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John Knott, M.D.

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HANDBOOK

OF

CINCHONA CULTURE.

A HANDBOOK OF CINCHONA CULTURE.

BY

KARL WESSEL VAN GORKOM,
Formerly Chief-Inspector of Cultures in the Netherlands East Indies.

TRANSLATED BY

BENJAMIN DAYDON JACKSON,
Secretary of the Linnean Society of London.

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Translator's Preface.

The following pages are a translation of the portion relating to Cinchona, published last year in the author's "De Oost-Indische Cultures in betrekking tot handel en nijverheid". My endeavour has been to give as close a rendering of the original as lay in my power, and I have chosen rather to run the risk of occasional awkwardness, than to express the author's meaning by periphrasis. This treatise being intended for practical men, I have tried to present the following record from a practical man, with the fewest possible changes; I have even adhered to slight peculiarities of arrangement, or division of sentences, with that end in view. I trust, therefore, that those readers into whose hands this volume will come, will kindly excuse any seeming inelegancies of style.

There is no need for me to bespeak attention on behalf of Heer van Gorkom; for he is too widely known as the energetic director of Cinchona culture in Java, and the author

—

of the success of the government plantations in that island, to require any advertisement at my hands In the narrative, which will be found in the proper place, it will be seen how much of the present splendid position of the Javan enterprise, is due to the indefatigable perseverance of the author: — it was he who found the culture in a depressed and languishing condition, from which he was able to raise it, and place it in its recognised high position.

The early history of Javan Cinchona culture has been lightly dwelt upon in Chapter IV; a full account of this phase of the undertaking will be found in Dr. De Vrij's "On the cultivation of Quinine in Java and British India". London, Eyre & Spottiswoode, 1865. 8°. pp. 27.

A few notes will be found scattered throughout the volume, which have been added by me, and are marked as such by my initials. They are usually reductions of foreign measures and weights to English standards, but occasionally they supply information of later date than the text.

Whilst this translation has been passing through the press, the seed of a new variety of *Cinchona Calisaya*, has been introduced into the London market. This, termed "Calisaya verde" is stated to be very vigorous in growth, thus resembling *C. succirubra*, and its yield of bark is very much larger than that of, *C. Ledgeriana*, although its percentage is only two-thirds of the best Ledgeriana. Its greater robustness and quickness of growth, are stated to give it a preference when planting, even over the choice Javan variety.

The Index which ends the volume has been compiled with a view to practical use; if I had indexed every mention of Cinchona the Index would have assumed an inconvenient length. Each important paragraph, will, I trust, be found set out in such a manner that the searcher for information may readily find what he requires.

B. DAYDON JACKSON.

30 Stockwell Road,
LONDON, S. W.
November 1882.

CONTENTS.

ERRATA.

Page 8, *line* 2 *from bottom, for* averdupois, *read* avoirdupois.
„ 14, „ 17 *for* governement, *read* government.
„ 32, „ 24 *for* height, *read* heights.
„ 33, „ 3 *from bottom, add* B. D. J.
„ 40, „ 28 *for* naturet, *read* nature.
„ 103, „ 17 *for* iudividuals, *read* individuals.
„ 149, *last line, two letters have been dropped, read* houses.
„ 170, *top line, for* content, *read* contend.
„ 171, *line* 25 *read* happen only in.... &c.
„ 211, „ 6 *for* nomenelature, *read* nomenclature.
„ 211, *last two lines, for* enough recognise, *read* have recognised.

HANDBOOK

OF

CINCHONA CULTURE.

CHAPTER I.

INTRODUCTORY REMARKS.

Cinchona has assumed an increasingly weighty position, amongst the newer colonial productions which have recently acquired significance in the markets of the Netherlands.

Previous to 1870, only a single sale by auction had taken place in the Netherlands, and this was due to mere accident, and not to direct importation. It consisted of a more or less damaged parcel from a vessel laden with Cinchona bark which had become subject to average, and was therefore compelled to discharge cargo in one of the Dutch harbours.

The results of this sale appeared satisfactory, and testified that articles of commerce in request do not need to be confined to a fixed market, but find a ready sale wherever the existing needs can be provided for.

The centres of the Cinchona trade at the present time are established in England, France and North America; as to the Dutch market, a continually increasing significance has been assured since 1870, provided it is supported and conducted by skilful brokers, and if the State does not permit itself to be induced to disturb the natural movements of the trade, by charges and formalities. We shall consider each of these more at length in the chapter devoted to the Cinchona trade.

In Cinchona we have a subject of wide extent. Indeed, it comprises not only important questions of production, trade and industry, but has also in a high degree to do with botanical, medical and chemical science.

Thirty years ago, ideas about the origin, differences, use and application of Cinchona, were very vague; they formed a mere chaos of contradictions. Little by little, this state of things has come to an end; in proportion as the field for important investigations was enlarged and sufficiently extended to admit of observation and attention to the most important phenomena, a clearer light was shed over the whole.

Even at the present time, if many points are not fully cleared up, at least they no longer escape attention, but are recognised as objects for accurate investigation. Every year brings us nearer to solutions of manifold and indisputable importance

Having devoted my best and strongest years in the field of experiment, that the before-named Cinchona questions might be brought out more clearly, it will be readily understood, why I entertain a certain predilection for the subject The history of it teaches that the labour is crowned with a satisfactory return. This explanation is not meant as self-adulation; but it must be borne in mind, that I shall by and by have to speak, principally on the ground of personal exertions and experience; exaggerated modesty indeed might as in this case, actually do haım to the public interest.

CHAPTER II.

EARLY HISTORY OF CINCHONA.

As a remedy, especially as a febrifuge, Cinchona bark was known in South America, as far back as the beginning of the seventeenth century.

Tradition states, that an Indian, who was lying helpless in the wilderness, sick of a violent fever, and urged by burning thirst, dragged himself to a pool of water, which he spied close at hand. When he had quenched his thirst, he felt his strength gradually return, so that he was able to get up and return home. The relation of his experience excited no small surprise, as no approved remedy had yet been discovered for intermittent fever, itself one of the most dreaded diseases. No wonder, therefore, that a desire to know about the case, caused the place itself to be visited. The bitter taste which the water had, seemed, after long search, to be owing to the bark of one of the trees lying in the pool, which was similar to several living specimens in the vicinity, and further on in the virgin forest.

The natural consequence of this discovery probably led to experiment with the wonderful bark, at first on the part of the natives themselves on due occasions, but later, when Europeans had learned the remedy, methodically and on a larger scale, on the fever patients in hospitals.

In 1636 the wife of the Viceroy of Peru, Don Luis Geronimo Fernandez de Cabrera y Bobadilla of Mendoza, fourth Count Del Chinchon was lying ill of fever, when the corregidor (town governor), Juan Lopez de Canizares, recommended the use of bark in the form of powder. This was followed by complete recovery.

If the whole story seems more legendary than historical, it gives in either case a very probable explanation of the manner by which the bark became known as a febrifuge; an explanation which possesses more probability than all traditions relating to the first knowledge of coffee and tea. In 1639 Count Del Chinchon despatched a scientific expedition having Texeira as its commander, to the Cinchona regions. We are indebted to the Jesuit, Cristoval de Acuna, who formed part of this expedition, for important communications and illustrations, and also for the first earnest attempts to diffuse the knowledge of the bark in a wider circle. In 1640 the family Del Chinchon removed to Europe, and naturally took the opportunity to bring with them a considerable quantity of the marvellous bark in powder.

How great a value was already attached to this remedy appears from the fact, that Dr. Juan de Vega, who accompanied the Viceroy, sold a pound of the powder for 100 dollars!

In honour of the noble countess who made this precious remedy generally known, and who generously distributed it, it was named *pulvis comitissae.* When later the Jesuits encouraged the diffusion, it obtained the name of *pulvis jesuiticus.* In Rome, where it was introduced by Cardinal Juan de Vega, it became known as *Cardinal's powder*, and in France it appeared as *Poudre de Talbor* (medicamentum Talborii, seu anglicum) after a certain doctor Talbor, who about 1671 brought it over from England, and sold it as a secret remedy to Louis XIV for 2000 Louis d'or.

In the language of the Incas it appears as Quina, China,[1] Kina or Kina-kina, febrifugal bark; and Quina-Quina (from which the French name Quinquina is derived) indicated specially efficacious bark.

The first description of the tree, from which Quina-Quina seems derived, was given by La Condamine, who travelled

[1] Markham states that this is a Spanish corruption. B. D. J.

through a part of South America in 1737—1738. He named it Quinquina de Uritusinga (Quina primitiva, our modern *Cinchona officinalis*). As early as 1742, Linnaeus established the genus Cinchona, and he called the species described by La Condamine, *C. officinalis.* At a later period Kunth, in Humboldt and Bonpland's 'Synopsis', changed it into *C. Condaminea,* but Hooker restored the Linnean name, which to this day is generally received.

In proportion as Cinchona bark became known and valued, the exports from the country producing it increased, and it happened frequently that the quality of different parcels varied so extremely, as to create doubts regarding its use and application. Thus gradually it came to be understood, that various barks from different species were mixed together.

The interests of merchants and pharmacologists were really concerned in a fuller knowledge of the subject, but nothing better could be arrived at, than that attained by botanists themselves, from investigations and researches on the Cinchona trees; indeed, the confusion in quinological matters continually increased as the number of searchers became greater, whilst their vanity and jealousy spurring them on, trade mystifications became yet more involved.

> Karsten writes: — "Whilst, on the one hand, botanists uncertain of the knowledge of species, intentionally complicated matters, on the other hand pharmacologists went astray in the endeavour to distinguish Cinchona barks widely distributed in commerce under manifold names, assigning them to species hardly known and altogether undescribed by botanists, supposing that the barks of all Cinchonas were met with in commerce."

We leave these accusations against scientific men entirely to the account of the eminent German professor. The same view is taken by the famous French Quinologists, Delondre and Bouchardat, where they assert: —

"The influence of mercantile trickery went so far, that at Cadiz, by the king's order, a large quantity of the best orange Cinchona, collected by Mutis at the king's expense, was burnt, whilst in all the Spanish hospitals there was the greatest scarcity of this precious product of America. A parcel of this Cinchona, intended for the flames, was secretly bought at Cadiz by some English merchants, and sold in London at high prices."

However this may be, the fact is, that as soon as the healing power of Cinchona bark became widely known, and the enquiry for this article gradually increased, a source of riches for South America was opened up, and the exploitation of the Cinchona trees assumed ever widening proportions.

The harvest of the fever-bark in the primeval forests of America is really an expedition. Experience, courage and perseverance are indispensable requisites for those who engage in it, and who form a special caste.

The collectors, known under the name of *Cascarilleros*, unite themselves into gangs, under the direction of a *major-domo*, and work on their own account, or as more often happens engage themselves on behalf of particular people or companies.

From the moment the working party sets out, it is exposed to continual dangers and endless hindrances; what they seek is only met with in distant, desert, inclement mountain regions, where all progress through the wild, formidable interlaced vegetable growth, has to be won by cutting a path, foot by foot, with the hatchet.

Days even weeks, sometimes elapse, whilst the party is engaged in endless climbing up and down, and environed by dangers and hindrances, before a single Cinchona tree is met with in the thick forests.

It is not seldom that the heaviest work then begins. The collectors are surrounded by a crowd of forest giants, inaccessible because of the strong, many, branched web of *llianas*, and by numbers of creeping, climbing and thorny plants, which must as a rule be cut down in order to clear a tolerably large space before one of the wished for trees can be felled and barked. The forest-clearer in the wild forest regions amongst the high mountain ranges in Java, can form some idea of the difficulties and troubles mentioned.

The most experienced *Cascarilleros*, the *Diéstros*, form the pioneers in the search. These people seem actuated by instinct, nothing escapes them, a handful of leaves carried by the wind on to their path, or the peculiar lustre of a leaf-tip, are for them sufficient signs of recognition to lead them in a direct course to the tree sought.

If a district is considered suitable for working, a sleeping hut is set up, and the ground cultivated so as to afford, during the uncertain time of their stay, some such food as maize, and pease; the men afterward scatter themselves in groups or single file in all directions so that the collection may be carried out over an extended field. The *major-domo* remains behind with a few people in the primitive headquarters, as much to guard these, as to dry and sort the barks successively brought in. The bark of slight thickness, from branches and slender stems, is sufficiently dried by the warmth of the sun alone, and rolls inward like quill cinnamon. For drying heavy, thick pieces of bark, sometimes assistance from fire heat is necessary, or else, during dry favourable weather they are stacked like firewood, and the mass weighted with stones. The latter manner of drying yields, as a rule, the thick flat bark of commerce. As soon as a tree of considerable dimensions is felled, the trunk and thick branches are deprived, by brushing, of their uppermost layers, and subsequently divided into equal portions by circular incisions. [1]

Between the incisions, the bark is afterwards cut lengthwise,

[1] It will be hereafter shown, that by this brushing the actual value of the bark is really diminished, without it being so considered or perhaps even conjectured by the natives.

lifted up and gathered, as far possible, in pieces of similar dimensions, one after another.

This cleansing with brushes is not done to the bark of the smaller stems and branches; these consequently retain their upper layers and mossy covering. The latter has been long considered a valuable means of recognising to what species the bark belongs, and still, at the present day, by druggists at least, it is highly prized.

The dried bark is packed in a light cloth, and transported by the Cascarilleros themselves, or by means of mules, to the houses of business. Here it is packed anew, either in cases, tubs, drums, or more usually in ox or buffalo hides, with the hairy side turned inwards. These hides, wholly or partly fresh, or at least purposely wetted, gradually draw together strongly, and thus firmly secure the packed bales, or *serons*. A seron weighs about 70 to 80 kilograms, [1] and, as a rule, contains a great admixture of barks, or at all events it is not sorted according to form and thickness, etc. The hides themselves have a marketable value and are turned to good account.

It is evident that so careless and crude a method of collecting, renders the separation of the various barks extremely difficult. Formerly the opinion was held that all barks came from one kind of tree; the produce therefore could only differ in shape and size, as it was obtained from the larger or smaller stems and branches. This opinion was not universal; on the contrary some even thought that the heavy pieces came from an entirely different species from the light ones. The customary trade names were of no use in determining their identity, these being derived from the colour, local origin, port of shipment, and the like, and thus little decisive or explanatory. The confusion became greater, when it was made known, that the

[1] In English averdupois, from 1 cwt. to 1¼ cwt.; for practical purposes, a kilogram may be reckoned as 10 per cent more than 2 lbs., and 1015 to the English ton. B. D. J.

Cinchona trees consisted of various species and varieties, and that to botanical descriptions of these species were mixed up, and confounded with the commercial names. The worthless names, which gave no information either of the parent-trees which yielded the bark, or of a still more important matter, the quality of their bark, were still retained.

As subsequently we shall see, science has been able, thanks to the bringing over of the Cinchona to the Dutch and English colonies, to disclose, or at least to make clearer, most of the mysteries; and it is known now that not only very many species and varieties of Cinchona exist, each possessing its own special form and composition, but that even the composition varies in the same species or variety, so that thougt the actual value of a bark may be approximated by means of the microscope, it can only be completely asçertained by chemical analysis.

It will be readily understood that the nearest and the most productive of the Cinchona districts would be first worked out, so that the workers must go farther and farther to find other advantageous spots. The rough manner in which they always went to work, chiefly thinking of present gains, could only lead to local exhaustion and extirpation. Primeval forests may maintain themselves, but the conditions, into which the Cinchona trees were brought were as a rule very unfavourable. Control and supervision were absent, and the care absolutely needed for Nature to restore and build up again, was wanting.

There was much wasted; for as long as abundance lasted for the covetous, there was no thought of economy in gathering the bark.

Delondre, who visited the Cinchona regions in 1816—17, wrote thus concerning them: —

> "On descending the mountain, I could not help lamenting the indifference with which the Indian delivered his axeblows at a certain height above the ground, so as not to have the trouble of stooping. It is the same in all the

South American forests; they also leave the trunk at the point whence the branches spring, and it may be generally calculated that only one half of the bark is collected which each tree could furnish." (Delondre & Bouchardat, "Quinologie", p. 21).

If a tree is felled at the surface of the ground as usually happens, under favourable conditions it is able to shoot up again and form new stems, of somewhat more slender dimensions; but the Cascarilleros did not permit of these favourable conditions, and even where these new shoots did show themselves on the prostrate trunk, numberless hindrances still interfered to prevent their further developement.

