Selections from the Records of the Madras Government.

No. LXVI.

EXTRACTS

FROM A

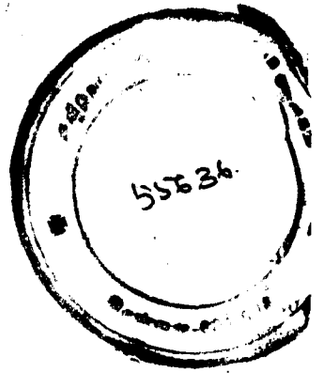
REPORT ON THE GOVERNMENT CHINCHONA PLANTATIONS ON THE NILGIRIS BY CAPTAIN C. WALKER,

AND FROM A

REPORT SUBMITTED BY A COMMITTEE APPOINTED TO CONSIDER VARIOUS QUESTIONS CONNECTED WITH THE ENTERPRISE.

MADRAS:
PRINTED BY E. KEYS, AT THE GOVERN

1880.



The following EXTRACTS from a REPORT on the GOVERNMENT CHINCHONA PLANTATIONS on the Nilgiris, by Captain C. Walker, and from a REPORT submitted by a COMMITTEE who were appointed to consider various questions connected with the enterprise, are published for general information.

CHAPTER I.

PAST HISTORY OF THE PLANTATIONS.

Introduction.

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.

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

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.

Mr. Clements Markham's Mission in 1859.

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 coadjutors in the enterprise, must not be lost sight of.

Messrs. Spruce, Cross, & Pritchett's services.

Mr. Clements Markham in South America and India, 1860.

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 *viâ* 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 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.

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.

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

Introduction of *C. pahudiana* from Java.

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 *Lucumæfolia*, appears also to have been received from Java, but this proved a worthless variety.

the Secretary of State (page 3, Vol. III, of Blue Book). These are summarised by Dr. King in his "Manual of Chinchona 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 labored 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.

Mr. Broughton's *Amorphous Quinine.*

The process followed in its manufacture was described at length by Mr. Broughton in a report dated December 1873 (G.O., Revenue Department, 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 alchol," 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.

First results favorable.

The results of its medical trial are given in a report by the Inspector-General, Indian Medical Department, recorded in G.O., Revenue Department, 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.

Committee appointed to investigate.

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., Revenue Department, 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., Revenue Department, No. 217, of the 11th February 1875, forms a valuable contribution to the literature of the chinchona experiment. They showed that "on the most favorable 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

Government abandon the manufacture.

done. Mr. Broughton resigned his appointment early in 1875, and no successor has since been appointed, nor the manufacture revived.

Cultivation.

Propagation.

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

Planting out.

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.

Mr. McIvor's method adopted by the Dutch.

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

Land trenched or pitted.

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′.

Weeding, pruning, &c.

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. 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.

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's first proposed lopping and thinning.

Wrote highly of growth coppice shoots.

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.

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."

Mr. McIvor adopts it.

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 formally abandons lopping, &c., for the mossing process.

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 chaffing."

Mossing and harvesting commenced.

By G.O., Revenue Department, 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 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

Quantity and amount realised for 1876-77.

1876-77 realised £34,000 in round numbers for 88,708 lbs. of dry bark of the various descriptions, the highest rate being 15*s.* 8*d.* per lb., realised for renewed crown from the Dodabetta plantation.

Coppicing experiments on a limited scale.

The experiments of harvesting under the coppicing system have, throughout, been on a very limited scale. In December 1865 (G.O., No. 3,102), Mr. McIvor was ordered to cut down

Experiment of 1865.

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 realised 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. 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 ten 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

Experiment of 1871.

Experiments of 1873.

Experiment of 1875.

* 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 248 lbs. 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 endeavor 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.

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 labor 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.

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

General conditions to be fulfilled.

Bark should not be collected during the monsoon.

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."

Bark should be dried by natural means only.

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 mossing system of harvesting, the bark is best removed during the monsoon 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 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 three and six weeks that the deterioration was not so great as he had expected.

Keeping it undried impairs its appearance and commercial value.

Analyses and Comparative Richness of various Species.

Chief alkaloids found in the chinchonæ barks.

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.

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.

On the whole, however, the analyses are favorable. 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, ten 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.

Marked tendency to develop chinchonidine.

The last analyses of barks of the *C. officinalis* from all the Government plantations made by Dr. Paul in February last are 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 thirteen-year old tree natural bark being respectively 5·13 and 4·11 per cent., whilst from nine and ten-year old trees the yield is 3·47 and 2·90 per cent. Still, 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 realized, 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.

