bark of our ancestors.

ORDER THEREON, 27th June 1877, No. 2,129.

RECORDED, with an intimation that if Mr. Money will send specimen of his decoction to the Surgeon-General, Indian Medical Department, inquiry will be made into its efficacy as a febrifuge.

(True Extract.)

(Signed) C. G. MASTER,
Secretary to Government.

22nd August 1878, No. 1,351.

Read the following paper :—

From Surgeon-General G. SMITH, M.D., Indian Medical Department, to C. G. MASTER, Esq., Secretary to Government, Revenue Department, dated Fort St. George, 8th August 1878, No. 447.

ADVERTING to the orders of Government marginally cited, I have the honor, in submitting a tabular statement showing the results of certain experiments on the therapeutic action of Mr. Money's tincture of Cinchona, to offer the following remarks for the information of His Grace the Governor in Council.

G. O., No. 2,129, dated 27th June 1877.
 " " 2,559, " 23rd August 1877.
 " " 2,641, " 4th September 1877.
 " " 1,055, " 11th July 1878.

2. Mr. Money obligingly placed at my disposal 100 quart bottles of his tincture prepared from crown and 100 from red bark. The precise mode of preparing the tincture was not indicated, but the ingredients were stated to comprise five ounces of pounded dry bark to the quart bottle* of "pure alcohol." Mr. Money refers to the preparation as a "decoction," but as the more accurate term would be tincture, I shall use that designation in this communication.

* The average capacity of a quart bottle is about twenty-five fluid ounces.

3. The supply of Mr. Money's tincture was distributed to the Medical Officers of Civil Dispensaries, &c., at the stations marginally noted along with a memorandum from this office which is embodied in the Proceedings of Government (Revenue Department), No. 2,641, dated 4th September 1877. The reports called for having come to hand

the principal facts in connection with the inquiry will be found arranged in a tabular form in the appendix.

4. Stated broadly the conclusions arrived at are that Mr. Money's tincture cannot act as a substitute for quinine in the treatment of the severer forms of malarial fever, or in those cases in which local complications exist; that in less severe cases its action, even when successful, is slower and more uncertain than that of quinine, and that quinine has at times to be used to complete the antiperiodic action of the tincture; that in ordinary uncomplicated cases it acts at times as satisfactorily as quinine; that its therapeutic value is probably not inferior to that of the secondary alkaloids; and that it is to be regarded as a useful antiperiodic and general tonic.

5. Certain drawbacks to the employment of the tincture have also been alluded to. In severe cases of malarial fever and in those complicated with local inflammations the administration of large doses of Money's tincture would be most dangerous, owing to the large proportion of "pure alcohol" present in the preparation. A further drawback to the tincture is to be found in the fact that under its use nausea, vomiting, diarrhoea, and dysentery sometimes occur, proving that the preparation is not free from toxic elements possessing an action of serious importance when fever patients are reduced in strength by debilitating causes.

6. It is seldom that medical men use the tincture of Cinchona of the British Pharmacopœia except as a valuable addition to the decoction or infusion of bark, for the simple reason that administered *per se* in severe cases the dose must necessarily be large and contain an inconveniently large proportion of proof spirit. The objection is more serious in the case of the tincture prepared by Mr. Money, inasmuch as he uses pure alcohol in lieu of proof spirit. In other respects the two tinctures differ very little except that the tincture of the British Pharmacopœia is made from the yellow bark, whilst Mr. Money's tincture is from the crown and red barks. The tincture of the pharmacopœia is a preparation carefully made by percolation, whilst that of Mr. Money is probably only a somewhat unscientific imitation of the pharmacopœial tincture. The tincture of the pharmacopœia, however, is not so rich in alkaloids as that of Mr. Money.

7. There is, however, one great objection to the general use of Mr. Money's preparation in connection with the supply of an antiperiodic cheap and efficient among the masses of the people, and that objection has reference to bulk. Each quart bottle contains but twenty-five one-ounce doses, or fifty-four drachm doses; consequently the expense of transporting the preparation throughout the Presidency would be so great as to amount to an actual prohibition of its use. I may be permitted to add that whilst acknowledging the value of Mr. Money's tincture as an antiperiodic in ordinary and uncomplicated cases of malarial fever, I am inclined to look in another and totally different direction for a cheap and efficient febrifuge which from its portability, safety, and proved potency will be likely to accomplish all that can be desired in the way of meeting the medical wants of the fever-stricken masses of this Presidency.