Cinchona seed is extremely fine and light, the sport of wind and weather; even if it reaches a fertile soil in the thick primeval forests, the chances of its germination, and the success of the tender plant in the struggle for life, are very small.

That the government for the time being, should have framed no regulations to guard against unnecessary loss and eventual extirpation, may seem strange indeed and greatly to be deplored, but it is apparent that the South American States have been constantly involved in political difficulties, which hinder manifold efforts or a strong policy. They are persuaded of the inexhaustibility of their resources, and are opposed to any organisation for a decisive forest-policy in the extensive chain of the Andes. Thus much is certain, that the existing governments have always had an eye to present rather than to future profit. At one time they burdened the exports of Cinchona with duties, granting the right of working to a certain company, and at another time forbade any exportation whatever. A systematic exploitation joined to simultaneous maintenance and proportionate replenishing by new plantations, whenever it has been taken into consideration, has never come to anything. For the first time, quite recently, as will be seen from a report of the Dutch Consul-general at

La Paz, Heer Schuhkraft, a systematic cultivation, of Cinchona has been attempted in its mother country. [1]

* *
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The classic land of the Incas, since its discovery and conquest by the Spaniards, though already a favourite country for investigation by naturalists and historians, enjoyed much increase of business after the indigenous Cinchona was found, and a number of learned men went thither, simply to accurately study the Flora of the country. Amongst the travellers who have specially devoted themselves to the knowledge of the Cinchona tree of South America, and who either as writers, or as collectors of material, have rendered themselves deserving of notice, we may mention: —

C. L. de la Condamine (1737—38), J. de Jussieu (1739), Santesban (1755), Mutis (1760—1800), Renquifo (1772), Ruiz (1790), Caldas Zea (1800) Pavon (1801), Tafalla (1802—08), Humboldt and Bonpland (1807), Bergen (1822), E. Poeppig (1827—32), Weddell (1843—48), Delondre (1846—48), Hasskarl (1853—54), Scherzer, Markham, Spruce, Pritchett (1859—61), Warczewicz, Triana, Rampon, etc. etc.

We do not attempt a bibliography of the subject *Cinchona;* a summary of the existing literature would bear the marks of incompleteness so numerous are the published works and scattered articles. If entertaining, instructive, and ample reading be wanted, the following may be consulted.

H. A. Weddell, "Histoire naturelle des Quinquinas". Paris, Victor Masson, 1849. C. R. Markham, "Travels in Peru and India", London, John Murray, 1862, and the splendid work published by L. Reeve and Co., J. E. Howard, "The Quinology of the East Indian plantations", London, 3 parts, 1876.

[1] Cultivation has also been attempted at the present time in the republics of Ecuador, Venezuela and New Grenada, it seems, even so far as importing rich species, by using seed collected in Bolivia.

With these special recommendations, we do not wish to prejudice the many other highly deserving writers and compilers. The works named give, however, the most complete natural historical and scientific summaries, by which most practical needs may be satisfied.

What we know meanwhile about the earliest history of Cinchona, by no means bears the stamp of absolute certainty, or even of completeness; this indeed was hardly possible.

Before the advent of the Spaniards in South America, there was naturally no notion of methodical search. When the medicinal virtues of Cinchona bark became known in whatever manner, to Europeans, they very decidedly aimed at diffusing this remedial agent, and it can readily be believed that its diffusion by various persons about the same time, and to its being tested in various ways, have given rise to the contradictions which have been recorded concerning the subject. The main point remains, that the discovery took place during the first half of the 17th century, and that its blessings have extended to civilised people, and will extend more and more to mankind at large.

No single scientific traveller has been able to learn all that the Cinchona regions, in their full extent may offer. Perchance in many places the forests which formerly sheltered the Cinchona tree, were already destroyed when the first investigators found them, and thus complete certainty cannot be attained concerning its original, natural, and geographical distribution, although on the other hand, botanists happened to state the fact, that various species of Cinchona existed and were met with there. In relation to the real remedial properties of the various species, gross darkness prevailed, until the moment when chemistry came forward to help, and by separation of the alkaloids (1820) indicated the only trustworthy means of recognition.

The noteworthy and fruitful journey of Dr. H. A. Weddell, is first of all, known on account of its important results [1].

Weddell drew serious attention, to the danger attending a continuous, irregular, uncontrolled exploitation, and it is above all due to his unwearied pleadings and his admirable writings, that the French government concluded to introduce the Cinchona tree into its colonies. This was the first powerful impetus given to the further acclimatization trials.

From a practical standpoint, (which we must as far as possible endeavour to vindicate), we have now to follow up the history, with reference to the explanations of Weddell and others, which led, as mentioned later on, to the importation of Cinchona cultivation into the colonies of European States

During the years 1845—48 Weddell was occupied with an investigation regarding tbe natural occurence of the Cinchona tree in South America, the description of the species, and the methods by which it might be cultivated.

Commenting on the recklessness with which the primeval Cinchona forests were cleared without any check, and expressing, as indeed many before him had already done, the fear that some day would see a necessary want of genuine Cinchona he says: —

> "There remains the resource of cultivation, and it must be employed. If there is a tree worthy of acclimatization in a French colony, truly it is Cinchona, and posterity will bless those who shall have carried out such an idea."

In the report of MM. de Jussieu, Richard and Gaudichaud read before the French Academie des Sciences, the following passage occurs: —

> "We can only recommend experiments, and it is the duty of government to make them, for although we have no exact

[1] In April 1877 Weddell took an important part in the International Congress at Amsterdam. Not long after the intrepid traveller died (in his 60th year); to him mankind owes an eternal debt of gratitude, for the impulse which he gave to the acclimatization of Cinchona.

data as to the number of years required by the tree for the bark to reach its maximum yield and perfection, we may calculate upon a tolerably long time, and the profits are too uncertain, and much too distant, to engage private industry in such attempts."

We must pay attention to this declaration, for it induced the French governement to undertake acclimatization trials in Algeria, which compelled other nations to follow that example.

The inducement to introduce Cinchona cultivation in the East Indies is thus explained, and we do not need to add to it anything further.

In the year 1869 an investigation set on foot by a scientific commission of five persons, ascertained the increasing scarcity of genuine Cinchona barks in America (see "The Andes and the Amazon", London, Sampson Low). In 1870 Dr Kerner, the wellknown chemist of Zimmer's quinine manufactory at Frankfort, in his "Beiträge zur Kenntniss der Chinin-Resorption" (Bonn, 1870, printed by Carl Georgi) dwelt with emphasis on the ever diminishing arrivals in Europe, of good barks, especially those rich in quinine.

Since the discovery of the special febrifugal properties of Cinchona bark, the seat of the alkaloids, and their separation earnestly attempted, the arrivals of this product have not actually diminished, although naturally we are more informed as to its percentage, and anon the figures given will plainly show that, though South America is very far from being exhausted yet, still a very unfavourable proportion may be increasingly remarked between the arrivals of the barks which are rich, and those which are poor in quinine.

So much apprehension was excited that South America at some time would fail to yield Cinchona, looking to the augmenting use of quinine, that the French Academie des Sciences, as already stated, offered a high premium for the preparation of this indispensable alkaloid, by the method of synthesis. Up to the present time there has been no indication of adjudication of the premium, but in another chapter we shall show that the idea is not abandoned, and really the intention seems now likely to be realised.

Many travellers and writers at different periods have pointed out the danger of a slow, but sure extirpation of the Cinchona trees in their native land; others on the contrary, believed that the primeval Cinchona forests were almost boundless and not even fully known, and further that Nature herself was competent to maintain this valuable plant.

We most decidedly side with the first declaration to a certain extent; although the occurrence of Cinchona trees (which in each case appear confined to limited areas not as yet fully understood), can with difficulty be compared, for example, with the distribution of the coal beds.

What the care of Nature means, we may sum up in a single word, our doubts and small expectations.

* *
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Under date 30 March 1865, Heer Schuhkraft, the Dutch Consul-general at La Paz, reports as follows: —

> "When in 1860, the prohibition on export was taken off, which is known to have been in force for eight years (in Bolivia), the exploitation of the forests and the exports there during 1861—63, amounted to about 50,000 Spanish quintals, of 46 kilos, [1] averaging 55 dollars per quintal on its dispatch from Bolivia.
>
> "To this must be added five dollars per quintal, export duty, and another five for packing and shipping charges in Peru, etc.

[1] A Spanish quintal would thus amount to 3 Qrs 17 lbs. B. D. J.

"The value of the exports, free on board in the Pacific Ocean may thus be estimated at 4,000,000 dollars, or about £ 650,000.

"The exports are chiefly consigned to England, but in consequence of the war, the United States have transmitted considerable orders, and the remainder goes to France and Italy.

"This trade has yielded the best results for all concerned in it; from the Indian labourer who fells the tree, strips off the bark and dries it, and the house exporting it in Bolivia or Peru, to the firm in Europe which receives the consignment. La Paz was the centre for this trade, to which all the Cinchona procured by the workmen from the forests, was brought to market."

Thoughout the entire report, mention is constantly made of the extent of the Bolivian trade, and the great profits thence resulting. No complaints were made of reckless exploitation, nor fear of extirpation, but, on the contrary, of local difficulties which made themselves felt in increasing measure. Schuhkraft was of opinion that the exploitation of the Bolivian forests must be stopped, whenever the prices ranged low as a consequence of the supplies from Columbia and other places. According to his notions the tree was not extirpated in Bolivia; but it was found only at constantly greater distances, and this naturally made the transport much more costly. He considered it illusory to expect the existing government to open up roads. Since 1863, several private individuals endeavoured to export Cinchona by the Madeira and Amazon rivers, viâ Para, on the Atlantic Ocean. The costs of carriage were so slight, that the Cinchona transport by that route could be delivered on board at Para, at most at 40 dollars per quintal.

The success of these attempts ought again to assure the first place for Bolivian Cinchona, and to the supplanting of all other sorts in the European markets!

Meanwhile, there appeared to be very great difficulties against this method of transport, and certain parcels of Cinchona, brought to Europe via Para, were found not to be the genuine *Calisaya*, and were therefore worthless.

The price of good quality Cinchona at La Paz, was 52 dollars per quintal.

In 1865 also, on the authority of a thoroughly competent judge, (in opposition to many earlier and later declarations of scientific travellers,) there was no positive fear of the rapid exhaustion of the valuable primeval Cinchona forests, but on the other hand, there was threatening competition, and the enhanced expense of exploitation.

In 1873 Schuhkraft sent to the Dutch government, an admirable map, wherein were indicated as far as possible, the previously mentioned Cinchona regions, with observations about their extent at the time, and of exploitation in the various forests. This illustrated representation gave but little real support to the loud and repeated lamentations about a rapid extirpation. It is quite evident though, that where no care is taken to maintain the forests, or to plant new, the future must be positively menacing. A new point of view is thus opened up by the report of our zealous and able Consul-general for the year 1878. In this Schuhkraft says: —

> "The great event in the agricultural region of Bolivia, is the planting of the Bolivian Cinchona forests, of which an earnest beginning was made in 1878, not by official pressure, but by a genuine initiative of the land owners and other private persons. The high prices of the last three years, and the reports of the Cinchona cultivation in India, have at last awakened here the spirit of enterprise. The river Mapiri, in the province of Larecaja, department La Paz, has been the centre of the movement, and already the young trees of two years growth, may be reckoned at from four to five hundred thousand.

"The Songo and Challana valleys in the same province which turn out equally fine quality Cinchona, number also some plantations, though of less importance. In the province of Yungas, the districts from Coroico and Coripata to the Casones river are being energetically planted, and an extensive valley where there still exist numerous groups of bushes, stumps, and shoots from old stems, called the Quinuni valley, has by purchase passed into the hands of private persons, who intend to close it for some years, to allow the young plantations to grow up.

"Planting is done in two ways; that which is done on private estates (*haciendas*) and that which takes place on government land (*terrenos baldios*). Excepting the Quinuni valley, and the lands on the Mapiri and Casones rivers, all that I have mentioned are private property, and formerly were divided into *haciendas*, whose principal produce were, coca, coffee, cacao, sugarcane, bananas, etc., These were cultivated from the foot of the mountains to three-fourths of their height, whilst the Cinchona tree was found in the forests which crown the summits, or in the mountain gullies (*quebradas*). The regions, formerly under cultivation, may properly be termed semi-tropical. The trees found there, on account of their near proximity to La Paz, were the earliest to be cut down, and later on, when the bark became dearer and scarcer, the collectors were driven into the tropical parts of the forests lying towards the interior, and not yet brought into cultivation; consequently on the land belonging to the state, the groups of trees have mostly disappeared.

"The former crude way of working is known; the tree was 'cut over' at the height of from one to two feet above the ground. The branches, which for a long time were not known to be actually richer in alkaloids than the stem itself, were cut off and left as worthless to rot upon the damp earth."

(As the testimony of experiments and chemical investigations in Java will show, Schuhkraft has here made an evident error. It can now be asserted quite positively, that the bark of the branches is in no case richer in quinine, than the stem of the same tree.)

"Merely the trunk was stripped, sometimes only on the side lying uppermost. If it was too heavy, or cost too much trouble to turn it over, it was allowed to lie half stripped."

(This declaration is in accordance with the experience of Weddell, Delondre and other travellers.)

"Similar stems, naturally of great value if they are not entirely rotted, ought at the present day, to be not infrequently found in the forest. The stumps remaining in the ground, again shoot out like willow trees, and from these stumps, shoots, branches, bushes, and here and there the young stem of a neglected or hidden tree, during the last ten years since the thick stems have been exterminated, quilled Cinchona has been obtained, which formerly no one besides the quinine manufacturer knew, but now is generally known, to be richer in salts than the stem bark."

(This opinion is not confirmed by experience gained in cultivating Cinchona in Java and elsewhere. The percentage of quinine is by no means dependent on the form of the bark, but on the contrary is closely connected with the kind of trees, from which it has been obtained. Thick barks preserve their original shape sufficiently in drying, if they are not cut too wide, in which case they curl up somewhat, whilst lighter, thinner barks roll together in drying.)

"When the price at La Paz, owing to excessive competition, reached 225 dollars per quintal, equalling about 8 francs[1] per kilo, free on board at Mollendo, in order to bring a few more pounds of bark to market, the collectors began to dig out the stumps and roots entire, so that exter-

[1] That is, about 3s. 2d. per lb. English. B. D. J.

mination would have been completed, if it had not been that only low prices were offered in trade for this description of Cinchona, and thereby no profit could be relied on, by which in some measure the ravage was at least confined within limits.

"The systematic replanting on private estates, was done cheaply enough. The contract between a Yungas landed proprietor and his Indian agricultural labourers (*peones, colonos*) for ages has been as follows. Each household receives a piece of land with dwelling in usufruct, and its members bind themselves to perform field labour on behalf of the *hacienda*, for 2, 3 or 4 days in each week, in return for wages of 4 to 5 reals for each man, $2^1/_2$ to 3 reals for each woman or child (13 to 16, and 8 to 10 Dutch stuivers respectively [1]) per day; the remaining days in each week, the colonist or peon is free to employ upon his own allotment. A few days in each year suffice to clear the ground for beginning a Cinchona plantation, to put out the plants from the nurseries, and to keep the ground free from weeds, one year, or at most two years. After that, the trees can take care of themselves. Such a Cinchona plantation costs the proprietor little or nothing.

(When we proceed to treat of the cultivation in Java, it will appear that there it is less simple and more expensive. If experience in Bolivia merely dates from 1878, we fear that time will bring forth disappointment; we willingly admit the Cinchona in its native country may show itself less susceptible and tender, than it does in those countries where it has been acclimatized, or even become naturalised.)

"In the regions still uncleared on the Mapiri, the undertaking requires greater labour and more capital. The land must be acquired of the state. The requisite petition is called a *denuncia*, and contains a description

[1] The Dutch stuiver is equivalent to an English penny. B. D. J.

of the land declared to be *baldio* (*vacans ager*) and a list of witnesses to testify that it is not private property. After the witnesses have been examined, there follows a valuation on behalf of the state, and thereafter a sale by public auction, at which the petitioner enjoys a certain preference or choice, above other bidders. Onesided preference always plays a great part in these grants. If the petitioner is an insignificant person, without influence or influential friends, his letter of request is apt to be delayed. On the contrary some lands are valued at low assessments, and, as in the case of the Quinuni valley, as good as given away. This valley, probably 10 German miles in extent [1] was given over to a private planter for the sum of £ 100, and a still larger estate on the Mapiri river, for £ 250.

"Planting on such land is done by contract with natives of inferior standing, who usually want advances, and in their turn sublet the actual work to Indians, thus acting as middlemen.