Latest analyses not altogether favorable to mossed and renewed barks.

No satisfactory conclusions can be arrived at from want of care in selection of specimens, &c.

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

Relative value of well-known species.

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.

Mr. Broughton discovers *C. angustifolia.*

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. 1,740, 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 (second 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 the *C. 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*.

Mr. McIvor discovers the hybrid *C. pubescens.*

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*, 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.

Effects of the Application of Manures.

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

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 percentage of pure quinine to total alkaloids,

Effects of stable manure.

15 out of a total of 7·49, renders the bark sufficiently pure for se without the expensive process of separating the sulphate of uinine from the chinchonidine, &c.

Ammonic sulphate and guano.

The results of the application of the ammonic sulphate and uano to the *C. succirubras* were less satisfactory, and Mr. roughton records his opinion that, "as the gain in the most uccessful case consists mainly of alkaloids other than quinine, it ill not be profitable to manure this species." In the case of . *officinalis* however the gain from the application of ammonic ılphate (lb. $\frac{3}{4}$) was 1·22 of total alkaloids, of which 0·57 was uinine and of guano (lb. 1) 2·53 per cent., of which 2·01 was uinine, the latter thus increasing the value of the bark by 1*s.* *d.* per pound, whilst the cost of the guano was not more than $\frac{1}{2}$*d.* per pound.

Alkaloids not active constituents in life and growth of plant.

The application of these nitrogenous manures caused no pparent increase in the luxuriance of growth, and the improvement in the bark was only apparent on analysis. Mr. Broughton ıad "long been of opinion that the alkaloids in the bark of the rees are not specially active constituents in the processes onnected with the life and growth of the plant, and this suppoition is supported by the circumstance that the increased amount of alkaloids produced by the manure causes no change in the ppearance and rate of growth of the tree." This has an mportant bearing on the stripping and mossing process, for, if Mr. Broughton's deductions be correct, they go far to account or the extraordinary fact that the repeated decortication of the rees appears so far not to have interfered with their growth and ıealthy condition.

Further experiments ordered.

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."

CHAPTER II.

PRESENT CONDITION OF THE PLANTATIONS.

Preliminary.

Interest and scope of the inquiry.

I turn, with pleasure, from a *résumé*, 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 inquiry, 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.

Want of accurate information as to the past.

Mr. McIvor left no records.

The Enumeration.

Commenced on Dodabetta plantation.

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.

More accurate boundaries and sub-divisions found necessary.

I saw at once that it would be necessary to sub-divide 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 sub-divided into blocks, natural features and plantation roads being made the boundaries, or dividing lines wherever practicable.

Methods pursued in enumeration.

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., sub-dividing 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.

Time occupied.

By these methods, steadily pursued, the enumeration of the trees in all the plantations has been effected in about 2½ months, or rather less if we allow for Sundays, holidays, &c.

Results.

Every living tree, or young plant likely to grow into a tree, has been counted, the result being a total of 569,031.

Plantations.	Number of trees actually found on enumeration.
Dodabetta	226,936
Neddivattam	208,780
Pykara—	
Wood	45,758
Hooker	87,557
Total ...	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.

Classification according to species.

This may be considered as two-fold, 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 inquiry and record in the ordinary working of the plantations, and will be greatly facilitated by the sub-division of the blocks, and knowledge of the total number of trees in each.

Results.

According to the above classification we have the following :—

Descriptions.	Numbers actually found on classification.
Red bark	260,837
Crown bark	305,432
Yellow	552
Grey	1,874
Other species	336
Total ...	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.

Classification according to age and growth.

To arrive at the second classification, according to age and growth, I have measured 30 or 40 average trees in each sub-division, and struck an average for the year's planting, the girth measurement being taken at breast high, or about 4½ feet. Where trees of more than one description occurred, in any quantity, in a sub-division, the average measurements of each were taken.

Results.