*Results of Experiments with Money's Tincture of Cinchona Bark with reference to the Orders of Government, Revenue Department, Nos. 2,129 of 27th June 1877,
2,559 of 23rd August 1877, and 2,641 of 4th September 1877.*

Station.	Medical Officer.	Type of Fever.	Number of Cases Treated.	Number of Days under Treatment.	Average Dose administered.	Special Therapeutic effects noted.	Results.		Remarks by the Medical Officer conducting the experiments.
							Successful.	Unsuccessful.	
Guntoor ..	Surgeon P. J. Farrell, M.B. A further report promised by the death of the Medical Officer.	Intermittent .. Do.	5 4	{ 1 day. }	3ss to 3ij four times a day. 3ij four times a day.	Stated to have a primary stimulant and secondary sedative effect. Its administration up to doses of 3ij has not been attended with any symptoms of Cinchonism. Useful in some cases of long continued suppuration attended by great prostration.	4	5	"Had to cease its administration (in 3i doses) and give quinine in 4 grain doses which cut short the fever." "Experience too limited to report on its advantages or otherwise, but found it so far a valuable as it is a pleasant antiperiodic in dose of 3ij. Used it "with most apparent advantage in some cases when malaria was as it were lurking about the system constantly showing itself in a subdual form." Similar cases were contemporaneously treated with 2 grain doses of Cinchona alkaloids other than quinine and with like results.
Bellary ..	Surg. Lionel Beech.	Slight intermittent.	A large number.	A little over 2 days.	Half a drachm crown bark tincture.	Found when administered in either large or small doses to patients who were also suffering from general debility it had a tendency to produce diarrhoea, but is doubtful whether this is really due to the tincture; occupies a place between quinine and the other alkaloids of Cinchona.	A considerable number.	..	Similar cases were contemporaneously treated with 5 grain doses of the Cinchona alkaloids and with like results.
Do. ..	Do.	Severe cases of ague.	A few ..	3½ days ..	Two drachms of the crown bark tincture.		..	..	Cases of same type treated with over 5 grain doses of quinine gave similar results.
Do. ..	Do.	Very severe intermittent.	Very few.	7 days ..	More than 3ij crown tincture.		Very few.	..	Of these one or two cases were complicated with delirium, and all yielded immediately on the administration of quinine in 10 grain doses. "Considers that this drug will never supersede quinine; up to a certain point it may be used with benefit, and like the other Cinchona alkaloids, must give way to quinine; thinks in mild or moderately severe cases it may be substituted for quinine. Used it for children in doses of a few drops up to 3ij according to age without any deleterious effect. To sum up thinks "it is an antiperiodic that ought to be in all hospitals."
Do. ..	Do.	Do.	Do. ..	..	6 drachms ..		..	All	

APPENDIX TO

CINCHONA COMMITTEE'S REPORT.