"The work chiefly consists in making ready the ground, which usually presents itself as thick wood. First of all, the trees, saplings, and plants, are cleared off the ground, piled up, and after some weeks, when they are considered dry enough, are burnt.

"The entire procedure is termed *la rosada.* During the time this is going on, the nursery, exposed to free currents of air, but lying partially sheltered, is sown with a liberal hand, and when the young plants are a foot high, they are considered fit to transplant. The cleared land or the so-called *rozadero* is cleaned a second time of weeds; the cuttings (the writer means the seedling plants) are put out in rows, at 5 to 6 feet from each

[1] If 10 German Geographical miles are here meant, this would be a fraction over 46 English statute miles in length. B. D. J.

other, bananas being planted here and there, to afford shade for the first and second years, and then the middleman by means of his Indians, looks over the ground from time to time, and keeps it in good order. From March to June is the most suitable season for beginning, for then the rains are over. A year after planting, the plantation is delivered over, the withered cuttings (read: young plants) are pulled out, and those remaining are counted. For each yearling plant the middleman receives two reals, or about seven Dutch stuivers [1]. According to this scale, the cost of planting on the Mapiri should be as follows:

Rent of land, 3000 francs; 300,000 plants at 35 cents = 105,000 francs; overseers, erection of dwellings, etc. 10,000 francs; for interest the second year at 10 % on 120,000 francs = 12,000 francs. Total 130,000 francs [2].

"It has already been stated, that cutting can begin in the fourth year, though I doubt this, and it is most likely that the bark on account of its young state, would possess but little quinine, for it appears to be an established fact, that, the older the tree, the richer it is in salts (read: alkaloids), and this explains probably the hithertho paltry percentage in Javan Cinchona, obtained from the seeds sent by me in 1865 (read: 1864)."

For a correct understanding, we must here introduce a few remarks. The reader is aware that there is a disagreement between the declaration, that the Cinchona tree is richer in alkaloids in proportion to the age reached, and the earlier statement, that the branch-bark is more powerful than the stem-bark. It is evident that in the same tree the branch-bark must in its entirety be younger than the stem-bark, and hundreds of ana-

[1] Sevenpence. B. D. J.

[2] Amounting at par, to £ 5,200 sterling. B. D. J.

lyses have shown, that a tree needs a certain time for the formation of its maximum percentage of alkaloids, though, at the same time, there is a limit which cannot be exceeded. Now it has already been mentioned that Schuhkraft's first dispatch of Cinchona seeds, reached the Netherlands in 1864; half were sown in that country, the other half were sent on to Java. This was the origin of the *Calisaya Schuhkraft* trees. The first plants were put out in the open ground in Java in July 1865, and at Lembang, Nagrak and Tjiniroean, there must still be some specimens which have thus reached the age of fifteen years.

Thus there was ample opportunity for determining the percentage of alkaloid at various ages, and analyses were carried out, and have decisively shown, that though the *Calisaya Schuhkraft* yields an excellent pharmaceutical bark, yet it cannot as a rule come into consideration, for the preparation of quinine, on account of its small percentage of that alkaloid.

„On the Mapiri plantation there are already some plants, which were put out earlier than 1878, and the proprietors affirm, that from these and two-year-old plants, they have already obtained 300 quintals of quilled Cinchona, say 13,800 kilos, and thus received back a part of their capital, though this seems to me to be only boasting."

Here also an explanation may be desirable. Since Schuhkraft has not informed us "from how many trees the 13,800 kilos were obtained", naturally we cannot judge, how far the produce was profitable. But in Java there are Cinchona trees 3 to 4 years old, developed under favourable conditions, which, while fit for harvest, have not yet attained their maximum per centage. It is evident that only quilled bark could be obtained from such young individuals, for it would be still thin, and thus curl up on drying. It is new information that the quilled form can be any criterion of its quality, it is rather the contrary.

"After delivery by the middleman of a number of 20, 30, or 40,000 plants, the buyer has to bear all risks, and must now commit the superintendence and proper maintenance of the ground to his subordinates. In the first and second years, the plant is exposed to two dangers, namely, drought, and destruction by ants; after that time there is no further danger from these. The drought which prevailed in 1879 throughout Bolivia (in India and Europe on the contrary, there was great complaint of the unusually wet weather) killed thousands of plants in Mapiri."

Once more we must venture a remark. It occurs to us, that there is a connection between the two dangers specified, drought and ants.

Schuhkraft says that plants are put out, when the rainy season is past. If this rule prevails, it is not to be wondered at that the young plants suffer from drought; we notice little provision for an artificial watering, where all the industries seem to be highly primitive and superficial. The young plants have thus slender chances for actual, robust development, and under these circumstances they are much exposed to influences from without, or from ants, to which they can offer but little resistance. If the plants were turned out some time before the rains, probably less loss would be suffered.

"Already new experiments have been made on young trees, to strip the bark and preserve the trunk, by ripping it off in long strips by portions, and leaving the trunk to cover itself with bark by another year; in other words, not to strip the stem once for all, but partially and at different times. The experiments through, have given the conviction, that it is better, as of old, to cut over the stem at one or two feet above the ground and to bark it entirely, for when the stump remains in the ground, it generally shoots up again."

The partial stripping of the tree by cutting out strips, was first tried by Mc Ivor in Madras, and distingiushed as *strip-*

ping, in contradistinction to *coppicing* or cutting down to the stump. The trees bore the operation well, provided it was done with care; Mc Ivor even contrived a special knife for it. To the stripping process was soon added the plan of *mossing;* the exposed portions of the stem were covered with moss, and from this it was expected not only would there be a more complete and quicker regeneration of bark, but also an enhancement of the alkaloid percentage. The experiments were crowned with complete success, and were carried into practice on a large scale; indeed the *renewed* and *mossed* bark, has, from the very first, in British India possessed a higher value. As to the various methods of harvesting the bark, we shall naturally recur more at length.

"Whether the planting in Bolivia (to which the planters in Java cannot be indifferent), will be earnestly prosecuted, depends partly on the market prices of the ensuing three or four years; if these fall in consequence of the increasing exports from the East Indies, or from other causes, then the enthusiasm will speedily cool, and give place to the old indifference and neglect, the more so, as the available labour in the Yungas, scarcely suffices to work the more profitable and surer coca plantations (we suspect that coca cultivation is said to be more lucrative, because the produce is greatly in demand on the spot, and thus does not require high transport charges, which make Cinchona bark so dear) besides, the increasing wellbeing of the *peons* or *colonos* of the *haciendas*, following upon high coca prices, makes them more and more independent of the landowners, and Chinese immigration is still unknown in Bolivia. Further, there prevails a feeling of insecurity, as to whether private property will be respected, or the law be powerless to prevent pillage on what were once state lands, but are now in private hands. The questionable origin of the newer possessions, and the doubtful right of the proprietors, are but too well known, and under a change of government it could easily happen, that for the existing Cinchona bark-cutting classes in the provinces, the plantations should be considered as public property, and no difference pleaded as to the earlier condition, when the felling of the forests was allowed.

"To oppose force by force, and to defend one's own property weapon in hand, would be permitted, though the European proprietor might be found wanting in such a struggle. Even with a favourable concourse of circumstances, I do not think that the replanting of Cinchona trees in Bolivia, need awaken great concern in Java. With absolute security for property and life, peace and order, capital going hand in hand with earnest spirit of enterprise; planters so situated can afford to sustain competition with a land where all these factors are wanting, and where no attention is paid to what has been done in Java; the plant here (in Bolivia) being endemic, all theories and experiments are held to be superfluous."

We cannot wholly endorse this opinion. We have already briefly stated, that in the different South American countries, various kinds of Cinchona are met with, which vary greatly in quality.

From the seeds which we repeatedly received in Java from Schuhkraft, which were thought to be product of the best variety of *Calisaya*, there were no trees derived which possessed a high percentage of quinine, and we have no reason to suspect that that species has degenerated in Java. It is true that in 1873 Schuhkraft sent us likewise, a parcel of bark samples, and the richest specimens appeared to contain 3.02 % of quinine, an amount which is also found in some of the Javan *Calisaya Schuhkraft* and *Javanica* but appears always higher in another variety of *Calisaya*, the *Ledgeriana*, which also was received from South America.

It seems to us that the great question remains, viz: — "which can yield the richest bark", and up to this time, commerce has received from the native country of Cinchona no produce that can compete with the *Ledgeriana* bark from Java.

This strangely sounding fact demands an explanation, and is we think, found. An actual and regular survey of our subject is however desirable, and this we give in the chapter devoted to the species cultivated in Java.

> "It is also by no means certain that the method of planting in rows like coffee trees, instead of groups amongst other trees as Nature seems to require, is not entirely wrong, and this plan will probably yield as a rule produce poor in salts (read: alkaloids) A bark yielding less than 2 % quinine, as export produce from Bolivia, is for trade, as good as worthless, and plantations of similar trees are good for nothing. Thus success is by no means sure, and in every case, the chances are every bit as much in favour of the Javan, as of the Bolivian planter. If however, this part of Bolivia were annexed to Chili, then from the stringent regulations of that country, an entirely different result might be expected, which would have serious effects upon the Cinchona cultivation in Java."

Although the Cinchona trees are met with in their natural state under and amongst their brethren of the thick, primeval forests, it is not thereby proved that only under analogous circumstances can they be planted out and thrive. Junghuhn clung to the opinion here enunciated by Schuhkraft, but ripe experience gained in Java and British India, tells quite another story. Every cultivator knows that plants put out under the shade of great, heavy trees, or, in thick, sombre forests, cannot come to proper development, setting aside the numberless dangers to which they are constantly exposed in the forests. Young plants want more light and air than they can get in such surroundings. Whatever may be known of the original occurence of the Cinchona trees in the American forests, it must not be forgotten that they form part of the forest itself, and are developed under the same conditions as their surrounding neighbours. This circumstance agrees more or less with the commencement of a Cinchona or coffee plantation, the plants and the sheltering trees growing simultaneously, and it is well to distinguish this from putting out young individuals in an already complete, thick forest, which dominates over the soil, light, air, and entire surrounding.

There is one supposition which might fairly be entertained, in conjunction with the fact, that Cinchona trees never form entire forests by themselves in their natural state, as for instance the *Djati* (teak) in Java, but are always accompanied by other trees, the supposition namely, that with an accumulation of Cinchona plants, perhaps the individuals might be deprived of an opportunity of forming their full amount of quinine. Against this, however experience acquired in close, regular plantations of *Cinchona Ledgeriana* and *C. officinalis*, has already sufficiently declared, and microscopical, united to chemical investigations, have also taught with certainty, that the alkaloid formation holds the closest connection with the anatomical structure of the types. Very strongly, indeed indisputably is this fact shown by the results of grafting, to which we shall hereafter recur in detail.

That barks having less than 2 °/₀ are worthless for export, is quite possible as regards Bolivia, because the cost of transport is very high there, but that such inferior barks must be worth as much to Bolivia, as to the other South American states, from which they are exported in quantity, is comprehensible without gainsaying.

The East Indian barks with less than 2 °/₀ of quinine, appear well worth exploitation and export; it is also true, that barks with less than 2 °/₀ of quinine may still be very suitable for the separation of this alkaloid, and are used for want of better, provided that separation is not hindered by too great a quantity of secondary alkaloids.

"The total export of fine factory Cinchona bark in 1879, from the port of Mollendo, merely amounted to between 300,000 and 350,000 kilos, half of which was derived from the province Caupolican, the extreme north of Bolivia, which tends to show that there the extirpation of the trees has not yet reached its climax as it has in the Yungas.

"A portion of the Caupolican bark is not Bolivian in a geographical sense, but is brought from the neighbouring province of Carabaya, belonging to Peru. Peru forbade cutting any Cinchona bark throughout the entire republic, doubtless with the intention after a certain time, of forming an *estanco* or monopoly of this produce, though the fruitlessness of these attempts having been recognised, the government of Peru by decree of December 11th, again permitted the cutting, on condition that every person engaged in this industry should plant ten trees in the forest annually, an ordinance which remains, and will remain, a dead letter. This is much to be deplored, for were such a regulation stringently maintained, it would effectually take away all fear of extirpation. The southern provinces of Santa-Cruz and Cochabamba yield an ample supply of false Cinchona bark possessing no quinine, and worthless for the manufacturer, but it serves for the fabrication of another very useful product in Europe, the so-called quinine-wine. Of these trees, from which I am doing my best to obtain seeds, is to be discovered as yet no trace of any diminution, although the yearly exportation of the bark exceeds 200,000 kilos, the average value being about three gulden per kilo [1]. The price of fine quill factory Cinchona varied in 1879 from 180 to 225 dollars per quintal free on board at Mollendo, equalling 15 to 17 francs per kilogram."

This repoıt of our esteemed fellow countryman Schuhkraft

[1] Roughly, about 1 s. 10 d. per lb. avoirdupois B. D. J.

is extremely interesting. From a recently received private report it appears that shortly afterwards, the Bolivian government promulgated a new and amended law as to obtaining state lands, by which the holders are assured of better guarantees.

An explanation is certainly wanted as to Schuhkraft's statement that he was busy collecting seeds from species of Cinchona whose worth he himself considered small [1]. That it is profitable to export barks which are only fit for pharmaceutical preparations, when it is previously explained that barks of less than 2 °/₀ quinine, are as regards export as good as worthless, sounds strange indeed, especially when we take into consideration the situation of the producing regions with relation to the nearest places of shipment Certainly a great difficulty for export from Bolivia, is that produce as a rule must find its way through foreign territory (Peru) to reach the principal, and oft mentioned port of Mollendo. But as the South American barks must be destined for the preparation of quinine-wine, then it will not be doubted that on account of the expense, it cannot remain in competition with the *Succirubra* barks raised in the British and Dutch Indies, which are eminently suitable for that purpose. This species can hardly thrive quicker and more robustly even in South America, than it does in suitable estates in the Indian possessions of both nations, where it can return a rich paying harvest in from 4 to 6 years, provided the prices of the last years do not fall too much.

[1] Letters received at the moment of going to press give us the key to the riddle, and it now seems that I myself can give the clue. I had commissioned de Heer Schuhkraft to collect seeds from various districts, that we might thereby possibly meet with superior kinds for cultivation.

CHAPTER III.

BOTANICAL DESCRIPTIONS. ORIGINAL OCCURRENCE.

The Cinchona trees grow on the eastern slopes of the Cordilleras, or Andes range of mountains, between North Lat. 10° and 22° South Lat., and thus are localised in the territories of the South American States of Bolivia, Peru, Ecuador, Columbia (formerly called New Grenada) and Venezuela. The height above the sea level, at which the trees occur, varies from 1200 to 3270 metres [1], and so extends from the temperate regions to the cold mountain zone. The exact limits cannot be given; on this subject the reports of numerous travellers differ widely, and as all of them furnish what appear to be accurate height measurements, it becomes very difficult to sharply define the places of Cinchona growth, since the exploitation of the trees in the course of time has materially altered and restricted the original limits.

Cinchona trees are usually met with, according to C. A. J. A. Oudemans [2], between 1620 and 2600 metres [3] above the sea. On the testimony of various travellers, who in his opinion had opportunity to become thoroughly acquainted with the subject, Junghuhn accepted the notion, that Cinchona barks were more powerful or effectual the higher and colder the district in which trees grew, on the other hand the less effectual the lower and warmer the locality. Humboldt and others seem to be of the same opinion; Weddell left the question open, and according to our experience in Java, this was very

[1] In English feet, 3937 and 10730 respectively. B. D. J.

[2] Handleiding tot de pharmacognosie van het planten- en dierenrijk. Amsterdam, (C. L. Brinkman) 1880. (Introduction to the pharmacognosis of the vegetable and animal kingdoms.)

[3] Reduced to English feet, 5250, and 8530. B. D. J.

prudent. To confine ourselves to simple fact, we observe that Junghuhn estimated the *C. Calisaya* zone to be between 4500 and 5500 feet, and the *C. lancifolia* zone between 6500 and 7500 feet above the sea [1].

We now know, that amongst the *Calisayas*, some are to be found very poor in quinine, yet to make up for that, the better *Calisayas* are much superior to the best *C. lancifolia*.

Meanwhile, the experiments in India have not as yet given us positive information whether the richness of the various species of Cinchona, or even of the individuals of the same species, is absolutely and by preference, dependent upon the relative situation of the localities of growth above the sea. Nevertheless, it is quite certain that the influences of climate and soil, produce effects upon the growth, development, and duration of the species and individuals [2].