The results are as follows :—

Year's 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	18⅔	...	...	...	17	11	...	...	...
1863	14½	16⅓	...	...	...	10⅛	11⅓	...	...	...
1864	12⅔	15⅔	...	...	...	10⅛	9⅔	...	...	...
1865	19¾	14	...	20⅓	...	11⅔	8½	...	8	...
1866	17¾	10½	...	...	...	11⅓	6½	...	...	...
1867	12⅔	9⅔	...	...	...	8	7¼	...	...	...
1868	14⅔	11	...	...	...	8	7	...	...	...
1869	12	8¼	...	15½	...	7	4½	...	6⅔	...
1870	9⅓	7⅔	...	...	...	6¼	4½	...	...	...
1871	...	...	...	...	...	...	...	...	...	...
1872	...	5	...	...	...	...	2⅓	...	...	...
1873	...	9	...	...	...	...	3½	...	...	...

The above statement is compiled by taking the averages of the several sub-divisions in all the plantations in each year's planting and finding the means. The averages vary greatly in separate sub-divisions, 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 23¾ 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 sub-division in which they occur in any number they are sickly and fast dying out.

Existing circumstances of each Plantation.

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

Propaga-

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. 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.

Nurseries.

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.

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

Dodabetta.

Elevation, soil, &c.

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

Rainfall and temperature.

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.

Sub-division and enumeration.

I divided the plantation into 39 sub-divisions, 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

Number and description of trees.

Crispa. There are many varieties and hybrid plants which require careful observation and study to define the species to which they belong.

Cultivation.

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 sub-divisions, 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. 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 sunlight decreased the amount of alkaloids in the bark. Besides this they are exposed to the full force of the south-west monsoon.

Northerly exposure best.

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.

Manuring.

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 Pykarra 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.

Harvesting the bark.

Yield.

The yield last year was as follows :—

	lbs.
Natural crown bark	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. :—

	lbs.
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.

The supply of moss is obtained from the sholas on Dodabetta, Snowdon, and the neighborhood, 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 Rupees 1-13-0, viz. :—

	RS.	A.	P.
200 lbs. of moss as above	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 1-7⅛ 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 Annas 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 Annas 1-10·8 as the *average* cost for all the plantations.

Drying and packing the bark.

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 Annas 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 Annas 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. Arbuthnot and Company, at a cost of Rupees 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 Annas 4 each per diem. This makes the cost of this carriage Annas 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 Rupees 6, or rather less than Annas 1 per lbs. 100.

Cost of collection and carriage.

Thus the Dodabetta bark costs about Rupees 12-1-8 per lbs. 100 or Rupees 271-2-1⅗ 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. :—

	RS.	A.	P.
Cost of collection and mossing per 100 lbs.	10	1	1⅘
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
Total ...	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., Rupees 8-11-6⅘ per lbs. 100 or Rupees 195-6-3⅓ per ton, making a total charge of Rupees 20-13-2⅘ 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.

Neddivattam.

Elevation, soil, &c.

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 Wynad tableland. 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*, *Melastomaceæ*, &c., and, according to Dr. McPherson, "the exact same small fern which covered the plants imported by Mr. Markham."

Rainfall and temperature.

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 the 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.

Sub-division and enumeration.

I divided the plantations into 29 sub-divisions, 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

Number and description of trees.

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.

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 Wynad and Ouchterlony 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 18⅔ inches. 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 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

Growth of the red barks.

Crown barks.

Yellow barks.

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 description 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 *Calisayæ* nor *Micranthæ*, both from Caravaya, have done well anywhere on the Nilgiris, whereas the *Succirubra* and all varieties of *Officinalis* which come from Ecuador, 10 degrees further north, have succeeded.

Manuring.

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. Subsequently stable manure has been applied in various portions of the plantation, exercising apparently a favorable 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.

Harvesting the bark.

With the exception of the few limited experiments in coppicing, 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 sub-divisions 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 sub-division,"—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 three or four times, and those known as the 1,000 experimental trees, *C. succirubra*, in Sub-division 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 paragraph 8 of G.O., R.D., No. 274, dated 20th February 1878. The bark is everywhere renewing freely, and the trees show no outward signs of deterioration from being subjected to the stripping process.

Mr. Rowson's estimate of trees barked in 1877-78.

Number of trees to be barked in current year.

1,000 experimental trees barked six times.

Yield.

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

	LBS.
Natural crown	9,400
Mossed do.	9,662½
Renewed do.	4,962
Natural yellow	1,845½
Do. grey	150
Do. red	11,748
Mossed do.	16,407
Renewed do.	14,090
Dust do.	58
Mixed	181
Total ...	68,511

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

	LBS.
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 amoui will be kept.

Moss supply and cost.