Kurnool ..	Surgeon J. Fitzpatrick, M.D.	From the simple quotidian to severe remittent.	17 63 16 64	5 .. 5	3j crown bark tincture three times a day. 3ij crown bark tincture three times a day. 3j red bark tincture three times a day. 3ij red bark tincture three times a day.	In the treatment of the severer forms of malarial fevers it was found quite useless. Found its action generally uncertain, and that it never had any decided effect until the fourth or fifth day. The disadvantages experienced in its use were (a) its uselessness except in mild cases; (b) it frequently gives rise to nausea and vomiting; (c) sometimes diarrhoea; (d) no action even in mild cases before the fourth or fifth day; (e) no effect whatever in the severer forms of malaria when quinine acts so magically.	51	29	To the 29 cases which proved unsuccessful in five days quinine had to be given and effected a cure. The 26 unsuccessful cases were finally treated with quinine in doses of from 3 to 4 grains three times daily and got well on the third day under this change of treatment. Found no difference in the relative value of the crown and red bark tinctures. Tried the tincture of crown bark in 5j doses three times a day in twelve cases of children "all of whom were cured in an average of six days," at the same time in 27 other cases of children gave quinine in doses of 3 grains three times a day which cured them on an average in three days. Considers its therapeutic value so far as rapidity of action is concerned "much inferior in mild cases" in the treatment of which only he found it of use.
Nellore ..	Surgeon-Major A. M. Ross.	"Uncomplicated cases," of intermittent (7 cases doubtful).	65	2-89	3ij (2 drachms) ..	In two cases treated with Money's tincture the fever ran very high, and the dose of the tincture was raised to 4 drachms with the immediate effect of lowering the temperature and checking a return of the paroxysm. "In no case did the tincture appear to give rise to any nervous symptoms," the headache noted in a few being of the character generally observed when the disease is not treated at all, as was also the vertigo complained of by a few.	65	..	The cases were not specially selected except as regards absence of complications. During the period they were in hospital 28 cases of a similar character were treated with quinine in 5 grain doses three times a day. Of these two were doubtful. The average number of days under treatment was 3-53. The experience of this reporter leads him to set a high value on it as an efficient (I believe a cheaper) substitute for the other Cinchona preparations. He states that taking everything into account Money's tincture in 2 drachm doses was slightly more successful than quinine in 5 grain doses, and the addition of alcohol is in many cases valuable; he prefers it in ordinary cases to quinine.

Station.	Medical Officer.	Type of Fever.	Number of Cases treated.	Number of Days under Treatment.	Average Dose administered.	Special Therapeutic effects noted.	Results.		Remarks by the Medical Officer conducting the experiments.
							Successful.	Unsuccessful.	
Coimbatore.	Surgeon-Major G.S. W. Ogg, M.D.	Nineteen cases mild uncomplicated intermittent, and 8 febricula.	27	4	2 drachms three times a day.	In several cases diarrhoea and dysentery supervened during or after the administration of the drug, but as these diseases were very prevalent in the jail in which the trials were conducted does not think that the bowel-complaint can be attributed to the action of the drug. Can offer no opinion as to its efficacy in large doses in the treatment of severe cases of fever, but considers that an obvious drawback to its employment in such cases lies in the large quantity of alcohol that would have to be administered in the exhibition of a full dose of the Cinchona alkaloids, the equivalent of 20 grains of the alkaloids being from 3 to 6 oz. of Money's tincture.	..	..	The cases of intermittent fever that occur at Coimbatore are according to Dr. Ogg in most instances "owing rather to sudden changes of temperature than to the presence of a special malarial poison." For this reason he considers that its apparent success can scarcely be taken as a test of its value in combating severer types of malarious fever. "Cases in which the treatment had to be modified in consequence of inter-current attacks of pneumonia or other disease were eliminated from the general return." Dr. Ogg is of opinion that Mr. Money's tincture may be regarded as a useful antiperiodic in the treatment of mild cases of intermittent fever.
Salem ..	Surgeon D. H. Cul- linore.	Intermittent	8	..	Half a drachm to 2 drachms.	In one case it gave rise to diarrhoea; otherwise it had no bad effect.	..	8	In none of these cases was its administration satisfactory. Quinine and arsenicals were found necessary to effect a cure.
Do. ..	Do.	Do.	1	8	One ounce reduced to 2 drachms three times a day.	Occasionally Money's tincture produced diarrhoea.	..	1	Was cured by arsenic and quinine.
Calicut ..	Surgeon H.D. Cook, M.D.	Do.	1	5	One ounce three times a day.	The Cinchona failed to stop the fever and produced head symptoms and some diarrhoea.	..	1	Quinine at once checked the paroxysm.
Do. ..	Do.	Do.	1	6	Do.	The tincture of bark failed and produced some diarrhoea.	..	1	Quinine at once checked the fever.
Do. ..	Do.	Do.	1	6	One ounce once, a day.		..	1	Was discharged on the 5th and admitted on the 9th November with fever which was checked by quinine.
Do. ..	Do.	Do.	1	6	One ounce before and one ounce after a paroxysm.		..	1	It was found necessary to stop the tincture and give quinine which arrested the fever.