The most westerly point in the Cinchona regions, lies in Loja, formerly called Loxa, the mart of the Cinchona barks of Ecuador, and the native country of *C. succirubra* and *C. officinalis*, South Lat. 4°, and West Long. 62° [3]; the most northerly at Caracas, the chief town of Venezuela, North Lat. 10° 30′, and West Long, 49° [4]; the most southern at Santa Cruz in Bolivia, South Lat. 18° and West Long. 45° 30′ [5]. The entire region thus forms a wide bay, the opening of which

[1] These height are given in Paris feet, and the equivalents in English measure are 4924, 6027, 7113 and 8207. B. D. J.

[2] Junghuhn has himself in a later report, doubted the influence of high situation on the amount of alkaloid, whilst De Vrij remarked that the amount of alkaloid and quinovic-bitter shows itself to vary so greatly in different material, that general conclusions may be derived from it, with some amount of certainty.

The *Cascarilleros* are convinced, that "el arbor qui mira la nevada" (the tree which looks upon the snow) is the richest, and the nearer to the snow the richer! Also the trees met with on the eastern slopes are considered the poorest and this in proportion as they grow lower down, and are more exposed to the mists rom the rivers.

[3] West Long. 79° 52′ from Greenwich. B. D. J.

[4] West Long. 67° 2′ from Greenwich. B. D. J

[5] West Long. 62° 23′ from Greenwich. B. D. J.

is turned towards the east. The whole Cinchona region is estimated to cover a surface of 20,000 square miles, [1] an extent as large as France, Spain and Portugal together.

As to Cinchona forests in a strict sense, there are none so far as we know; the trees are met with scattered throughout the forests. In the territory of Bolivia, the Andes reach their greatest height, and at the same time their greatest breadth. The elevated valleys of the Andes have an agreeable climate; in Peru the Andes divide into two or three parallel chains, which again unite into colossal groups of mountains, and so may be considered to form a series of table lands and high valleys, which average from 3500 to 4000 [2] metres above the level of the sea. The highlands proper have a dry climate, visited however, almost daily by tremendous thunder storms.

Humboldt estimates the average temperature at a height of from 5400 to 7200 feet in the Andes, at 20—18° centigrade [3]. Subsequent observations by Caldas show however, 15—14° centigrade, for a height of 5000 to 8300 feet [4]. Numerous observations taken by Junghuhn on high mountain summits in Java, yield the result that in all zones lying above 6000 and 7000 feet, the temperature falls more rapidly than is the case in similar latitudes in South America, so that thus the snow line would in all probability be lower in Java, and might perhaps be found at a height of 13,000 feet or thereabouts, if mountains of that elevation existed in Java.

The greatest ascertained height there is only 11,500 feet. The difference in temperature can be explained by the isolated situation and conical shape of the Javan mountains, by the excessive steepness of the slopes considered as a whole, and also by the general condition of the island, which is all together

[1] 20 000 geographical square miles, 15 to a degree, are equal to 4,237,522 English square miles. B. D. J.

[2] In English feet, 11, 483 and 13, 124.

[3] In English feet, 5910 and 7880, and a temperature of 68—64° Fahr. B. D. J.

[4] Similarly reduced, 5472 and 9083 English feet. B. D .J.

wanting in the extensive, outstretching table-lands, like those which the continent of South America possesses.

In spite of these observations, and the conclusions drawn thence, Junghuhn supposed that in the temperate mountain zone of South America where the Cinchona trees are met with, especially on the eastern slope of the Corderilleras between 5000 and 7000 feet, that on declivities covered with forest, under similar circumstances, the same, or at least a slightly varying temperature is found, as is the case at similar heights, and on the same, or nearly the same latitude as Java. The difference should by analogy of outward circumstance, be actually not more than one degree centigrade lower than in South America. In the latter country however the temperature shows 3 to 4 degrees more than in the same zone of elevation in Java.

As Junghuhn has pointed out, the similarity of the flora of South America and that of Java at about the same heights is remarkable. That he nevertheless, as much as possible aimed at cultivating Cinchona in the latter at a greater relative height, than it was met with in the former, is explained by the opinion to which he clung so long, that more efficacious barks are obtained from the trees, in proportion as they grow at a greater elevation.

We are involuntarily obliged to speak of the original occurrence of the Cinchona when entering into comparisons with regard to Java; we have come to it by a regular transition, and its intimate connection with our present topic, and thereby spare a longer relation, when we shall presently have to treat of the acclimatization of the Cinchona plant.

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The genus *Cinchona* belongs to the Natural order RUBIACEAE, of which CINCHONEAE form a section.

Cinchonae are evergreen trees or bushes with opposite, decussate, simple, entire, petiolate leaves, having the centre vein strongly developed, and on the under surface, a considerable number of side veins. In shape the leaf varies from nearly circular to lanceolate, the upper surface being with or without hairs. Certain species met with in Java, *C. Pahudiana*, *C. Hasskarliana*, and some varieties of *C. Calisaya* are very hairy; *C. lanceolata* is so to some extent, though this may be considered as identical with *C. Pahudiana*, or almost a variety of it. The leaves of nearly all Cinchona plants of whatever species are hairy at first. The circular leaf is mostly met with in the large leaved kinds, of which we possess in Java, *C. succirubra*, *C. caloptera*, *C. micrantha*, *C. Calisaya*, and its variety *anglica*, and *C. officinalis*, which are divided into almost numberless varieties, amongst which the lanceolate leaf occurs.

In the axils of the primary side veins in some species, for example the true *C. Calisaya*, *C. officinalis*, *C. lancifolia*, *C. micrantha*, and *C. Hasskarliana*, are found little pits, or *scrobiculi*, which exude an astringent juice; in other cases a small tuft of stiff hairs. In the intervals between the insertion of the leafstalks, on both sides of the young branches, there are two crooked, small, supporting leaves, or stipules, which soon fall off, and belong naturally, one to the right, the other to the left hand leaf.

The flowers form at first a dichasium[1] which again forms a rich, feathery, radiating inflorescence, shortly stalked, and provided with bracts. They have further, an inferior, two-celled ovary, with numerous ascending ovules, attached to the partition, a trumpet-shaped sweet smelling corolla, with five oblong or ovate segments, having tufted fleshy hairs, or fringe on the inner surface and along the edges, valvate in aestivation, with a small five-toothed calyx, five stamens alternate

[1] A dichasium is, according to Dr. Oudemans, what was formerly termed a cyme, that is an inflorescence which never gives off moie than two side branches from the axis. The same phenomenon repeats itself frequently in the secondary axes, which themselves branch in the same manner.

with the segments of the corolla, situated either low down in the corolla tube of the long styled flowers, or high up in those of the short styled form, dehiscing inwards by slits, towards a short or long style, which terminates in two stigmas. The flowers of *Cinchona* are thus dimorphic; but whether dimorphism occurs in the same tree, as asserted by some, has never been certainly seen by us.

The fruit crowned with the calyx, is an ovate, oblong or lanceolate capsule, which divides from beneath upwards, the fruit stalk also splitting, springing open with two valves, and contains numerous flat, broad-winged, shield-shaped seeds.

When properly matured, the seeds are brownish yellow or light brown, those of *C. officinalis*, however, are always darker coloured, sometimes chestnut brown. These are also distinguishable by their considerably greater size and weight, and their broader thicker embryo. Well developed capsules contain 12 to 38 perfect seeds, on an average about 25. A thousand well dried seeds, freed from all impurities, weigh from 0.355 to 0.365 gramme, consequently a single seed weighs about half a millegramme. [1]

The seeds of *C. officinalis* however, form an exception; we have not our observations on this point at hand, but we shall not be far from the truth, in estimating them to be from 50 to 100 per cent. heavier.

As regards the odour of the Cinchona flowers, we cannot fairly compare them with any well known European flowers. They resemble the jasmine, as well as the lilac; it is worth mentioning however that, this scent does not occur in every species of *Cinchona*, for it is strongest in *C. Calisaya*, and absent from *C. Pahudiana*. The colour of the flowers, varies from pure white, as in the true *C. Ledgeriana* and *C. micrantha*, through rose, in *C. Calisaya*, *C. succirubra*, *C. Pahudiana* to

[1] One thousand seeds would therefore average, say five and a quarter grains, about one-ninetieth of an ounce troy; a millegramme is approximately 0.1543 of a grain. B. D J.

violet or purple, in *C. officinalis* and *C. lancifolia.* The colour of the leaves is also very varied; ranging from light green in *C. succirubra,* to a darker lustrous tint in *C. officinalis* whilst *C. micrantha* is brownish-green, *C. caloptera* shows a lighter shade, and certain varieties of *C. Calisaya,* such as *Schuhkraft* and *Ledgeriana,* are coloured on the underside of the leaf with clear chestnut brown. Indeed if attention be given to the various shades and shapes of the leaf, even on the same tree, they are found to be so various, that by them alone a species or variety cannot be recognised with certainty.

All the forms, even of the tree in its entirety, seem dependent on a chain of circumstances; it has further been amply ascertained, that *Cinchona* easily degenerates, and passes through innumerable gradations, in consequence of the influences of soil and climate, as well as of hybridization.

The height and age attained by Cinchona trees in South America, are naturally difficult to state, for no one has followed the development-history of individuals; in the East Indies, the cultivation of the acclimatized plant is still of too a recent date to give an answer. However, so far as experience has gone, we shall hereafter show.

In America trees are met with of a height of 80 feet, with a circumference of five feet; on the other hand, there are also bushes merely from 4 to 12 feet high. According to Weddell, a tree of the best description, may yield 6 to $7^1/_2$ *arobas* of dry bark, each *aroba* being $11^1/_2$ kilos; and from individuals of 10 metres high, and 0.6 metre in circumference, an average of 10 kilos is obtained. Plenty of specimens like this, from 10 to 15 years old, can already be pointed out in Java, and we may refer to the information given by S. von Warsewicz, inspector of the botanical garden at Cracow, who made important investigations in America, that *C. officinalis* is a tender species, but it seems to thrive well in Java, growing there as quickly and even taller than in America. Warsewicz was obliged to search eight days in the Cinchona forests, before he found *C. Calisaya* growing as high as 50 to 60 feet.

In the East Indies the most important thing is, that many Cinchona trees there have already attained an age of 20 years, and that their development, where they have been planted and maintained under moderately good conditions, on comparison with other introduced cultivated plants and even with indigenous trees, in our judgment, leaves nothing to be desired.

The Cinchona plant possesses a so called tap-root, like coffee; this form however is only absolute in young individuals, and alters much during the further growth. The roots rarely penetrate deeper than 0.6 metre, and as a rule branch immediately from the collar, in which case, the secondary roots become more strongly developed than the primary or tap-root itself.

CHAPTER IV.

THE INTRODUCTION OF CINCHONA INTO JAVA.

In our historical summary, the instigation towards undertaking trials for acclimatizing the Cinchona plant, was sufficiently set forth. At the instance and by help of Weddell, the French government took the initiàtive in Algeria. At the beginning it appeared as if good results might be looked for; but either the choice of situation was not fortunate, or else the officials were insufficiently acquainted with the needs of the foreign nurslings, so that they were not placed under the most favourable conditions; the experimental planting, therefore, soon went entirely to the bad; according to the official reports they were annihilated by the sirocco.

The English government was no more fortunate in its first attempts, and it was generally thought that the Netherlands in its rich and extensive colonies, possessed the best opportunity with regard to satisfactory results, to venture on a new and earnest experiment. Indeed, the question of a lasting supply from the mother-country of Cinchona, having regard to the uncontrolled exploitation in South America, had taken an international character, in which all civilised peoples may be said to be concerned.

In the Netherlands, the full weight of this consideration was also felt. A first attempt towards bringing over the Cinchona to Java, was made in 1829 by Blume. During the years from 1830 to 1837 the subject was considered also by Korthals, Reinwardt, Fritze and Junghuhn; meanwhile with but little good result.

The government was quite convinced of the desirability of earnest efforts being made, but the conditions of the time could not be called favourable for the prosecution of a task which would doubtless demand considerable pecuniary sacrifices, and of which the results and eventual fruit could not be anticipated.

It is a noteworthy fact, that, when the Director of Cultures in Java, Heer de Vogel, in 1837 drafted model-contracts for issue in hiring waste lands, he was already thinking of the possibility of a special exploitation by private means for Cinchona culture.

But the time for vigorous measure had not yet arrived; men however like Vrolik, Mulder, de Vriese, and Miquel were not weary of calling the attention of the government to the subject and keeping it awake, and it may be added that finally the travels and writings of Weddell, gave an impetus towards a decision which could no longer be restrained, after his increasingly weighty argument, of the real urgency of the case and his exact information given about the ways and means towards succeeding in the quest.

It was reserved for the Minister for the Colonies, Ch. F. Pahud, to undertake and carry out the necessary arrangements for the great work. In the year 1851 Pahud communicated his plans to F. Junghuhn, at that time sojourning in the Netherlands, and already famous as an Indian naturalist. These plans were on an ample scale, and of wide comprehension.

The government wished to send an expert to South America, there to collect seeds and plants and bring them over to Java. Junghuhn was chosen for this difficult but honourable task, and it was expected of him, that he would eagerly seize the opportunity to attain to a thorough knowledge of the country, which had become famous by the classical writings of A. von Humboldt and many others. Junghuhn applied himself assiduously to study all the existing writings and official information, which would conduce to his preparation for this highly important mission, and the satisfactory issue of the subject.

Meantime, the project came to nothing. As Junghuhn testified some years later in his reports, he gave up his commission, and the distinction of the mandate, on behalf of his old friend, J. K. Hasskarl, who had been the colonial botanist during the years 1837 to 1843, and in 1846 was engaged at the state botanical garden at Buitenzorg in Java, but afterwards having been removed from his proper sphere, was at that time in Dusseldorf employed in business, still ardently longing to be replaced in active service, which would satisfy his scientific knowledge and love of Naturet.

What followed need not be detailed. The fact is, that the Dutch government forced the difficult mission on Dr. Hasskarl, whose doings and actions we must now briefly recount.

Difficulties and dangers of all kinds were involved in the commission, for cooperation on the part of the South Americans could hardly be reckoned on. It might rather be expected that every step, and every action which might seem to threaten the maintenance of their monopoly would be resisted, whilst in the distracted political condition of the South American Republics, any foreigner appearing to cherish the design of attacking the most notable and richest source of livelihood, had very little guarantee of his personal safety [1].

Thus the commission required the utmost delicacy of management. Confidence was reposed in a scientific man, who possessed besides courage and hardihood, a strong constitution, experience and hearty devotion.

Hasskarl was sufficiently prepared and ready to start, when a circumstance happened which did not make his task seem easier, and moreover compelled him to be very careful. An interested but somewhat clumsy publicist, unseasonably disclosed the plans of the Dutch government abroad, and it was reasonable to expect that this would be reported to South America, where the inhabitants thus enlightened, would certainly do their best to counteract and frustrate all attempts. Hasskarl's papers were drawn up and made ready, with an eye to these facts and considerations.

The intrepid explorer left Europe in December 1852, as Herr Müller, native of Cassel, living at Amsterdam. Having arrived in the West Indies, he thence travelled over the Isthmus of Panama to Callao, which port after numerous difficulties and perils was reached on the 31st January 1853.

In the West Indies and at Panama yellow fever was then raging, consequently quarantine was observed in the splendid bay of Callao.

A surgeon came on board to inspect the crew and passen-

[1] It appears quite true, by reports just to hand from the heart of the Cinchona countries, that the South Americans are still out of humour at the disturbance of their monopoly. At the present time however it is easy to collect seeds of Cinchona there, although the illusion of thereby getting possession of the better sorts must not be entertained. On the contrary, there prevails a resolute intention, to further the propagation of inferior descriptions outside their own country.

gers. He did ample justice to the abundant table of the steam ship, and probably it was to be ascribed to this, that he did not notice the symptoms of the dreaded disease, which according to everyone else, were plainly to be recognised in one of the passengers; the official doctor saw no danger, and declared everything in order. The quarantine was raised, the passengers disembarked, and the following day, Callao for the first time became acquainted with the terrible yellow fever. The passenger died; Callao was infected.

Herr Müller hastened to leave the place, and turned immediately eastward towards Lima, the ancient royal city, the Paris of South America. Various circumstances here compelled him to a stay of three months, which he turned to profit in acquiring the language of the country, and opening up good connections.

Just at this time, the Peruvian government had the idea of peopling the eastern districts of its territory with European colonists. The distant uncultivated wastes were still for the most part unknown.