The moss supply is derived from Government sholas at the head of the Ouchterlony Valley and towards Pykarra bungalow. Mr. Rowson estimates the cost of collection, barking, and mossing at Annas 1-7·86 per lb. of dry bark, of which the collection costs Annas 1-0·6 and the labor of stripping and mossing Pies 7·80. The total cost per pound is therefore very similar to that at Dodabetta (Annas 1-7⅓) and may be accepted as correct.

Cost of collection and carriage.

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 mossing, drying and packing (including bags) and carriage to Mettapolliem amounts to Rupees 14-15-6⅔ per lbs. 100, or Rupees 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, Rupees 23-11-1⅔ per lbs. 100 delivered in London.

Pykarra.

Situation of Wood and Hooker estates.

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 154·1 acres. The circumstances of both being very similar, I shal consider them together. The highest elevation is 6,200 feet a

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 subsoil 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.

Elevation, soil, &c.

Rainfall and temperature.

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.

Sub-division and enumeration.

Number and description of trees.

Cultivation.

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 10 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.

Growth.

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 or less covered with lichen.

Crown barks.

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 favorable to the growth of *C. officinalis*.

Grey barks.

The 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 shown signs of general decay, chiefly attributed to moisture at the roots caused by leakage from a water-channel above.

Red barks.

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 are

Extension. excellent specimens. 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 10 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. 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. 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. The yield last year for both estates was as follows :—

	LBS.
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
Total ...	31,495

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

	LBS.
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.

Moss, supply, and cost. 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 Annas 1-4·03 per lb. of dry bark collected as compared with Annas 1-0·05 at Neddivattam, or, if we include the barking and mossing the trees, Annas 2-3·05 per lb. as compared with Annas 1-7·86 at Neddivattam and Annas 1-7·33 at Dodabetta.

Drying and packing the bark. 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. 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.

Cost of collection and carriage. The total cost of collection, drying, packing, and carriage of the Pykarra bark is given by Mr. Rowson at Annas 2-9·09 per lb. of dry bark. On this estimate it costs Rupees 17-13-4⅕ per lbs. 100 or Rupees 399-7-10$\frac{2}{25}$ per ton at Mettapolliem Railway station. The estimated cost per. 100 lbs. delivered in London would be Rupees 26-8-11 as compared with Dodabetta Rupees 20-13-2⅘ and Neddivattam Rupees 23-11-1⅕. 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 :—

Plantation.	Cost of collection per 100 lbs. of dry bark.	Cost of collection, mossing, drying, packing, and carriage to Mettapolliem per 100 lbs. of dry bark.	Remarks.
	A. P.	RS. A. P.	
Dodabetta	1 7·33	12 1 8	Exclusive of all charges for supervision, office, buildings, &c.
Neddivattam	1 7·86	14 15 6⅘	
Pykarra (Wood and Hooker).	2 3·05	17 13 4⅕	

General condition of the Plantations.

Trees generally healthy. 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 form. I ascribe this to the situation being too low, subsoil 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.

The detailed statement of enumeration (Appendix A) exhibits also a large percentage of renewals (chiefly in Dodabetta plantation) and failures. The worst sub-divisions 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. micranthæ* and *C. calisayæ*.

In the case of the *C. micrantha* on the Wood estate I believe they suffer from overmuch 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 the 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 *Micranthæ* and *Calisayæ*, 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.

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.

The plantations are very well supplied with roads, which greatly facilitates their sub-division 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.

Comparison of the Mossing and Coppicing Methods of Harvesting.

Limited extent of coppicing experiments.

Circumstances under which experiments were carried on.

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. I visited the

Neddivattam plantation with Mr. Cockerell in 1875 and was shown the coppicing experiments. 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 Dodabetta, 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.

As regards the *total* yield in a period of eight or ten 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 31 lbs. of dry bark every two years, this will give 15 lbs. in ten years, whilst, under the coppicing system, granting that we get slightly more, say 4 lbs. on first harvesting, we cannot, I think, calculate on a larger yield on second crop, which would give 8 lbs. in eight years, or say 10 lbs. in ten years against 15 lbs. by the mossing system; but on these points we have really no sufficient data, and we have nothing to go upon regarding the second 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 system.