[illegible]

(Signed) G. SMITH, M.D.,
Surgeon-General, I.M.D.

ORDER THEREON, 22nd August 1878, No. 1,351.

COMMUNICATED to the Committee now sitting under G.O., 1st June 1878, No. 830.

2. It is observed that 50 lb. of renewed red bark (green) and 50 lb. of renewed crown bark (green) were supplied* to Mr. Money from the Government plantations for the preparation of the tincture furnished by him to the Surgeon-General for experiment, and that the value of this bark at the rates realized at the last sales was at lowest upwards of Rupees 120.

(True Extract.)

(Signed) C. G. MASTER,
Secretary to Government.

4th September 1877, No. 2,641.

Read the following paper :—

Endorsement of the Surgeon-General, Indian Medical Department, dated Fort St. George, 30th August 1877, No. 550.

Read the following Memorandum from Surgeon-Major G. BIDIE, M.B., Secretary to the Surgeon-General, Indian Medical Department, to the Medical Officers in charge of Civil Dispensaries at Gunttoor, Bellary, Kurnool, Nellore, Coimbatore, Salem, Calicut, and Mysore, dated Fort St. George, 30th August 1877, No. 5,469 :—

* Proceedings of Government, Revenue Department, No. 2,129, of 27th June 1877.
Proceedings of Government, Revenue Department, No. 2,559, of 23rd August 1877.
† One dozen red bark preparation.
One dozen crown bark preparation.

GOVERNMENT having directed* that the efficacy of Mr. Money's tincture of Cinchona bark as a febrifuge be tested, the Surgeon-General has directed that two dozen quarts† of it be sent you for trial in the treatment of malarious fever.

2. Mr. Money's tincture contains 5 oz. of crown bark *C. officinalis* or red bark (*C. succirubra*) to the quart bottle of spirit, i.e., 24 oz. The British Pharmacopœia *Tinctura Cinchona Flavæ* has 4 oz. of bark to 20 oz. of proof spirit.

3. It has been roughly estimated that Mr. Money's tincture contains from 3 to nearly 6 grains of Cinchona alkaloids per ounce. The dose of the Pharmacopœia tincture is $\frac{1}{2}$ to 2 drachms. It will be your duty to determine by careful trial the minimum, medium, and maximum antiperiodic doses of Mr. Money's tincture.

4. The object of this trial is to determine the therapeutic value of Mr. Money's tincture relatively to that of quinine and the other Cinchona alkaloids at your disposal. In summarizing the results of your trials, it will be necessary to state what quantity of the tincture is, in your opinion, equal to the ordinary antiperiodic doses of quinine; whether it is more successful when used in large medium or small doses; whether it has any advantages over the other preparations of Cinchona now in use; and if not, what are the drawbacks you have experienced in its employment.

Its use in the case of children, and in cases in which the employment of stimulants would be inexpedient, must be avoided.

FORWARDED to the Secretary to Government, Revenue Department, with reference to G.O., No. 2,559, dated 23rd August 1877.

(Signed) G. SMITH, M.D.,
Surgn.-Genl., Indian Medl. Dept.

ORDER THEREON, 4th September 1877, No. 2,641.

RECORDED.

(True Extract.)

(Signed) C. G. MASTER,
Secretary to Government.

GOVERNMENT OF MADRAS.

REVENUE DEPARTMENT.

Read the following papers :—

From the Acting Commissioner, Nilgiris.

(Here enter 16th July 1878, No. 133.)

(„ „ 15th October 1878, No. 136.)

ORDER THEREON, 24th February 1879, No. 463.

THE Government have now before them the report of Captain Campbell Walker who inspected the Cinchona plantations early in the year 1878, and the report of the Cinchona Committee whose investigations were carried on during July and August with the valuable assistance of Dr. King, Superintendent of the Botanical Gardens, Calcutta, and Government Cinchona Plantations in Bengal.

2. *The Plantations.*—Captain Walker devotes fifteen pages of his report to a history of the enterprise and the circumstances under which the Ootacamund, Neddivattum, Pykara and Maikonda estates were formed, and the last was abandoned. All the facts are known to Government, and there seems nothing therein requiring remark.