Our traveller made good use of this circumstance. He had pretended to travel with a scientific aim, and now agreed to give his best experience and observations, provided the government assured him of its moral support.

Thus it fell out; recommendations were sent to officials and the clergy in the interior; the government therein expressed its desire that all things required by the traveller Müller, should be furnished, and indeed, he thus obtained the best opportunity to procure the necessary knowledge and data.

For more than a year Hasskarl roamed about the Andes, sometimes penetrating to a height of 15,000 feet above the sea[1].

From every point of view, and in ample measure he experienced difficulties, incidental to a waste, unknown, aud very primitive or uncivilised country. There was no lack of dangerous, and some-

[1] In English feet = 16404. B. D. J.

times droll adventures; with all that even in the midst of the Cinchona forests, it seemed still difficult to collect seeds and plants. Now and then, it cost much toil and tact, to dispel arising distrust or to adroitly divert it, and once in that position, there was no end to obstructions and impositions.

Nevertheless he succeeded in getting possession of some seeds, and sent them by trusty hands direct to the Netherlands, and after the turn of the year, several hundreds of young plants were collected, which safely reached the coast, packed in twenty one cases. By a concurrence of accidents, some others dispatched in advance, were injured by neglect at Panama.

At the end of August 1854 Hasskarl was able to embark at Callao with his costly treasures on board the Prins Frederik Hendrik, a war ship sent from the Indies. A heavy task was accomplished, but the series of cares and disappointments was not closed with it.

Sailing in a westerly direction in the Pacific Ocean, they arrived at Makassar, where the war steamer Gedeh took over the charge, and brought it to Batavia on the 13th December 1854.

The concern now was to forward the young plants to the cool mountains as speedily as possible. During the long voyage they had suffered much, so that not more than seventy reached Tjibodas on the Gédé range of mountains, an establishment to be described presently.

Hasskarl's mission may be said to have been completed with credit and satisfaction, and the Dutch government gave him substantial proofs of recognition and estimation. Certainly to no one better than to him, could the further care of the new colonists be entrusted; so Hasskarl was charged with the direction of Cinchona culture in Java, and acquitted himself of the task according to his powers till the commencement of 1856, when, in consequence of continued weariness, constant application and perhaps also of disappointments without end, he became ill and found himself obliged to return to Europe, about the middle of the year [1]. Dr. F. Junghuhn was enjoined to take over Hasskarl's work and to continue it.

What was it meanwhile that had taken place there at that time and previous to Hasskarl's mission?

Many years previously, a plant which had been sent to Java by Miquel, was planted in the hospital garden at Weltevreden, and there was long considered to be the true *Cinchona*. In 1856 I saw the plant, then a healthy bush, but it had been known for some time, to be nothing else than *Cascarilla muzoniensis*.

In 1851 there was in Paris a true *Cinchona* plant belonging to the best species, *C. Calisaya;* it was raised from seed, collected by Weddell in America. Professor de Vriese received this precious specimen from MM. Thibaut et Keteleer of Paris, in exchange for certain Indian plants. Transferred to the garden of the academy of Leyden, it was afterwards placed with the greatest care in a specially prepared case and dispatched to Java, 1st December 1851, by the sailing vessel Frederik Hendrik, P. Huidekoper, master. In April 1852, Teijsmann, the curator of the state botanical garden at Buitenzorg, received this firstling. It had suffered so much, that it could not be kept alive, but thanks to Teijsmann's care, one cutting was obtained before it succumbed, which developed robustly and was transferred to Tjibodas in the Gédé range of mountains, the so-called strawberry garden of the Governor General, about 4400 feet above the sea [2]. The diligent Teijsmann quickly obtained a new individual from this plant, itself once a cutting, and the specimen booked as Calisaya No. 2, obtained a place close to the parent plant, between the thick roots of a hewn down,

[1] Dr. Carl Müller gave a long account of Hasskarl's noteworthy travels, in the "Deutsche Revue der Gegenwart" for 1873. The whole question of the introduction of the Cinchona tree into Java, was taken up by Dr. W. H. de Vriese in an interesting pamphlet in 1855.

[2] In Paris feet, or 4812 English feet. B. D. J.

gigantic forest tree. Though this situation may seem very narrow and confined, experience had taught the skilful propagator to reckon precisely on it, that on the other hand, an excellent shelter would be secured for the tender nursling.

The parent tree and its offspring vied with each other in rapid growth; according to the observations of 1st January 1856, N°. 1 had developed to 3 metres, and N°. 2 to $2^3/_4$ metres. In July 1859 the dimensions indicated were 16 and 15 feet, and in January 1865, 28 and 24 feet. In 1866 N°. 2 (the cutting obtained from N°. 1) began to languish, and then threatening to die, it was sawn off about 2 decimetres[1] above the ground. The tree of about fourteen years old had reached a height of 8.125 metres, with a circumference round the trunk of 0.8 metre. 10 kilos of dry bark were obtained from the sawn off stem, whilst if the tree had been dug out, and the bark harvested from all the branches, the stump, and the roots also, the outturn would certainly have amounted to 12 kilos. A large piece of the sawn trunk was forwarded to Bandoeng, and being of historical value, it is carefully preserved in the office of the Director of the government Cinchona culture. In the same way, disks were taken from the handsome stem with the bark still on, and sent to the Colonial Museum at Haarlem. The tree N°. 1 remained several years alive, and attained considerable dimensions; from the stump of N°. 2, numerous, robust suckers sprang up; but the original Cinchona establishment was abandoned about the year 1866, and attached as a section to the state botanical garden. Special care being no longer demanded, the nurseries for Cinchona cultivation were transferred to the central range of Preanger, and then, as the original trees at Tjibodas were no longer necessary for propagating, they had less attention devoted to them, so that at the present time, they probably are no longer to be found.

[1] Nearly eight inches. B. D. J.

It will presently appear that the two nurslings so often mentioned had their full share in the multiplication, and thereby must constantly have been subject to severe treatment. Thus, for the purpose of chemical investigation, strips had been repeatedly cut from the bark of the stem, all of which taken together from these two, as well as from all the remaining original Cinchona trees at Tjibodas, so much and so long experimented on, in every shape and form, that their tenacity of life may be appreciated now that they did not succumb more speedily and in greater numbers. In the barks of Calisaya 1 and 2, from 5 to 6 °/₀ of alcaloids were found, under different circumstances, and by various analysts, produced for the most part as quinine and its analogous compounds.

We were therefore right in hoping we possessed the best and richest description of Cinchona, and it is not to be wondered that, that the endeavour was to increase the number of individuals of such excellent quality by artificial propagation, as rapidly as possible. The trees flowered repeatedly but the flowers always withered, and fell off without setting fruit. From 1864 onwards, the trees at Tjibodas were allowed to rest, and in the year named, two of the specimens in the strawberry-garden were manured. In 1865 they yielded some well developed capsules, from the seeds of which a few young plants germinated and were planted out at Tjineroean in the Malawar range. The seedlings did not wholly resemble the parents, but by progressive development, the majority at an advanced period of life, came to resemble small trees showing single, unmistakable, important deviations, amongst other things, in hairiness of the leaves.

The strawberry garden at Tjibodas, where the two parent trees stood isolated, was so far separated from the higher situated Cinchona plantations, where other species occurred, that it was hardly possible to suspect hybridization, unless insects might have conveyed the pollen from the trees at a higher station; the wind though could not be the carrier, for a broad strip of forest between both sections of the nursery was left untouched.

We shall subsequently see that bastards or varieties are mostly obtained by multiplication by seeds, and that these, harvested from one tree and at the same time, as a rule produce plants, very various in appearance and form. It is well to remember that from seeds brought by Weddell from America, hybrids or varieties were already derived (See Vol. 1, p. 61 of my book, De Oost-Indische cultures in betrekking tot handel en nijverheid, where the distinguishing points of hybrids are considered,) and in this case it is explained, that in the seedlings the characters of both the parent-trees revert.

With regard to quality, it appeared in the course of time, that the barks just described were not in reality so good as the first repeated analytical results had declared. Since chemistry has taught how to separate with greater nicety the various Cinchona alkaloids, analysis brought to light the fact, that much of the pretended quinine in the Calisaya barks, N^{os} 1 and 2, was nothing else than quinidine and the so called amorphous alkaloid.

Having thus in a short space sufficiently recounted the history of the first Cinchona plant which reached Java, we must now return to Hasskarl's mission and closely follow up its results.

We have mentioned in passing, that Hasskarl during his stay in America, sent seeds to the Netherlands. According to his statements, these were derived from two varieties of *Cinchona Calisaya*, and also from *C. ovata*, *C. amygdalifolia*, and *C. pubescens*. Some of these seeds, were, with the powerful cooperation of de Vriese, immediately sent to India, and the remainder were entrusted for sowing, to the directors of the botanic gardens in the Netherlands.

In Java, the curator Teijsmann was naturally selected as the man to take charge of the treasure thus acquired. Teijsmann knew that the home of the Cinchonas was in the higher, cooler, mountain zones, and at Tjipannas, Tjibodas, Tjibeurem, and Kandang-batak, respectively about 1200, 1290, 1460, and 2372 metres above the sea, [1] he, with the assistance of the skilful superintendent Teuscher, laid out numerous and extensive nursery-beds, on which the seeds were sown with the greatest care, and provided with the needful protection.

These estates were chosen, for the simple reason that no other land under Teijsmann's supervision was available. He gave an account of his proceedings in letters dated 30th January 1854, to which he added a proposition, that in order to ensure the germination of the seeds, a commission of experts should be nominated, whose function it would be, to trace out suitable lands, and to determine their elevation. He further urged the experimental culture of Cinchona in selected places, not confining it to that region, but also seeking elsewhere for suitable land.

With this reminiscence, borrowed from authentic sources, we join in a hearty protest against the accusation, so often rumoured, that Teijsmann "obstinately and irremovably clung to the purpose of fixing the future Cinchona culture, exclusively to the Tjibodas estate". Whoever at the present time, ascribes the sad ending of the Tjibodas Cinchona plantation to Teijsmann, simply shows insufficient acquaintance with the facts, and besides, inattention to the history of the plantation. It would be useless, and here at least is not the place for it, to awaken old quarrels, or to take sides with this or that champion, but esteem for Teijsmann's industry compels us to place the facts in their true just light, and as we were never infatuated with the idea of an extended Cinchona cultivation on the narrow mountain ridge on the northwest aspect of the Gédé

[1] In English feet 3637, 4232, 4790, 7546. B. D. J.

range, we may not deny, that the soil and climate at least did not appear unfavourable there. The two oldest Calisaya trees, and many others, of 10 to 14 years old planted still higher, which we have visited repeatedly, have always astonished us by their strength and active development, in spite of the mortal experiments to which as will immediately be shown, they were subjected when young by attempts at artificial propagation.

How many of the previously mentioned intended nursery-beds succeeded, we cannot say for certain. The plants resulting therefrom, with those subsequently brought from the Netherlands, raised from the seeds entrusted to the various botanic gardens, were put out at regular intervals of 20 feet, in the specially cleared ground. In December 1854 Hasskarl himself came over, and brought with him specimens from America, though it seems uncertain what this number was. On the first of January 1856 there were mentioned as being at Tjibodas, the two Calisayas in the strawberry garden, respectively 3 and 2.75 metres high, 42 Calisayas and 60 Ovatas, raised from seeds. Amongst the plants introduced direct from America, there were three, 0.8, 0.5 and 0.25 metre high. The weather was unfavourable at the beginning of 1856; many plants were damaged by violent winds, and the frequent showers did much harm. By this time 238 Calisayas and 50 Ovatas, had been obtained from cuttings. It was said in the earliest reports, that the plants showed a strong inclination to branch quickly, and these branches made suitable cuttings. On attentively going over the monthly reports in succession, it will be perceived, that Hasskarl and Junghuhn also, by persevering, accomplished much by making cuttings, although it becomes apparent thereby, that relatively few grew up to plants, though Junghuhn states in one of those reports, that not more than 10 °/₀ of the cuttings failed.

The truth is, as we have found during eleven years, when we could avail ourselves of riper experience and better means, that, except in *C. succirubra* and *C. officinalis*, cuttings as a rule, are most troublesome and deceptive. If well put in, and looked after, cuttings will sometimes for months maintain a favourable outward appearance, and some will even seem to grow. If however they are examined more closely, there will be found little or no sign of rooting, but on the contrary, at the base of the cut surface, a knob shaped thickening, the so called *callus.*

Now we can imagine, that at first the propagators allowed themselves to be deceived by these appearances, and that they seemed to see thrifty, healthy plants, while they really were merely fresh and green cuttings, without a good system of roots. Such individuals planted out in the open ground, must as a matter of course speedily die, and we must seek in this direction for the explanation of numberless disappointments, which were constantly experienced in propagating, when this was not accomplished by means of fresh, well developed seeds.

So also at the present time it does not seem strange to us that so few plants germinated out of the mass of seeds sent by Hasskarl. Granted that they were in a germinative condition, it remains still a fact, that the older the seed, the more difficult to start it into growth, and if many even now are lost from fresh, healthy seeds, sown broadcast on beds however protected against wind and weather, etc., it is evident that but little was to be expected from seed that had travelled far, was neither new nor fresh, and treated in the way above mentioned. From 1864 onward, we have repeatedly received Cinchona seeds direct from America, or viâ the Netherlands, and by another method of treatment, which we shall describe hereafter, we always obtained a satisfactory number of plants. If the seed sent by Hasskarl had yielded results in proportionate measure, Java would in 1855 already have rejoiced in the possession of many thousands of Cinchona plants. But the properties of the Cinchona seed were to be learned only by costly and tedious experience. The cultivator Teijsmann himself, who had by the end of 1853 extensive beds, sown with Cinchona, which judged from our present standpoint, really obtained no results worth naming, taught us in March 1864 a method of germinating seeds which we have always found excellent, even when we had to do with seed no newer and even worse cared for, than that sent in quantity by Hasskarl.

On the first of May, 1856 there were recorded at Tjibodas, 43 *Cinchona Calisaya*, 76 *C. ovata* and 3 *C. lanceolata* besides 865 cuttings.

The total number of plants was thus actually lessened by one *C. Calisaya*, but increased by 15 *C. ovata.* The *C. lanceolata* which are here enumerated for the first time, appear later on to be identical with the *C. ovata*, or at most only a variety of it.

In the strawberry garden the two oldest Calisayas continued growing, and there also we find mentioned a specimen of *Cinchona pubescens*, introduced as we suspect, from the Netherlands. This plant did not long survive, at least it was soon omitted from the reports, and it may be left out of our reckoning, for no propagation if it seems to have taken place. This single specimen had reached a height of 0.5 metre.

Ths latest reports of Hasskarl concerning Tjibodas, are dated 2 and 3 July 1856, and are compiled from data of the superintendent Teuscher on duty there.

According to this official report there were on July 1st as follows, 113 *Cinchona Calisaya* and 88 *C. ovata*, the latter better developed than the former. Junghuhn who on the3rd July following personally inspected the condition of the plantation, reported only 63 plants in all, 37 being *C. Calisaya.* The dimension of these were, 26 under, and 9 above 0.25 metre; the two others had reached a height of even more than 0.5 metre, whilst of *C. ovata* only 8 specimens attained more than 0.275 metre. With the transfer of the direction of culture, there was thus suddenly brought to light the inaccuracies, for which Hasskarl, then already under treatment in the hospital at Weltevreden, can hardly be blamed.

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Quite in accordance with Teijsmann's representations of 30 January 1854, Junghuhn had already succeeded in directing the attention of the Dutch government to the excellent situation for an extension of Cinchona culture offered by the central mountain range of Preanger. He had moreover weighty objections to Tjibodas, and also in a general way, against clearing the Gédé range.

The objections consisted in the unfavourable formation of the ground, the want of shelter against wind and of water supply, the inadequacy of the ground, as well its quality and lastly the impending danger from the active neighbouring crater. Above all, Junghuhn considered the plantation to lie too low.

In the Malawar range (Zuid-Bandoeng, about the centre of the Preanger regency) there was not one of these drawbacks; on the contrary every condition was favourable, both in regard to climate and soil, as to the formation of the ground and the amount of suitable lands disposable. Junghuhn visited this region first in October 1839, and all his subsequent writings and actions testify to his great liking for this neighbourhood. At that period, there was nothing to be found but boundless, impenetrable forests, in which the only open spaces were due to the sulphur springs of the Wajang mountain, and a few warm springs close by. The entire tableland of Pengalengan, within the vertical limits of 4400 to 4500 feet above the sea, [1] estimated to be 9 kilometres from east to west, and fully 10 from north to south, was covered with forest to the tops of the surrounding mountains. No other mountain district exists in Java which can vie with this, in its great extent, proportionate height and favourable situation. Towards the close of 1839 a *passangrahan* (resting place for officials and travellers) was built, an opening made in the forest at the most suitable point, and a road constructed. From this point, the forests

[1] Respectively 4812 and 4921 in English feet. B. D. J

were begun to be cut down, and plantations laid out; this increasing year by year, ended by taking in a considerable portion of the higher lands.