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 realizing 15*s.* 7*d.* and, *unmossed crown* 13*s.* 9*d.* against *renewed crown* 13*s.* 5*d.*, although the highest price 15*s.* 8*d.* was for *mossed crown*. For red bark the unmossed (natural?) fetched the highest price 11*s.*, whilst *branch* realized 9*s.* 3*d.* and

renewed 9*s*. 2*d*. per pound, whilst in the account sales of Neddivattam red bark for 1877-78 just to hand, *Renewed* heads the list at 4*s*. 4*d*. to 5*s*. 10*d*.; next comes *mossed* at 2*s*. 6*d*. to 2*s*. 9*d*., and *unmossed* (natural) bark last at 1*s*. 7*d*. to 1*s*. 6*d*. Turning to the latest analyses of crown barks by Dr. Paul, we find *natural* bark from Dodabetta trees of thirteen years old yielding 4·11 of crystallized quinine sulphate, and that of nine and ten-year old trees 2·90, whilst *mossed* bark from ten and eleven-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.

Latest analyses of crown barks.

Results varying and uncertain.

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 14,327 lbs. of dry bark in seven years, a yield which I do not think could be reached under any circumstances by the coppicing system.

Advantages claimed for the barking and mossing system.

Yield.

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.

Quality.

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 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 and the latter in 1864. Some of the former sections do exhibit decay in the wood, due apparently to careless barking and consequent damage to the cambium layer. 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.

Effects of barking and mossing on growth.

No external signs of decay visible.

Comparison of sections of barked and unbarked trees.

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.

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 without moss uncertain.

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.

Objections to the barking and mossing system.

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. The drying difficulty may be got over by local manufacture from the bark in its green state, the best method of treatment 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

Their consideration.

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

mmary. 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.

OOTACAMUND,
10*th July* 1878.

OOTACAMUND, 31*st August* 1878.

From

THE PRESIDENT AND MEMBERS OF THE
CHINCHONA 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.

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.

It seemed so important to obtain the evidence of Dr. G. King, Superintendent of the Chinchona 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.

As stated by the Government of India, the main object which the Government had in view in the establishment of chinchona 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.

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.

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.

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.

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 utilizing the bark for the use of the population at a reasonable cost.

(*c*) The consideration of Captain Campbell Walker's report on the present condition of the Government chinchona estates on the Nilgiris, and other papers relating to chinchona.

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

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."

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.

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.

It was shown by the Committee that the 445½ lbs. 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 chinchona bark (*paragraphs* 18 *to* 25). It was further demonstrated that the commercial value of the 445½ lbs. 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 lbs. 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 lbs. of sulphate of chinchonidine, or 2,055 lbs. of sulphate of chinchonine, by which means, fort he 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).

The original estimate of the late Mr. McIvor was that red chinchona bark could be produced on the Nilgiri estates at a cost of 6*d.* (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 6*d.* per pound referred only to expenses of cultivation and collection.

With the subject of local manufacture again reopened, 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.

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.

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 (lbs).	Cost per Pound.
					Rs. A. P.
1875-76	44,657	49,018	93,675	65,170	1 7 0
1876-77	70,875	50,495	121,370	103,341	1 2 9
1877-78	68,681	53,645	121,676	138,807	0 14 0

The estates are probably now in full bearing, and considering the present age of the trees, we do not think it probable that the estates will in their present state yield more than 200,000 lbs. of bark yearly.

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 lbs. 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.

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.

We wish to note here that cultivation of chinchonas on the Nilgiris being entirely experimental in the first instance, was necessarily more costly than it would have been if there had been

* The area under chinchona, 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.

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 chinchona culture both in Southern India and Ceylon. Costly as the cultivation has been, the realized 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.

The cost of production of bark has been very much less than on the Nilgiris. Nearly the whole of the cultivation in Darjeeling is of the red bark (*succirubra*), 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.

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.

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).

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.

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.

Under the direction of Mr. Wood, the Quinologist to the Bengal Government, a temporary manufacturing establishment was organized 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 chinchona 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 manufacturing 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.

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

Quinine (crystallisable)	15·5
Chinchonine	33·5
Chinchonidine	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."

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 lbs. 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.

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 chinchona bark, quinine, chinchonine, chinchonidine, 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 chinchonidine very nearly so; and that sulphate of chinchonine, 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.

If the separated alkaloids of chinchona have by severe tests been proved to possess the power of curing malarious fevers, and if the chinchona 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.

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 chinchonine and chinchonidine, 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 chinchona 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 tests" of the Pharmacopœia.

But while admitting the medicinal value of amorphous chinchona 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.

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.

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

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

"We are unanimously of opinion that although the chinchona 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.)