3. This section of the report includes a financial statement of the capital account which it is proposed to close at the end of 1875-76, but a revised statement has since been submitted by the Accountant-General, and a copy having been furnished to the Committee appears in Appendix E, page 51, of their report. In this is included on the credit side a sum of Rs. 61,939-8-4, being the value of the bark supplied to the quinologist. The data for the valuation of this bark were supplied from the Government Office, and are the same as those which were given by the Committee of 1874, and then accepted. The quantity and kind of bark supplied was ascertained from the records and checked by reference to the Commissioner's Office.

4. The rest of the statement has been prepared in accordance with the instructions of Government. The amount under the head "Buildings" is so small as apparently to indicate that this item may not have been always distinguished; but, as a statement of the Government expenditure and the recorded receipts, the return may be accepted. Interest at $4\frac{1}{2}$ per cent. on the yearly balance of charges is included and the result is—

	RS.	A.	P.
Total charges up to 1875-76	12,96,287	15	11
Receipts	1,74,171	0	5
Net charges...	11,22,116	15	6
In 1876-77 the charges were	1,21,371	10	3
And the receipts	4,36,804	14	10
So that the Capital expenditure was by 31st March 1877 reduced to	8,06,683	10	11

In a foot-note to page 3 of their report the Committee note that the bark sent home in 1877-78 has realized £33,231, and that when the charges of the year are paid there will be a balance of upwards of two lakhs to set towards the further diminution of the capital expenditure.

5. *Number and Classification of Trees.*—Captain Walker next reports the area

now under cultivation to be by the revised survey 842.92* acres, and the result of his enumeration of the trees in the existing plantations to be 569,031 trees, viz. :—

Red Bark	...	...	...	...	...	...	260,837
Crown	...	...	...	...	...	...	305,432
Yellow	...	...	...	...	...	...	552
Grey	...	...	...	...	...	...	1,874
Other species	...	...	...	...	...	...	336

Of these he considers only 450,000 to be fully established, and states that this "is certainly not a sufficient crop for the area under cultivation, being only 530 trees per acre." Captain Walker intimates that his classification is of no accurate scientific value as varieties and hybrids are "classed with the parent whose growth they most resemble." The oldest trees were planted in 1862, and the tallest Red bark was one of that year's planting at Neddivattum, and measured 37½ feet. The tallest Crown bark was found at Dodabetta. It was planted in 1863 and measured 26½ feet. The greatest girths at 4½ feet from the ground were—Red bark 28 inches and Crown bark 23¾, both at Neddivattum.

6. *Present System of Cultivation.*—In regard to the cultivation of estates the present system is considered satisfactory, but there seems to be a danger of "wash" and consequent denudation in some of the steeper parts of Dodabetta.

It is generally agreed that in the original planting the trees were placed too far apart, and that sufficient attention was not paid to renewals or "supplies." The estates do not thus bear as many trees as they might.

7. *Present Condition.*—The present condition of the plantations is not uniform. This is shown to arise—

- (1). from certain species being grown at elevations or aspects which have proved unsuitable;
- (2). from Red barks being grown in situations which experience has proved to be exposed to strong winds;
- (3). from Red barks having been tried in places on grass land.

This want of uniformity is the necessary result of experimental culture, and it is satisfactory to find that Dr. King saw nothing on private estates better than portions of the Neddivattum plantation, and very little that could beat "patches of Crown bark at Dodabetta."

8. The Pykara plantations are not favorably spoken of. Parts are much exposed to the south-west monsoon, and being beyond the reach of daily direct supervision, cultivation has suffered. Manuring also has not been attempted there from various causes.

The Wood estate, which is cut off from Neddivattum by the Pykara river, is the estate that is thought least well of, and its sale is recommended.

9. *Future Prospects.*—The future prospects of the Government plantations are considered by Captain C. Walker to be "most encouraging," and he sees nothing to denote decline of vigor among the healthy trees. Drs. King and Bidie on the other hand noticed even among the best parts of the plantations numerous trees of sickly foliage carrying dead twigs and bearing "an enormous amount of flower and seed." This last they consider a sign of deficiency of health and attribute it to the barking, for it seemed most prevalent where the trees have been barked oftenest.