Junghuhn had fixed his eye upon this region, so highly favoured by nature. Here would be room for an almost unlimited extension of Cinchona culture, and in these highlands, which offered the most striking resemblance in climate and vegetation to the native land of the Cinchona, these plants brought from South America would not feel strange. The similarity is really remarkable enough to warrant the hypothesis, that here the Cinchona tree would have to undergo a process of naturalisation, rather than acclimatization.

Junghuhn started to return on the 1st September 1855 by the sailing vessel "Minister Pahud" (W. Pfull, master), bringing with him the Cinchona plants which had been left in the Academy garden at Leyden. Timely information had previously been given to the Indian government, so that regulations could be drawn up for the speedy transmission of the plants on their arrival at Batavia, to the place chosen by Junghuhn at Pengalengan.

Hasskarl charged himself, during the close of 1855 with making the ground ready for the reception of the new guests. Two kilometres north east of the *passangrahan* Pengalengan, the centre of the extensive government coffee plantations, and above these, a space in the forest of about 300 feet in length, and the same in breadth, was cleared with the utmost celerity. From the stream which there flows, the future establishment was named Tjinieroean, 1566 metres above the sea [1].

Junghuhn had come back with four cases of a special construction, the so-called Wardian cases, containing 55 *Cinchona Calisaya*, 88 *C. ovata*, and 6 *C. lancifolia* plants, which whilst on board, one with another, had reached the height of 1 to $1^1/_2$ feet. Arriving at Batavia in the first week of December, Junghuhn reported to the government, that he had succeeded

[1] That is, 5140 English feet. B. D. J.

in bringing over 139 plants out of 149, in a perfectly healthy and fresh state. During the voyage, the plants had grown so much, that their diligent guardian was obliged to cut off some of the tops, which were put in as cuttings.

On hearing of the arrival, Hasskarl hurried to Batavia, to transport the new treasure himself to Tjinieroean By the 2nd of February he was compelled to record the death of 4 *C. Calisaya*, and 18 *C. ovata*. Most of the plants seemed to lose their leaves and buds, so that they really looked greatly diminished in general aspect. On the other hand, the same plants had a tendency to bud out at the bottom of their woody stems. This appearence was a natural consequence of the topping practised by Junghuhn.

By Hasskarl's report there now remained only 103 plants, that is, 46 *C. Calisaya*, 50 *C. ovata*, and 7 *C. lancifolia*. The biggest plant was 0.2 metre high [1].

We must here remark, that the *C. lancifolia* plants were not derived from seeds collected by Hasskarl. The Berlin professor, Dr. Karsten, travelling in New Grenada, had there procured seeds, which by exchange with the Governor of Surinam, were presented to the Dutch government. From these, 6 or 7 plants were raised in the botanic garden at Leyden, which reached Java under Junghuhn's care.

About the same period as the dispatch of the "Minister Pahud", there were shipped to India by the "Corigene" (Rijken master), 106 plants, which were raised in Utrecht. This consignment did not receive skilled supervision, and thereto it must be ascribed that although these plants were dispatched forthwith to Tjinieroean, according to Hasskarl's report, not more than 7 came to hand in a fresh state, and 13 in a doubtful condition.

On the 1st April there were only 40 of Junghuhn's plants, *C. Calisaya*, 33 *C. ovata* and 6 *C. lancifolia* still living; whilst of the Utrecht consignment not more than two remained.

Dating from Tjinieroean, Hasskarl presented another report,

[1] Not quite 8 inches. B. D. J.

with a description, of the Cinchona varieties indicated, accompanied by *C. Calisaya* leaves of five different forms, to show that the form of leaf differs remarkably in individuals of the same species. The report and appendixes were sent to the Netherlands for the opinion of De Vriese, who confirmed the accuracy of Hasskarl's statement. It was of the utmost importance, to know whether we really possessed the true *Cinchona Calisaya* because this species was generally considered to yield the barks richest in quinine. De Vriese had kept back a few plants, and on his proposal Weddell, who was still held to be the highest authority in the domain of quinology, was invited to inspect this treasure and pass his opinion thereon. This took place at Leyden, on the 27th September 1855, and whilst still at a distance, Weddell recognised and distinguished amongst the plants, "the true Calisaya, and nothing else, without the slightest doubt".

It is necessary to bear in mind, that at this time, only young plants were to be had for investigation and determination. As peculiarly characteristic of *C. Calisaya*, the *scrobiculi* and the dull velvety appearence of the leaves were relied on, although this last is due to a special condition of the cells of the upper surface of the leaf.

How deceptive these characters are, and how difficult it is to distinguish even developed, flowering, and fruiting Cinchona trees, will be seen later on. The *scrobiculi* do not serve as a special characteristic of the true *C. Calisaya*, for as we have already shown, they are also met with in other species, though certainly *not* in the species then called *C. ovata*.

On the other hand, *C. ovata* displays in its young state, as plainly, its peculiar velvety surface. One after another fact was cleared up by the dispute which ensued later as to specific determination, as also the fact that the original names seem to be not entirely irreproachable.

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In June 1856 Hasskarl returned to Europe, resigning the prosecution of Cinchona culture to Junghuhn.

With this transference of management, the first period of the new culture was closed. There was now a trial plantation at Tjibodas, disapproved of by Junghuhn as already stated, and a second at Tjinieroean, which estate be considered to lie too low, whilst he moreover deplored the planting out of Cinchona trees on cleared ground, he had there placed them under the shade of intentionally planted *Dadaps* [1].

Junghuhn also saw a threatening danger in the circumstance that the stumps and roots of the felled forest trees were left in the ground; in his opinion the vegetable portions would proceed to rot, and in every respect open a favourable opportunity for cryptogamic vegetation, of which the developed *mycelium* would overrun and kill the delicate Cinchona plants. The fact that afterwards, sickly or dead Cinchona plants were met with, attacked by *mycelium*, gave support to Junghuhn's suspicions and fears. Meanwhile we may now, by reason of many years' experience on hundreds of hectares of ground cleared and again planted, declare with the greatest possible certainty, that the causes of the deaths of the Cinchona plants did *not* lie in the method of clearing and planting.

Junghuhn's first report was dated 25 July 1856. Besides the 7 *C. Calisaya* and one specimen of *C. pubescens* in the strawberry garden at Tjibodas, there were then recorded in that plantation, 41 *C. Calisaya* and 65 *C. ovata*.

A mighty revolution was begun in the Malawar range. From Pengalengan to the summit of the mountain, were twelve nurseries made, adjoining in a straight line, Tjinieroean being one, which was already made by Hasskarl. These collective trial nurseries now lodged 143 plants, 66 of which were at Tjinieroean, Junghuhn now distinguishing 7 as *C. lanceolata*. In the higher plantations there were placed 56 *C. Calisaya*,

[1] Various species of *Erythrina* B. D. J.

77 *C. ovata*, 7 *C. lanceolata*, and 3 *C. lancifolia*, all protected with the greatest care against injury by animals, etc. The plants brought by Junghuhn himself from the Netherlands, were all at Tjinieroean, those higher up the mountain, were derived from Tjibodas, where the oldest individuals, and the more difficult to remove, were destined to remain to supply cuttings, under the care of the superintendent Swart.

In August 1856, the first propagating house at Tjinieroean, 18 feet long and 13 feet wide, was finished; Junghuhn was hard at work to turn the Malawar range into an English park, by making roads, leading from Tjinieroean to the upper regions, which cut through the primeval forest in various directions. Above Tjinieroean, in the middle of a thick, majestic forest, at a height of 5790 feet, a small *passangrahan* was built, and ground cleared. From this place, Gedong-banteng, Junghuhn wished to regulate and watch his projected gigantic labours.

On 31 August 1856 there were emunerated; on the Malawar range 143, and at Tjibodas 105 plants; the latter were mentioned by Junghuhn as being already great, heavy trees. Some hundreds of cuttings (as the small branches or ends of branches when cut off are called) were taken from these every month, which were then wrapped in *pisang* (*Musa*) leaves, and sent to Tjinieroean, and there received in the propagating house.

It needs scarcely be told, that the first planted or transplanted young trees were placed by Junghuhn in the thick shade of the forest. It appears from everything, that he remained convinced that these conditions were the prime requisites for a good and lasting development of Cinchona. At first the young nurslings were put out along the newly constructed roads, and thus had, relatively at least, more light and air, than the rows which were later made, at distances of 25 feet apart, in the thick forest.

Both undergrowth and trees alike were felled; the ground cleared simply of weeds, and the Cinchona turned out into a deep, broad hole, so that they were at least from six inches to a foot when settled, above the trodden ground, in consequence of breaking up the soil in the hole, after which they were provided with stout fencing. In this fashion gradually a hundred thousand Cinchona plants were systematically planted out in the forests of Malawar, Wajang, Kendeng, Wringin, Patoeha, and Tangkoeban-Prahoe ranges.

In October 1856 Junghuhn's expectations of the near future were so great, that he drew up an outline of instruction for the officers, charged or about to be charged with the superintendance of Cinchona culture, and of rules for the foremen in that department. A preliminary Guide to the culture, soon saw the light namely in 1858, and even from our present standpoint, it contains considerations and information in natural history and climatology of extreme interest.

Junghuhn on the 2nd November 1856, reported that 22 plants had died at Tjinieroean, which he attributed to the still imperfect experience of the foreman; the remaining plants grew day by day.

At that time there was actually an experimental planting in the Ajang-range (Besoeki) in order to observe the influence of a drier climate.

Junghuhn carried out this plan on the 21st May 1859; 9 *Cinchona Calisaya*, 8 *C. ovata*, and 4 *C. lanceolata* were planted at that date at Wonodjambi, 2219 metres[1] above the sea, in very fertile soil, in the midst of the forest, each plant separately provided with a strong fence, since it would not be possible there to keep a constant watch.

Within two years, 3 individuals were dead, and when the writer of this visited Wonodjambi in September 1865, he found still there, 15 vigorous and tall trees, but in want of air and space, so that a thinning of the surrounding forests was greatly to be recommended. At the same time it appears that in 1859

[1] In English feet, 7280. B. D. J.

young plants could not be clearly determined; for there stood prominently forth a handsome specimen of the species, which Miquel afterwards described as *C. caloptera.*

In 1863 Junghuhn planted on the cleared table-land Diëng; 2046 metres above the sea [1] behind the *passangrahan* there, in an enclosed nursery, 16 Cinchona trees, belonging to *C. Calisaya, C. Pahudiana* (formerly called *C. ovata*) *C. lancifolia,* and *C. succirubra,* (met with amongst *C. ovata,* and at first called *C. cordifolia,* but afterwards *C. caloptera*) four of each species. When I surveyed this plantation in September 1865, there were still 14 freely developed bushes living.

At Tjinieroean meanwhile the dwellings of the foreman and the staff of workpeople, and the nursery accommodation were actively pushed on. On the 4th December it was said; all "plants in the open ground more than three inches high, are growing admirably, those in the frames satisfactorily; the cuttings root so fast, that they must be shifted into the largest sized pots. Tjibodas yields about 300 cuttings per month on an average, and this number will be increased to 500 or 600, as soon as sufficient nursery accommodation can be prepared at Tjineroean." At Tjibodas they began at this time to take *tjangkokken,* or layers, from the biggest trees, by which means robust young trees could be readily assured.

The report of the 4th January 1859 states, that many plants in the open ground had died, in consequence of frequent rains, against which the insufficiently rooted cuttings appeared unable to contend. In future so far as possible, planting out will be done after the rainy season. At the end of 1856 at Tjibodas, there were still recorded, 41 *C. Calisaya,* and 64 *C. ovata,* and on the Malawar hills, 66 *C. ovata,* 62 *C. Calisaya* 7 *C. lanceolata* and 3 *C. lancifolia,* without reckoning the cuttings in the propagating houses. Contrary to the great expectations cherished of the artificial propagation, and often repeated, the

[1] That would amount to 6713 English feet. B. D. J.

actual increase cannot be considered particularly satisfactory.

A new period of happy augury set in, when on the 10th June 1857, flowers were discovered for the first time on a specimen of *C. ovata* 9 feet in height. In August, 6 *C. ovata* from 8 to 12 feet, and 7 *C. Calisaya*, of 7 feet high each were flowering; Junghuhn remarked, that those branches on the *C. Calisaya* tree which were intended for layers, bore the most flowers. Amazement at this, surely testified to want of experience in propagating trees. The operation of *ringing* as a provocation or incitement to flower, was known long ago, and often in later years it has been applied with the happiest results to trees of *C. Calisaya*, *C. lancifolia*, and *C. caloptera.*

In the month of June 1869 Junghuhn noticed a specimen with a large leaf, amongst the *C. lanceolata* which was held to be *C. cordifolia* until more recent investigations and comparisons convinced him that here he had to do with *C. succirubra*[1]. But this opinion also seemed wrong, when he was able to compare this species, with specimens of *C. succirubra* received from British India in 1862, and Miquel recognised it as *C. caloptera.*

The pretended *C. succirubra* remained for years known to the labourers in the Cinchona establishments as *Kortefolia*, (short-leaf) and we also, previously to 1866, did not dare to doubt officially, its identity with the true *C. succirubra.*

Miquel undertook and completed the task of making an end of the existing confusion as to species. In arranging the material collected by Hasskarl in America, which was preserved in the Leyden herbarium, the expert systematist Miquel by set study and analysis, arrived at accurate botanical determinations. Where the data for a thorough investigation failed, the plantations in Java were able to supply them. We had the privilege of supplying the eminent botanist with important and desired

[1] According to Oudemans, Howard considered this plant to be *C. succirubra* Hasskarl however had not visited the mother country of this species and so it must be considered strange or purely accidental if he had brought seeds of it thence.

material, and numerous questions concerning the natural occurrences of the living tree were readily and with the greatest exactitude answered.

In 1869 the fruit of his labours saw the light; it was entitled: — "De Cinchonae speciebus quibusdam, adjectis iis quae in Java coluntur", Amstelaedami (C. G. van der Post).

Miquel's declarations were not implicitly received on all sides; as for ourselves we had no definite reasons for doubting the accuracy of his botanical determinations, although we could advance certain objections to the estimated values of the species and varieties investigated, on the strength of the chemical analyses which were made in Java.

It would lead us too far, were we to follow minutely the official reports as to the history of the development of Cinchona culture in its second period, under Junghuhn. Many times and in many ways it was faulty, but it was an experimental field in the fullest sense of the word, and conclusions and deeds of the most apparently logical kind could only expose the experimenters to disappointment so long as experience had not yet, by means of long practice, decisively declared. A man like Junghuhn stands too high, for the errors which arose under his superintendance, to depreciate his well merited fame and name. His unbounded love of nature, his unwearied diligent endeavours, his clear and sharp insight, and his comprehensive knowledge, speak in his numerous and most important writings. Junghuhn's work in Java is unsurpassed of its kind at the present day, and will always remain a trusty, unmistakeable testimonial to the Indian naturalist. Cinchona culture has benefitted immensely by his information as to the most suitable soils for it, and his perseverance in accomplishing his task. His acrid criticism on his predecessors, Teijsmann and Hasskarl, criticism which indeed had no right to be made, is however to be deplored. If the course adopted by conviction by both these men, and dealings with regard to Cinchona culture did not coincide or agree with those of Junghuhn, this champion for light, right, and truth might have refrained from depreciating and discrediting the activity of his predecessors, though which his own mistakes and shortcomings, were more or less hidden.

The acclimatization experiments have set loose debate, in which many have taken part, both Dutch and others. It becomes an international question, in as much as all civilised peoples must have an interest in the success of the attempts to subject Cinchona to regular cultivation outside its native land[1].

We will not interfere with the contentions of passion caused by devotion to the object, perhaps also a little by vanity. Henceforth we have merely to do with actual facts, and by them, to ensure a clear exposition of the whole history, which may serve as fruitful instruction, and as sure guidance to planters of the present day, as well as those the future[2].