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 chinchona 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 chinchona alkaloids which stops short of the crystalline form." (*Paragraphs* 57 *and* 58.)

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 chinchonidine	... ...	8 „
Do. of chinchonine	... ...	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 chinchonine is considered a nauseating component), it should be not only effective, but popular with all classes.

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 lbs. of sulphate of quinine (bleached)	... at	79	4	=	317	0
8 „ of do. of chinchonidine	... „	21	0	=	168	0
9 „ of do. of chinchonine ...	... „	6	0	=	54	0
21 „ 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.

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.	chinchonine sulphate	...	2	0	1
29·0 do.	chinchonidine sulphate	...	6	1	6
17·0 do.	amorphous ...	...	0	10	10
	Total	...	21	0	5

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.

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 chinchonidine can be obtained from the European manufacturers for less than Rupees 20 a pound.

In nine-tenths of the fever cases of India chinchonidine 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 chinchona alkaloids required for the use of the public service and the poor, to whom it may be necessary to issue febrifuges gratuitously.

It has been objected that with a steady demand for chinchonidine and chinchonine 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.

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 chinchona 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 chinchona production will be one of the chief industries of the hilly country of South India and Ceylon.

It seems to us that in its dealings with the produce of the chinchona 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 chinchona 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.

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.

"Other Modes of utilising the Bark for the use of the Population at a reasonable Cost."

In regard to this branch of our labors, we are unanimously of opinion that no simple preparation of chinchona 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 chinchona 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.

A preparation of bark has recently been advocated by a chinchona 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. The 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.

"Report of Captain Campbell Walker and other Papers."

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. 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 chinchona 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.

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 chinchona is a phenomenon that brings us to the threshold of a new department of inquiry and research, which might be profitably entered upon by the scientific officers entrusted by Government with the progress of the experimental culture of the chinchonas."

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 hybridisation 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. Chinchona 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."

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.

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.

APPENDICES.

APPENDICES.

APPENDIX A.

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

GENERAL.

Question.	*Answer.*
What species of chinchona are cultivated on the Bengal Government estates, and what number is there of each species?	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. succirubra.	3,286,000	These are the only species actually cultivated.
„ *calisaya* ...	* 354,500	
„ an unnamed hybrid ...	21,000	
Cin. officinalis...	25,000	These are mere relics of past cultivation: none of these three species is being propagated now.
„ *micrantha.*	20,000	
„ *pahudiana.*	5,092	

Have you any experience of hybrids, and if so, what is your opinion as to their productive qualities in respect to alkaloids?	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 hybridisation, I am not prepared to say. I do not myself know of a single form of chinchona of which the

* 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.
	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 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 chinchona 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 chinchona *sp. ignota*.
Are you of opinion that valuable varieties may be produced by careful hybridisation?	In selecting forms for cultivation we guide ourselves by analysis of bark and by habit of growth. We have never practised hybridisation. The recent observations of a German botanist (Herr Kuntze), who visited

Question.	Answer.
	lately both the Java and the Sikkim plantations, lead me however to believe that carefully conducted experiments in hybridisation 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.
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 chinchona under your charge? If so, will you kindly favor the Committee with the available information?	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.
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 chinchona barks according to the ages of the trees?	
Have you any facts to show that after 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?	
What is the average percentage of alkaloids in the Bengal red and crown barks respectively, viz., (*a*) Red stem bark. Red root bark. Red branch bark. (*b*) Crown stem bark. Crown root bark. Crown branch bark.	I have no figures for crown bark, which has been a failure with us.
What are the relative proportions of the several alkaloids in the red and crown root barks under your charge?	For *succirubra* the question is answered in the tables given as a foot-note on page 48 of my Chinchona Manual.
Does your experience lead you to presume that manuring and careful cultivation generally will have any influence in increasing the amount or	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. Manuring does not appear from our experience to increase the amount of alkaloids in red bark, but it improves the health and increases the

Question.

altering the kinds of alkaloids produced by a chinchona 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?

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

(*a*) Red bark.
(*b*) Yellow bark.
(*c*) Crown bark.
(*d*) Grey bark.

What is the average yield of bark per tree of

Red
Yellow
Crown
Grey

(*a*) by coppicing?
(*b*) by uprooting?

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

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

With reference to coppicing, what experience have you—

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

Answer.

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.

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.

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.

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.

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, 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.

Question.

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

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

Answer.

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.

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.

Further Questions submitted to Dr. King.