10. Captain Walker estimates that there are 200,000 trees of the more valuable and 250,000 of the less valuable varieties of Cinchona.

The yield of the former he puts at ½ lb. dry bark, and the yield of the latter at 1½ lb. dry bark per tree per annum.

The former kinds, he remarks, have recently realized an average of 7s. 6d. per lb., and the latter he thinks may safely be valued at 2s. 6d. per lb.

The result is an estimated annual harvest of 391,666 lbs., realizing a gross income of £80,208-5-0.

11. This estimate of yield is considered by the Committee as over sanguine. They remark that "the estates are probably now in full bearing," and they do not think it likely that they will "in their present state yield more than 200,000 lbs. (dry) bark yearly." This view the Government observe is supported by the

fact that the harvest of 1877-78 was*
 * G.O., 15th November 1878, No. 1,828. 138,838 lbs., and that of the current
 † G.O., 6th January 1879, No. 20. year is† expected to be only about
 100,000 lbs.

12. *Mossing.*—The present inquiries establish the fact that with care the stripping of the bark under the mossing system can be frequently repeated with all varieties. It is however now found that renewed bark is rarely fit for removal until the third year, and it is then by no means of uniform thickness, but fetches a higher price than natural bark.

13. At the time of Captain Walker's inspection harvesting operations were not in progress, but the Committee had the advantage of witnessing them, and the use of the mossing system for a term is recommended.

It is pointed out that the danger lies in the process being persisted in too long; for if a tree is injured or becomes sickly its bark is of little or no value. Drs. King and Bidie think many of the trees on the various plantations are at that stage when to secure a profit from them they should either be cut down or grubbed up.

14. *Coppicing.*—Unbarked trees have been cut down in small numbers at different times, and though the method of coppicing that was followed is condemned by all, it is generally agreed that both Red and Crown barks have been successfully coppiced. An interesting experiment was made by Drs. Bidie and King. A tree that had been coppiced five years ago was grubbed up in order to examine the root development, which was found to be much larger than in the case of two trees of the same planting which had been allowed to grow up but had been barked. It is to be regretted that comparison was not also made by them with the roots of an unbarked or maiden tree.

15. In view of the above results it is suggested that mossing may probably be profitably conducted until a tree shows signs of declining vitality, and that then coppicing should be resorted to. It is however very doubtful whether coppicing will or can be well expected to succeed in the case of trees that have been barked to an extent inducing decay. If not, the trees must be grubbed up, and the bark, including that of the roots, which is also valuable, be secured before the tree dies.

16. Of the comparative yield under either system pursued separately there is no sufficient evidence, nor yet of the value of the bark of shoots from the stool of a coppiced tree.

17. *Future Management.*—The Committee and Captain Walker are alike averse to Government abandoning their plantations, and recommend the appointment of a special officer as Superintendent. The former point has already been decided, but the remarks of the Committee (paragraphs 56 and 57) condemning the supposition that Government thus injures or retards private enterprise invite and deserve attention.

18. *Local Manufacture of a Febrifuge.*—In considering the question of the resumption of the local manufacture of a febrifuge that shall be cheap and efficient, the Committee start with the statement that "to produce a cheap manufactured article the raw material must, first, be obtainable at a low price; secondly, the process of manufacture must be inexpensive and exhaustive; lastly, the product must be efficient and economical in use." They then show that the late quinologist's manufactory was a failure because the bark supplied to it was costly and the method of manufacture did not prove exhaustive in practice. They, therefore, endeavor to ascertain what the cost of Nilgiri bark now is, and whether by the light of the experience gained in the manufactory in Bengal, a product that shall exhaust the precious constituents of the bark can be made in India.

19. The first point is settled by means of the Accountant-General's financial statement, and it is demonstrated that, assuming an annual yield of 200,000 lbs. dry bark, its cost after 1878-79 will be about 7 annas a lb., and that if sold and the proceeds applied to the reduction of capital expenditure, the bark might in a few years "be produced and harvested for something like 4 annas a lb." This is about the cost of production of Sikkim bark at the present time, and is the reason why the febrifuge there manufactured is sold at so low a price. But though sold cheap it is not, as at present manufactured, an economical product, for only about 50 per cent. of the alkaloids known to be present in the bark have been recovered, whereas 85 to 90 per cent. ought to have been extracted. The loss of febrifuge has therefore in three years been at the lowest computation 7,792 lbs., or in money value at the present price of the febrifuge, Rs. 1,55,840.