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[1] Among the many foreign periodicals, which have applauded the success of Hasskarl's mission as a triumph of science and civilisation in the cause of humanity, we may name, Hooker's "Journal of Botany", — the "Annuaire des deux mondes" of 1855, and various Journals and Reviews of the United States etc.

In 1867 Rochussen wrote:

> "The eyes of Europe are fixed upon this enterprise, which interests it in the highest degree; for it is, so to speak, to procure for the sick, the means of life, and to procure it at a cost which will not exceed his means. This is no common speculation, it is a humanitarian work that the Dutch government has undertaken and carried it out; it does not wish for monopoly; it does not hide it under the veil of secrecy."

Even so lately as 1864, it was expressly stated by decree of the Indian government of February 14, that the culture of Cinchona must not be regarded in any aspect as a financial speculation.

We know to day that the sacrifice made on behalf of humanity, has actually in the end, succeeded fiscally, and also as private undertakings.

[2] It long was a great mistake in British India, as well as in Java, that the concern was much more for what might be, that is to say, for what was hoped for, — than for what was. Many disappointments were felt by going too fast and too far, which would not have been experienced in calmly working on.

CHAPTER V.

CONTINUED DEVELOPMENT OF CINCHONA CULTURE IN JAVA.

The first seeds were obtained in Java about the middle of 1858 at Tjibodas. The bearing trees had thus scarcely attained the age of four years, but although the crop of seed constantly increased up to 1866, it took place exceptionally, or in very small quantities, in the species considered the best, *C. Calisaya.*

At the end of 1859 there were out in the open ground, 19 *C. Calisaya* and 27,702 *C. ovata,* raised from Javan seed. In addition there were in the nursery beds, 2,401 *C. Calisaya,* and 68,569 *C. ovata,* whilst 11,668 *C. Calisaya* and 408,230 *C. ovata* seeds had been sown. There were held in reserve, 950 *C. Calisaya,* and 415,000 *C. ovata.*

It deserves remark that the seeds were still carefully counted, so high a value was set upon them. With artificial propagation there was no need henceforth to be so strict, the extension of the cultivation in that direction was no longer necessary and in truth, even at the present time but comparatively paltry results have been obtained from it. At the end of 1859 the total number of trees, brought from elsewhere or raised from cuttings, amounted to 1,445, amongst which, there were probably many cuttings of doubtful vitality.

The subjoined summary shows the out-turn of the five following years.

	1859	1860	1861	1862	1863
Seeds not yet germinated. . . .	722,681.	593,660.	479,750.	391,486.	208,322.
Plants in the nurseries	108,603.	355,901.	541,861.	633,944.	612,770.
Do. in open ground	33,483.	58,548.	135,580.	330,965.	539,040.

We shall presently record the proportionate numbers of the various species. Meanwhile it already appears from this summary, what strides the culture took, as soon as seeds could be used. Junghuhn utilised his ripe knowledge of soils, in extending the Cinchona establishments, and did not restrict himself in that, to the Malawar range, but chose a series of central localities, situated on different mountains and various elevations, so as to bring together as many factors as possible, for comparing the power of growth, under widely different circumstances.

Besides the existing establishments at Tjibodas (1430 metres above the sea) and Tjinieroean (1566) there were successively formed, Tjibeurem (1560) on the Malawar in 1858, Rioeng-oenoeng (1625) on the Tiloe in 1859, Kawa-Tjiwidei (1950) on the Kendeng in 1859, Nagrak (1625) on the Tang-koeban-Prahoe in 1859, Tjibietong (1527) on the Wajang in 1860, Rantja-Bolang (1917) on the Kendeng-Patoeha in 1860, Telaga-Patengan (1576) on the Patoeha-Djampang in 1862, and Lembang (1251) on the Tangkoeban-Prahoe in 1862.

We have already mentioned the small experimental plantings at Wonodjampi in Besoeki, and on the Diëng in Bagalen; there was no previous talk of further extension there. Each of the above named ten establishments however, all situated in the western half of the Preanger regency, was separately placed under the orders of a European superintendent, for whom a suitable boarded dwelling was built, and to whom was assigned a native foreman (*mandoer*) and several permanent labourers (*boedjangs*). For the latter, uniform dwellings were made under a roof, whilst day labourers (*koelis* or *coolies*) served as wanted at the time. Only the superintendent, at Tjinieroean and Lembang had shut-up propagating houses; at the others places merely nursery beds were used.

At Gedong-Banteng on the Malawar between Tjinieroean and Tjibeurem, but situated higher than these, also at Lorrok-Kidoel, between Rantja-Bolang and Telaga-Patengan, Junghuhn built *passangrahans*, where he could stay during his periodical inspections, and whence he could visit the seven establishments lying south of Bandoeng. His own dwelling was at Lembang, from which place it was possible to reach Nagrak in an hour's time.

Meanwhile, during the progress of these activities, investigation as to the worth of the various species of Cinchona, and the exact definition of these, was not discontinued. On the other hand, outside Java gradually arose a great dispute in this matter, which bore very much the semblance of passionate vehemence.

As far back as 1855, doubts were entertained in the Netherlands, about the good quality of those species of Cinchona collected and dispatched by Hasskarl. Professor De Vriese at that time assuredly was the person who had the greatest share in everything that concerned the introduction of Cinchona culture into Java. He was not only the scientific adviser of the government, but also at the garden at Leyden most Cinchona plants were raised, whilst all that were sent from America, there underwent critical investigation. The questions which were here considered, could not from their very nature, be mysterious or secret; though it appears to be a fact that Professor Blume at Leyden, who may certainly be styled an authority in botanical matters, vainly instituted attempts to see the Cinchona plants which had been reared in the academical garden. It was not until after Weddell's visit and declaration mentioned on page 55 that this readily comprehensible desire was fully gratified, when Blume also recognised plainly, the *C. Calisaya* type, in the specimens which had been left behind [1].

[1] The writer of this is thoroughly acquainted with the special circumstances of the case, and was concerned in them more than was agreeable to him. He was at that juncture at Leyden, by command of the colonial minister, on purpose to employ himself with quinological studies, and saw the living Cinchona plants for the first time simultaneously with Blume, who complained that De Vriese should have carefully denied all access, until Weddell had reported on the identity of the *C. Calisaya*.

The seeds which Hasskarl had sent, belonged to the following; *Cinchona alisaya, C. Covata, C. amygdalifolia* and *C. pubescens*. From the last but one, nothing seems to have been raised, whilst of *C. pubescens* only one plant was produced, which however must soon have died.

Junghuhn soon had suspicions regarding the *C. ovata* and for a short time supposed them to be *C. Condaminea*, although they were already in 1856—59 entered in the reports as *C. lucumaefolia*.

Junghuhn sent leaves, flowers and fruit of this sort to Mr. J. E. Howard of London, who saw in it a new and hitherto unrecognised species, and christened it in honour of the Dutch statesman to whom Javan Cinchona culture is so deeply indebted, *Cinchona Pahudiana*. Since 1861 it is has been mentioned in the reports under this name, and still affords dispute among botanists, whether Miquel in his monograph formerly quoted, has not described it as a worthess species, *C. carabayensis*. This question is no longer of practical importance, for since 1864 the propagation of *C. Pahudiana* or *C. carabayensis* has been discontinued. Its further propagation was forbidden so early as 1862, by decree of the Indian government of 11 September, because of the doubts concerning it, and the possession of other species whose value was considered superior in every respect [1].

Amongst the imported *C. ovata*, certain specimens were distinguished and considered to be *C. lanceolata*, and amongst these, Junghuhn noticed an individual, which by its peculiarly large form, as well as by the colour and substance of the leaf, showed marked divergence and was styled *C. cordifolia*. Subsequently named *C. succirubra*, Miquel has finally pointed out its identity with *C. caloptera*. The dispute however did not end with these confusions and elucidations.

[1] In spite of prohibition, the multiplication was not actually stopped. Plenty of seeds were obtained from *C. Pahudiana*, and of the others few or none. In striving after extension, we were obliged to make shift with *C. Pahudiana*.

From the first harvested *C. Calisaya* seeds gathered at Tjibodas from plants which were raised from seeds sent over by Hasskarl, there were 5000 plants obtained in 1859—61, which were naturally regarded as *C. Calisaya*. In 1864 it was abundantly evident, that these were very different in outward appearance from all those of *C. Calisaya* which had been obtained by cuttings, and also from a few individual seedlings planted out in the forest at Nagrak. When, in the beginning of 1865, these doubtful plants began to flower, the suspicion gained ground that here also confusion must have prevailed, and since then these *pseudo-Calisaya* have been distinguished, as *C. dubia*, until Miquel recognised them as a particular species, and named it in honour of Hasskarl, *C. Hasskarliana*.

Others have asserted and still do assert, that this *C. Hasskarliana* is a hybrid originated at Tjibodas, from the fertilisation of *C. Calisaya* flowers by pollen from *C. Pahudiana*. *C. Hasskarliana* has truly a strong family likeness to *C. Pahudiana*, though it is wholly distinct from the latter, and it will hereafter be seen that it again runs into varieties, shown by superficial differences in the shape of the fruit as well as in form and more or less hairiness of the leaf. *C. Hasskarliana* in common with *C. Calisaya*, possesses the oft mentioned *scrobiculi* in the axils of the veins of the leaf. However this may be, we certainly do not consider ourselves qualified to take sides in the dispute; Miquel was an established authority as a systematic botanist, and he had found material in Hasskarl's collections identical with *C. Hasskarliana*, a tolerably good proof that this existed in America before its discovery in Java. Still further we would recall the fact, that amongst the originally received *C. ovata*, there were also found divergencies from the typical form, and that both Hasskarl and Junghuhn met with great diversity amongst the earliest specimens of *C. Calisaya*.

Besides, it is very difficult to base knowledge upon an investigation of dried leaves, flowers and fruits; young Cinchona plants resemble each other so much, that even the most experienced eye must sometimes hesitate, before making a categorical declaration.

At the same time it happens, that the chief distinguishing characters of *C. Calisaya*, namely the presence of *scrobiculi*, and the velvety appearance of the leaves, are both criteria borne also by many other species. Both readily show that mistakes would be sure to arise so long as no arrangement existed and the fully developed material at hand requisite for thorough study and mutual comparison. The eminent systematist may have made mistakes in dealing with defective data, such as obtained in this case at first, without endangering his reputation.

Thus much as to the species, to which we must again return when speaking of their chemical value.

We already know Junghuhn's opinion, that Cinchona ought to be planted in primeval forests, and we are also aware that he held to this system with great tenacity. In this respect he blamed the principles of both his predecessors, which once more gave opportunity for a strong debate, and this time it resulted in the express desire of the government that a trial at least be made, in planting on cleared and unshaded ground. To this mandate is owing the origin in 1862 of the Cinchona establishment at Lembang. Junghuhn here was able to arrange it on ground cleared some years before, in the immediate neighbourhood of his own dwelling, situated on the southern slope of the Tangkoeban-Prahoe range, at a height of more than 1251 metres above the sea.

The ground was thus under Junghuhn's own personal supervision, by which regular observations and continuous comparisons were possible.

On the other hand however, according to Junghuhn's own ideas and conviction, the elevation was far too small. There were formerly coffee plantations laid out here, which, however, were soon obliged to be given up because they did not succeed; the ground thereafter became like a meadow, frequented by buffaloes, oxen and horses; it was level, hard trodden, and gradually became covered with a rampant growth of *alang-alang*[1].

It was first begun to be planted in 1863, and then with 6000 *C. Pahudiana.* The ground for them was not worked or otherwise prepared; the *alang-alang* was merely cut away at certain distances, so as to allow of regular plant-rows. Thus the young Cinchona plants possessed in this thrifty, tall growing grass, sufficient shelter on the north and south sides; on the other hand in the long run, the most injurious influences must have been experienced from a weed, dreaded most justly by the planter; from all that we can gather we are not convinced that he was in earnest in this experiment, but rather it seems to us that he gave a passive execution to an explicit, *a priori* pre-condemned order. In conclusion, when we have recalled the fact that Junghuhn both at Tjibodas, and Tjinieroean caused many Cinchona trees to be lifted, and transplanted near the higher situated forests, with the intention of withdrawing them from the unfavourable conditions under which he had seen fit to place them, we can herewith regard the second period of Cinchona culture in Java as closed.

CHAPTER VI.

CINCHONA CULTIVATION CONTINUED; FROM THE DEATH OF JUNGHUHN TO THE PRESENT TIME.

In the second half of 1863 Junghuhn began to feel himself ill. He had demanded too much from his strength, and relied on its inexhaustibility. By the beginning of 1864, his condition had become critical; a visit on furlough to the Netherlands for the

[1] Imperata arundinacea, *Cyrill.* B. D. J.

restoration of his health, could no longer be deferred. This leave was granted as a matter of course by the government, and at the same time, 14 March 1864, the temporary succession of the director of the Cinchona culture was provided for. The nature of the malady made it necessary to return to Europe by a sailing vessel; but when the wished for opportunity of embarkation arrived, the patient was so far exhausted, that his journey was perforce delayed. The great naturalist died on the 24th April, he whose eminent abilities, unwearied and fruitful activity are fully acknowledged, although he was engaged in scientific disputes more or less all his life long. His ashes were committed to earth in a spot chosen by himself in the middle of the future Cinchona plantation at Lembang, and a simple pillar placed over his grave.

Junghuhn might well say in 1859 in poetic language: — the splendour of Cinchona cultivation in Java to our earthly vision can hardly be exceeded! for his risen spirit may behold the Cinchona forests at the present time representing millions, and ready to yield a richer reward.

The Cinchona plantation at Lembang was laid out in such a manner, that Junghuhn's grave made a point of junction with two main paths, along which at the present time are formed fine avenues. The white column may be descried from far down these; the peaceful spot at the mountain's foot, agrees well with the respect and appreciation due to him, and involuntarily cheers one to thankful remembrance of the great and gifted man, who endowed with rare knowledge and unequalled industry, and animated by inward reverence and love for Nature, investigated the geological formation and vegetable productions of Java, and in many writings of greater or lesser extent, strikingly made plain these facts to all.

His formal resignation of the supervision of Cinchona culture could not take place; but his undivided devotion declared itself in the broken utterances in which Junghuhn committed in trust to his successors, the continuation of work begun by him.

Truly, this continuation was no easy task. However esteemed the mandate might be, the new director felt to the full the heavy responsibility laid upon him, and did not conceal his serious anxieties from the Indian government [1].

What then was the state of things? To judge accurately of this, it is necessary to follow yet further, the history of Cinchona in those days. The third period of the culture is distinguished by radical divergencies from the system previously followed, and this must be explained by an exposition of the facts themselves, without in the least clouding the great services and renowned name of Junghuhn.

[1] In June 1855 the Colonial Minister requested Professor G. J. Mulder to select a person who should be appointed by the government as chemist to the then recently introduced Cinchona culture in Java. The choice having fallen upon me, I considered it my duty, by order of the minister, and following out Mulder's advice, to concern myself exclusively with quinological studies at Leyden and Utrecht in succession. In April 1856 having set out for Java, I found myself on my arrival at Batavia, effectually disappointed in my expectations. Appointed army apothecary to the large hospital at Weltevreden, I was, however, after eleven months of pharmaceutical service, nominated assistant at the Laboratory of agricultural chemist y at Buitenzorg. In September 1860 this institution was given up, and the government placed me in the Inland Board, where I remained as acting-Controller until the enactment of 31ˢ December 1863, appointing a commission to enquire into the condition of the government coffee culture, and I was assigned as secretary to the commission. Then, when Junghuhn needed a substitute, the government remembered my original destination and no longer delayed entrusting to me the further conduct of Cinchona culture, despite the real difficulties I pleaded in the presence of the Governor-general Baron Sloet van de Beele. The provisional appointment in March, was followed by the definitive in August, and thanks to the powerful support of the government, as well as to the hearty help and cooperation of scientific men, at home and abroad, it has been my good fortune to carry on the work not without success, so that when I in my turn, in March 1875, resigned the conduct of the Cinchona culture, on my being nominated Chief-inspector of cultures, a candid observer might see that my devotion and endeavour to establish firmly and extend Cinchona culture, were not fruitless. In a scientific point of view, from the first I found especial support in my old fellow-student J. G. Bernelot Moens; and I have to thank his many sided knowledge and powerful cooperation for a considerable portion of the success which has been obtained.

At the end of 1863 there were in the open ground:

C. Calisaya . . .	7,408,	amongst which 5000 were *C. Hasskarliana.*
C. succirubra . .	71,	of which 56 were *C. caloptera.*
C. lancifolia. . .	104.	
C. Pahudiana. . .	531,456,	in which are included the identical *C. lanceolata.*
C. micrantha . .	1,	with 12 true *C. succirubra* received from British India in 1862.