Question.	*Answer.*
Will you kindly favor the Committee with such information as you possess in regard to— (1) The extent of private chinchona culture in Sikkim? (2) The present condition of private enterprise? (3) Your opinion in regard to the future extension of private cultivation?	There was never more than one private plantation in Sikkim entirely devoted to the growth of chinchona, and that was and is still owned by the Darjeeling Chinchona Association. But in several tea gardens in the district, patches of chinchona (chiefly *succirubra*) were put out some years ago. And in these and other gardens avenues of *succirubra* trees were planted along roads. The Chinchona 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 Chinchona 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 chinchona 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 chinchona trees, do any trees now remain. (2) I do not know of a single garden in Sikkim (except the Government plantation) on which chinchona 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 chinchona 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

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

Question.	*Answer.*
	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.
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.	(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 chinchona 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[illegible]re in good leaf, are com-p[illegible]e from flower and seed, have [illegible]at girth fairly well, and stand r[illegible]larly and close together. I have seen nothing in any private chinchona plantation better than a large patch of *succirubra* in the Napier estate or than the fine piece of the same species near the Neddivattam 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

Question.

Answer.

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. 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 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

Question.

Answer.

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 neighboring 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 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

Question.

Answer.

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

Question.

Answer.

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, 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 Neddiwattum and on the Balmadies 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,

Question.

Answer.

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.

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 uprootal 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

Question.

Answer.

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.

(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 chinchonas 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 chinchonas 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 position 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 C.

During the progress of the investigations of the Committee, they expressed a wish that Dr. King and myself should visit the several Government chinchona 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. The subjects noticed in these notes are as follows :—

Neddiwattum plantations—present state and future prospects.
Pykarah do. do. do.
Dodabetta do. do. do.
Yellow barks.
Grey do.
Supply of seeds and plants to planters.
Coppicing and mossing.
Hybridisation.
Valuable species of varieties of chinchona deserving of attention.
Decline in the amount of alkaloids in Nilgiri barks.
Appendix to Notes on Dodabetta estate.

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. Some of the later plantings of red bark, such

* 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.

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.

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.

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 chinchonas 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 5½ lbs. † In appended notes, under No. 4, there will be found remarks regarding a tree coppiced in 1873, which we uprooted with the 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 lbs., roots 5 lbs., total 11 lbs. 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

* See page 70.

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

and that referred to as No. 1-A were planted in 1863, and each has been barked once. Their yield of bark was as follow when uprooted :—

	No. 1-A, a semi-sickly tree.	No. 5, a healthy well-grown tree.
	lb.	lb.
Root bark	4	4
Stem	7	10
Branh	4	9
Total ...	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 :—

		lb.
Coppice shoots (of Nos. 1, 2, 3, and 4)	5 *years old* (average) ...	1·100
Semi-sickly tree, No. 1-A,	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 :—

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

For further particulars, see notes

Yellow Barks (*Chinchona 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 neighbourhood 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 neighbourhood of Neddivattam. 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 Deyala District of Wynad, but time did not permit of our inspecting them.

Grey Barks (*Chinchona 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 chinchonine. 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 Neddivattam seeds are collected and the propagation of young plants carried on to meet those demands. The price of seeds is at present Annas 4 per ounce, and of plants Rupees 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. 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, chinchonas 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 loss 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 chinchonas 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 laborers, 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.* 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 Neddivattam 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

---

* 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.

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 chinchonas, 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 chinchonidine. 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 chinchona culture.

VALUABLE SPECIES OR VARIETIES OF CHINCHONA.—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. 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*. 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 Neddivattam 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-leafed 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 barks; 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 NILGIRI 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 Neddivattam, 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 shows a deficiency in alkaloid of each of the three sorts, the renewed and unmossed showing 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 shows 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 chinchonidine 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 alkaloids constituents of chinchona 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.

OOTACAMUND,
31*st August* 1878.

G. BIDIE, M.B.

APPENDIX TO NOTES ON DODABETTA ESTATE.

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

No. 1-A.

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 lbs.	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 lbs.

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 lbs. 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 lbs.

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

	lbs.
No. 1 stool coppice bark	8
„ 2 do. do. do.	5
„ 3 do. do. do.	3
Total ...	16

Average yield of bark per tree $5\frac{1}{3}$ lbs. 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. 1-A, 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 :—

	lbs.
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. 1-A, 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. 1-A. 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 :—

	lbs.
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. 1-A, the total harvest in that case having amounted to only 15 lbs.