20. The quinologist in Bengal admits that imperfect and crude appliances are of no avail, but he estimates that in a proper factory at Calcutta seven-eighths of the alkaloids in the bark could be recovered, and that with bark supplied at $3\frac{1}{2}$ Annas a lb. a febrifuge could be produced at Rs. 11-9-0 per lb. Experience has yet to confirm this anticipation.

21. But there is a further point. The Bengal and Madras barks have different qualities and different commercial values. Sikkim bark contains but a small amount of crystallizable quinine and is therefore of low commercial value. Nilgiri bark on the other hand containing a large proportion of crystallizable quinine is of high commercial value. Quinine is the most effective of all the Cinchona alkaloids, although the others are practically efficient in the cure of ordinary fevers. The Bengal febrifuge may therefore be medicinally as useful as a similar preparation made from Nilgiri barks would be; but commercially it is of small value, and is now sold at about its real value in the market though the price put on it is determined only by its cost.

A Nilgiri febrifuge if sold at a price similarly determined, would be disposed of much below its commercial value, and the inevitable result would be that it would be bought up for the purpose of resale at its real and materially higher value.

22. The Committee thus show clearly that there is no present probability of the Madras Government being able to work up their bark economically or exhaustively, and that even if it were otherwise the benefits of a cheap febrifuge could not be secured as long as Nilgiri bark (and therefore any preparation from it) is of high commercial value.

23. It has been shown that all the Cinchona alkaloids are, in general practice, of about equal therapeutic value. If therefore the Government wish to utilize their bark to the best advantage this, the Committee point out, will be effected by selling it at the high price which its quinine-yielding qualities command, and with the proceeds buying and distributing the cheaper but sufficiently efficient alkaloids. These also it would be desirable to obtain not in the crude form of the present Bengal febrifuge, which, though undoubtedly efficient, has certain disadvantages (such as want of solubility, unpleasant appearance and taste, and nauseating effects), but as sulphates or crystalline salts which cannot in appearance and taste be distinguished from sulphate of quinine. The Committee show that the cost of a mixture of quinine and these sulphates "in the proportion of the composition of the Bengal febrifuge" would at recent prices have been Rs. 21-0-5 a lb. against Rs. 20 the price of the Bengal febrifuge. By reducing the proportion of quinine which has been unusually expensive, a still cheaper febrifuge could be obtained.

24. Dr. King objects to this suggestion, giving it as his opinion that with an increased demand the price of the (now) cheaper sulphates will rise; but the Committee think otherwise, for the supply of the bark which produces them is very abundant and capable of being increased. Moreover, it may be assumed that the price of quinine will fall either with lessened demand or with that increase in production of the better barks which the spread of Cinchona cultivation in India, and Ceylon renders probable.

25. It follows then that the Committee are opposed to the suggestion of the Government of India, for Nilgiri bark being sent to Bengal for manufacture either into a febrifuge or sulphate of quinine. They further point out that the cost of carriage and freight of the bark would probably be nearly as high as to England.

26. Preparations of bark of a simple nature the Committee consider cannot be "economically substituted for the cheaper Cinchona alkaloids of European manufacture." They are, moreover, shown to be unsuitable for general use from various causes connected with their bulk or liability to spoil. Reference is made to the report of the Surgeon-General, Indian Medical Department, on the experiments made by order of Government with the tincture prepared by Mr. J. W. B. Money. "The results," it is said, "are not favorable to the use of such a preparation for public purposes."

27. As the Committee do not recommend the resumption of local manufacture they do not think a quinologist necessary, provided that a Superintendent such as they recommend is placed in charge and permitted to refer to and communicate with "an European chemist of repute."

28. Lastly, the Committee point to the importance of scientific culture and experiment, attention being specially directed to artificial hybridization.