G. BIDIE, M.B.

OOTACAMUND,
15*th 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	26
April 6th and 11th ...	659	...	515	...	99	1,273	...	...	...	170	170	264
April 25th	313	...	1,495	56	331	2,195	...	...	...	9	9	60
May 4th and 9th ...	281	...	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
July 27th and 1st Aug.	184	...	690	39	156	1,069	...	...	47	6	53	97
August 10th and 15th ...	182	...	557	335	7	1,081	...	...	99	...	99	97
August 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
January 25th and 30th ...	217	45	66	18	259	605	...	...	3	49	51	14
February 12th and 13th ...	561	25	264	67	209	1,126	...	...	10	17	27	66
February 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
March 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
May 17th and 24th ...	576	207	404	...	559	1,746	...	32	...	75	107	101
June 14th and 19th ...	216	140	679	15	118	1,168	...	108	76	108	292	72
June 28th and July 3rd.	710	12	...	74	83	879	...	85	1	78	164	15
July 12th and 17th ...	246	...	11,28	...	57	1,431	...	...	3	27	30	19
July 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
August 23rd and 28th ...	361	300	1,256	86	140	2,117	28	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	278
November 29th and Dec. 4th.	254	21	938	163	185	1,559	29	74	590	...	693	161
December 13th and 18th ...	311	104	944	130	58	1,547	65	...	16	...	101	240
Total ...	7,965	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 Chinchona 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 Commissariat.	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.	Value of Convict Labor.	Interest on Balance of Charges.	Total.
	1	3	4	5	6	7	8	9	10	11
	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.	Rs. A. P.
1860-61	...	...	...	...	...	...	4,821 5 0	...	...	4,821 5 0
1861-62	...	...	...	...	...	...	22,914 15 4	...	216 15 4	23,131 14 8
1862-63	...	...	...	...	...	...	48,390 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	1,43,267 11 7
1867-68	...	287 8 0	...	287 8 0	26,087 3 1	2,600 0 0	43,295 14 4	48,666 10 8	19,687 7 6	1,40,337 3 7
1868-69	...	...	1,680 0 0	1,680 0 0	25,671 7 10	2,030 0 0	30,636 1 0	46,666 10 8	27,779 7 8	1,34,783 11 2
1869-70	1,512 6 4	...	...	1,512 6 4	25,783 5 4	1,650 0 0	19,163 0 0	...	33,769 2 3	80,365 7 7
1870-71	4,364 14 8	3,479 3 6	323 14 0	4,688 12 8	23,730 5 4	300 0 0	6,143 0 0	...	37,317 8 6	67,490 13 10
1871-72	9,542 12 8	4,388 2 1	...	13,022 0 2	17,157 5 4	850 0 0	13,160 4 9	...	40,143 10 0	71,311 4 1
1872-73	16,806 15 8	36,417 6 3	227 1 4	21,422 3 1	12,724 0 0	550 0 0	16,441 0 0	...	42,786 10 3	72,481 10 3
1873-74	21,136 7 0	...	300 9 0	57,854 6 3	12,574 0 0	558 0 0	15,091 14 0	...	45,064 5 1	73,288 3 1
1874-75	8,576 0 0	...	273 4 0	8,849 4 0	16,406 8 0	1,700 0 0	17,417 0 0	...	45,758 13 5	81,282 5 5
1875-76	...	60,404 7 11	2,000 0 0	62,404 7 11	17,234 0 0	1,550 0 0	27,423 0 0	...	49,618 5 3	95,225 5 3
	61,939 8 4	1,04,976 11 9	7,254 12 4	1,74,171 0 5	2,63,793 2 3	18,513 0 0	4,89,257 0 7	1,46,000 0 0	3,78,724 13 1	12,96,287 15 11
	...	4,33,746 9 4	3,058 5 6	4,36,804 14 10	12,467 7 2	...	58,408 14 10	...	50,495 4 3	1,21,371 10 3
1876-77	...	...	...	...	...	...	...	...	...	...
	61,939 8 4	5,38,723 5 1	10,313 1 10	6,10,975 15 3	2,76,260 9 5	18,513 0 0	5,47,665 15 5	1,46,000 0 0	4,29,220 1 4	14,17,659 10 2

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
	12,43,488 9 9
Deduct receipts of 1876-77	4,36,804 14 10
Net charges up to 1876-77	8,06,683 10 11