How far this was practised by the late Mr. McIvor is not known, but in the letter quoted by the Committee, he intimated that it had been attempted successfully and that important results might be expected from its prosecution.

Dr. King has a similar belief, but the Committee and he agree that the experiments must extend over many years and be the work of a person "thoroughly trained in the theory and practice of scientific gardening."

29. His Grace the Governor in Council agrees generally with the conclusions of the Committee as above reviewed, *Vide* despatch in G.O., 1st June 1878, No. 830, which will accordingly be submitted to the Secretary of State with reference to the questions raised as to the retention of the Cinchona plantations, the appointment of a successor to Mr. McIvor, the re-employment of a quinologist, and the resumption of the local manufacture of a febrifuge.

30. In reply to the letter of the Government of India in connection with the same subject, it will be intimated that 7th March 1878, No. 82, in G.O., 1st June 1878, No. 830, in view of the facts elicited by the Committee His Grace in Council does not consider it advisable, under existing circumstances, to have Nilgiri Red bark converted into febrifuge or the Crown bark into sulphate of quinine in India.

31. The desirability of obtaining the services of a scientific but yet practical horticulturist, His Grace considers to be fully established.

It will be the duty of this officer on the one hand not only to see that the best results are secured from the existing plantations by bringing to bear his practical acquaintance with the most approved methods of cultivation, but especially to conduct those experiments in hybridization which carefully pursued will, it is hoped, result in the production of valuable varieties that can be remuneratively grown by planters at lower elevations and in varying climates, and thus increase the supply of bark and familiarise the people with its cultivation and uses. In the mean time the management and conduct of the plantations will remain as at present subject to the following remarks.

32. Inspections of the plantations and examination of sections of trees that have been felled after frequent barkings have led His Grace the Governor in Council to entertain serious doubts as to the health of trees that have for any length of time been subjected to the stripping and mossing process. The undue proportion of flower and seed noticed by all observers is, in the opinion of His Grace in Council, more noticeable in the case of barked than of unbarked trees, whether of the Red or Crown bark species, and microscopic examination of sections of the former when felled showed that the cells of the wood had hardened and had assumed the appearance of dry seasoned wood.

33. Under these circumstances and in view of the fact that coppicing has not yet been really tested on the Government plantations, His Grace resolves to direct its being tried on a sufficient scale and with unbarked as well as barked trees. It is especially important to ascertain—

(1.) Whether barked trees that have been rebarked until signs of decay are perceptible will shoot from stool with any certainty.

(2.) Whether the young shoots so produced will yield bark of any richness or be comparatively worthless.

The Commissioner of the Nilgiris will accordingly arrange for coppicing experiments at all the plantations. He will bear in mind the defects in the methods hitherto followed in many of the experiments as pointed out by* Captain Walker and Dr. King, and as to extent, cultivation and treatment generally, will conform to the advice of the latter whose valuable opinion in regard to the future working of the plantations as founded on his own experience, is† recorded by the Committee. It will be seen that “at

* Page 35, paragraph 61.

least 5 acres should be done in one place,” and suitable blocks should be at once selected.

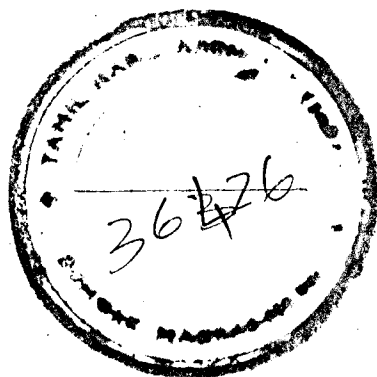
† Pages 33—35.

The period most favorable for coppicing is stated to be “when the trees are most at rest,” but this is a point on which the Conservator of Forests will be requested to advise Government.

34. In conclusion His Grace in Council desires that the Commissioner of the Nilgiris will convey to the Committee the thanks of Government, whose obligation to the Government of Bengal for placing Dr. King's services at their disposal, and to that gentleman for the ready and valuable assistance rendered by him, will also be acknowledged.

(True Extract.)

(Signed) J. H. GARSTIN,
Acting Secretary to Government.



J.P. 6911-2117 & M78

M78