In the nurseries at the same time there were:

C. Calisaya . . .	4,685,	amongst which were 4,144 so called rooted cuttings.
C. succirubra . .	18,	cuttings, all *C. caloptera.*
C. lancifolia. . .	147,	do.
C. Pahudiana. . .	607,920,	amongst which were 55 rooted cuttings.

Besides these, there were 208,322 seeds sown of *C. Pahudiana* which by the end of the first quarter of 1864 were compelled to be written off as bad. Further, 737 *C. Calisaya* seeds, which gave no favourable return, and about 7000 cuttings of the various species, with 6500 of *C. Calisaya,* from which little could be expected.

A marked disproportion thus prevailed between the species considered valuable, and the others which were held to be doubtful. Very little alkaloid was found in the young *C. Pahudiana* bark, and therefore relatively little quinine, but some were of opinion that the amount would augment with age, and Junghuhn estimated the age of exploitable Cinchona trees at 30 years. The future would thus it was thought bring improvement, and this suspicion based itself partly on the circumstance, that the roots of *C. Pahudiana* contained more alkaloid than the stem-bark.

On the other hand, trust in the future was precarious, and it was established as an indisputable fact, that although the

C. Calisaya plants were of the same age as those of *C. Pahudiana*, the former were already far richer in quinine than the latter. The question could have been positively settled, or even obviated, if a careful analysis of the barks of the various descriptions brought over by Hasskarl had been made. For that purpose there was certainly old material at disposal, of *C. Pahudiana* or *C. ovata* as it was originally called.

It is certain that Junghuhn did not propagate *C. Pahudiana* by distinct preference, but because the first seeds, and afterwards a constant abundance, were harvested from it. Everything shows that the few *C. Calisaya* specimens at his disposal, had the greatest care devoted to them, and were valued most highly. The regulations which he devised for this purpose, seem not very happily chosen, and witness rather to his well-intentioned purpose.

Transplanting fully developed trees from the cleared grounds to the shady forests, could not conduce to flowering and fruiting. Light and air are of the first requisites for the production of blossoms and seeds.

Those trees which were too big to be transplanted remained in their original, unsheltered position, but care was taken to better their condition. A bamboo roof was provided for shelter against wind and rain, but we shall bye and bye see that this measure was not altogether a success. The trees showed considerable inclination to flower, and already in the years 1859—61, a tolerable supply of seeds was harvested, which produced about 19 *C. Calisaya* (planted at Nagrak in the forest) and quite 5000 *C. Hasskarliana*. These, at all the older establiments were planted out in the forest, and since 1864, were particularly well looked after, so that most developed into healthy trees, some of which may still be met with here and there at the present day.

Although the oldest specimens were now sheltered from wind and rain, nevertheless it acted injuriously, hindering robust growth, and the flowers did not come to development. By 1864, these were free strong plants, with thick stems and branches and well spreading crown, but bearing every token of being drawn up in vertical growth. They appeared like bushes with a short thick stem. When it is borne in mind that these few individuals, were continually being severely cut back each month to obtain cuttings, it cannot be a matter of surprise, that constant and great disappointments should take place.

The small branches and twigs which were cut off, could not possibly be called good cuttings, and this explains the fact that in spite of constantly putting-in on a large scale, no commensurate number of healthy flourishing plants were obtained. Experience of later years has amply shown, that *C. Calisaya* can only be successfully propagated by cuttings, if thrifty twigs from young, strong plants are procured, or better still, healthy, fresh young shoots; even in this case good results appear greatly dependent on many factors, lying outside the general routine in the nurseries. It also seems that good and healthy roots are not put forth in every season.

At all events, the government decree of the 11th September 1862, containing the express order to suspend all further multiplication of *C. Pahudiana*, was and remains in full force. Junghuhn, strong in *his* convictions, had not actually adhered thereto, but in the transfer of the direction this had to be looked to in the very first place, followed by an orderly amelioration in the proportion of species to each other, — the exclusive multiplication of the more suitable, better species, and thereby make use of the lesson which disappointing experience had enforced.

Making cuttings from the oldest trees was therefore suspended, and their artificial roofing was taken away.

Several specimens of *C. lancifolia* and *C. caloptera* (at that time still booked as *C. succirubra*) which had been transplanted into the high forest on the Malawar range, were dug out with an enormous ball of earth, and brought back to their original station on open ground at Tjinieroean. All these measures were intended for nothing else than to favour the flowering and fruit setting, and they appear to have been successful in that direction. So also, with partial success, detached spirals in the manner of *ringing*, were tried on the thickest branches of the oldest *C. Calisaya* tree, and also on a *C. lancifolia* and *C. caloptera*. From the first named, a couple of hundred young plants were obtained in 1865, which were planted out at Tjinieroean, though most of them died. In 1866 the first seeds of *C. caloptera*, and in the following year, the earliest germinable seeds of *C. lancifolia* were harvested. In 1866 seven *C. Calisaya* trees at Tjinieroean were so heavily laden with fruit, that their branches bent under it.

Since that time the production of seeds has constantly augmented, so that gradually a selection could be made in accordance with the comparative analyses of the barks, to decide concerning this or that variety.

In 1867 so great a value however was still set upon the seed-crop, and so emulous were the superintendents as to their management in this, that from each careful collection, the portions obtained after cleaning, were accurately counted and parcelled out. It is well to recall these facts, for at the present time owing to the actual abundance little attention is bestowed on economy or careful treatment.

It can hardly be realised now, that long years of trouble and debate ensued, before the first seeds of a Cinchona tree of good quality were obtained, and these then were worth their weight in gold, and counted by tens. [1]

In the meantime the government had also made use of the help of its consular agents in South America, to provide Cinchona seeds, and succeeded therein, thanks to the exertions

[1] This reminiscence has this confirmation: Within the last dozen years, millions of good seeds have been distributed to private speculators both at Java and else where. What has been obtained from these, is relatively paltry, and surely does not plead in favour of an always exact valuation of what is liberally bestowed.

of our energetic Consul-general Schuhkraft. As early as 1864, he sent a parcel of Cinchona capsules to the Netherlands, which by Miquel were determined as the produce of three varieties of *C. Calisaya*, namely, *vera*, *morada* and *Josephiana*. Half of the seeds were entrusted to the nurseries in the gardens of the Academy, the other half were sent to Java.

In the first half of 1865, about 200 plants raised from seed, were sent from the Netherlands by various means to Java, and planted out at Nagrak. Nine were planted at Lembang and probably are still there in part. In Java itself 1200 plants sprouted, which found room at the various establishments and since then have been distinguished as *Calisaya Schuhkraft*.

In the months of May and December 1868, seeds were again received from Schuhkraft, from which many plants were obtained, which did not differ in appearance from the first sent. In 1873 there was again a small remittance; the dozen plants which grew from these, showed for the most part, a chestnut brown colour on the underside of the leaf, these stand in the small plantation at Tjinieroean. From yet another parcel sent in 1877, about 2000 plants were obtained, although up to the present time it does not appear that Schuhkraft succeeded in procuring for us the *Calisaya* variety, which excels in its large amount of quinine.

In the beginning of 1868 seeds reached Java under the name of *C. succirubra*, sent by the Dutch Consul-general Roldanus at Caracas, which however I was not fortunate enough to see germinate. In 1870 from the same source came a second remittance, which was said to be derived from *C. cordifolia* var. *rotundifolia*. According to the consul's report, great quantities of bark of this species were exported, although stated to possess only one per cent of alkaloid. The seeds produced ten plants. which when developed to trees, were recognised as *C. caloptera*.

In December 1865 we came into possession of a parcel of

Calisaya seed, from which 20,000 plants were raised, though not more than 12,000 were planted out, because at Lembang as well as the highest situated establishments Tjiwidei and Ranta-Bolang, on account of their still incomplete arrangements and capacity of propagating houses, many thousands of plants perished in their first stage of existence. We forbear speaking particularly of this sort, at this moment, which afterward became generally known as *C. Ledgeriana*, because by it, the Cinchona culture of the future has entered upon an entirely new phase.

Negociations were set on foot with the directors of Cinchona culture in British India, at Madras, Bengal, and Ceylon in 1864 by means of the English consul at Batavia, Mr. Fraser, assuring the transmission of new valuable species of *Cinchona*, such as *C. officinalis* and *C. succirubra*, in exchange for *C. Calisaya* and *C. lancifolia.*

In 1862 there were received 12 *C. succirubra* and 1 *C. micrantha*, which were planted out in one row, along the pathway near the crater at Nagrak, and there grew into tall trees, except two *C. succirubra*, which died. In 1865 four cases of *C. officinalis* were sent from Madras; hardly a dozen plants arrived in a thoroughly healthy and fresh state at Tjinieroean, and here, after a short time of preparation, they were turned out into the open ground. From these handsome specimens, we got cuttings as quickly as possible, and it appeared that the species was propagated without difficulty by that method. In the course of 1865 there were further received some seeds of *C. officinalis* from Madras and Ceylon, and in 1866 another batch from Bengal, with seeds of *C. succirubra.*

Thus in truth, a new period was entered upon, and the results of the attempts to improve and increase the species of Cinchona considered superior to *C. Pahudiana*, surpassed our most daring expectations.

There were 100,000 plants of *C. Pahudiana* still in the nurseries, when the culture was transferred in March 1864, and these were as soon as possible planted out in the open, where, according to official reports more than half-a-million of this species already existed.

In Junghuhn's system, the Cinchona plants were distributed in the forests of the frequently mentioned mountains. They stretched over an extent of about 75 square *palen* (a square *paal* = 320 *bouws*, and each *bouw* = 7096.5 metres [1], and any one who knows what the high, uncultivated mountain regions are, will understand that under such circumstances, subject to neither strict control, nor to a constant sufficient maintenance there but little to boast of.

Wild beasts, falling trees and many other destructive causes, must cause the ruin of thousands upon thousands of plants, whilst moreover the natural conditions are not wholly favourable for an unobstructed development.

By 1864, the condition of cultivation permitted a rigidly accurate observation and comparison, as well as an estimate of the different influences. At a glance, only those trees were in a fresh and robust state, or growing well, which had been allowed enough space, or at least had been assured of a fair amount of direct sunlight. So also, amongst other things, here and there along the principal roads, by accident, or else by the caprice of a superintendent, some had been planted in more open spots. In seeking for the original plant-rows in the forests, many of them appeared to have wholly vanished; even where scattered Cinchona plants had bidden defiance to their unfavourable surroundings, they showed themselves slender, spindly, and almost branchless, and with respect to these, entirely out of proportion between vertical and horizontal development. It was evident that these tall, slender trees, could not support themselves if the surrounding growth was cleared or even if vigor-

[1] This would make each *bouw* a trifle more than 1 acre, 3 poles. B. D. J.

ously thinned. Besides, the bark of the oldest and best developed trees was as thin as paper.

There was nothing to hope for in the future from this state of things, and as to providing more light and air to the 100,000 *C. Pahudiana*, by cutting out forest trees, that, apart from the question as to whether the doubtful value of the bark would repay it, must be looked at from reasons of administrative and technical character. Therefore we confined ourselves as much as possible, to bringing under more favourable conditions, the 5000 or more trees which stood in our books as *C. Calisaya*, but have been since named *C. Hasskarliana*.

This fact was truly surprising, that just the few trees which abundantly enjoyed light and air, were seen to be most strongly developed, and that not less in the lower, than in the highest situated plantations. Wherever both conditions of existence were fully conceded, the plants appeared to develope readily into trees.

On the basis of these observations and of various economic considerations, the decree of the government of the 29th September 1864 was issued, containing the injunction : — "That no more *C. Pahudiana* plantations on a large scale shall be laid out, and the stock of plants in the nursery-beds, shall be applied only to repair and replenish". Further, "that no more labour and expense shall be devoted to existing *C. Pahudiana* plantations, than is unavoidable to prevent their total extinction".

These restrictive measures, caused by the fact that it did not appear necessary to institute experiments on so large a scale, together with the insufficiency in the first place of material for the propagation of species of good quality, led to the following changes.

The Telaga Patengan establishment was given up in 1865; the *passangran* Lorrok Kidoel was removed to Kawah-Tjiwidei, and the neighbouring Rantja-Bolang moved to this establishment.

Two years later the transfer of Tjibodas to the curator of the government botanical garden took place. The number of superintendents was consequently reduced from 10 to 7, and in the course of 1864, the forests were begun to be cut down systematically, from each superintendent's dwelling onwards, to make room for the plantation of Cinchona on the open spaces. Thus these dwellings gradually became the centres of plantations, and proportionate riper experience more and more showed, that Cinchona, under conditions in other respects favourable, does not require shade; on the contrary there were manifest difficulties in single forest trees being allowed to stand; so the forests were more completely cleared, only leaving strips untouched, where these might serve as protection against wind.

Having thus to deal with new species of Cinchona, and to plant them out under entirely fresh conditions, the method of rearing them also gradually underwent alteration.

The number of propagating houses was considerably increased, and each establishment had its own arrangements. The bamboo nursery pots, which seemed very dear, while possessing many good qualities, had also preponderating bad ones; these were laid aside, or at least the manufacture of them was stopped, and they were regularly replaced by pots of baked earth, which three Javanese at Bandoeng under our instruction, and after a little practice, very soon learned to turn out in great numbers and at very moderate cost. Previously to this, Junghuhn had imported several thousand flower pots from the Netherlands, but the expense was so great, that it could not be continued.

The method of germination, also underwent a radical change, under the direction of Teijsmann, which we shall notice when describing the cultivation.

The progress did not confine itself however to these modifications and changes. There was another question of quite as great importance, that was, the labour question. From the beginning, both at Tjibodas and Tjinieroean, all the business of Cinchona culture was done by paid statute-labour, and all supplies of material were ordered by the Administration. This state of things could not continue; Cinchona culture was not reckoned among the cultures "by the powers that be" as a consequence of the known system. By government decree of the 24th February 1864 (N°. 27) it was laid down, that labour in Cinchona culture merely by way of exception, might be performed by paid statute-labour, and that as a rule, permanent, voluntary workmen should be engaged for that service. The advice of the Administration as well as that of the Inspector, Junghuhn, had stated, that free supplies of material in the elevated cool mountain ranges, was out of the question, and still less dependence could be placed on a regular provision of the necessary voluntary workpeople. The Preanger Regencies were at that time still in an entirely special condition of proprietary and patriarchal administration; the chiefs and head men as so many great and little potentates were predominant, and the people could with difficulty form a fair idea of individual freedom, because they had never experienced it. Investigation instituted showed, that the young Cinchona culture in the last few years, required on an average 300 rendering statute-labour besides the permanent labourers settled upon the establishment, which were accounted for by the Inland Administration. This regime could not exist officially, though actually in force, and on the transfer of the culture in 1864, there were free supplies of materials and voluntary statute-labour still seeming to find countenance. The superintendents unanimously declared that if the system were given up, they must be dependent on the caprice of the labourers, and their belief found powerful support in the Inland Administration, so that greatly fearing a rupture of its authority and power, that body preferred to permit the continuance of the compulsion.

At the end of March 1864, after a careful inspection and complete consideration of the condition of things, I approached the heads of the Administration with the request, that they should forbid all direct interference with Cinchona culture on the part of their officials and chief clerks, and only to afford help when it was asked through me personally. It was emphatically impressed upon the superintendents that they would be simply removed and replaced, in case it appeared that they were wanting in the tact to provide themselves by voluntary agreements with material and labour. One helped another; during 1864 there were still many appeals for help from the administration, because the new regulations did not sit easily at first, and the population came slowly to just ideas, but little by little improvement set in, and since 1864 there has been no question of direct interference of the Administration. When in May 1865, Governor-general Sloet van de Beele came to inspect the Cinchona plantations, after searching interrogatory of the officials he was able to state the fact, that the government-culture had now really become a wholly free undertaking.

The above named decree also contained an emphatic recommendation, that whilst the greatest possible economy was to be observed in the culture, it was never intended that the introduction and prosecution of it should be merely a financial speculation. This recommendation was a direct consequence of the impatience which gradually showed itself in the Netherlands, where it was fancied that the results were not proportionate to the considerable sacrifices already incurred. All these together did not make the task an easy one to the new Director, and it was made still more burdensome by a stringent protest of the Administration against cutting down the forests, which had been begun as an indispensable condition to the success of the undertaking.

Hereupon followed the previously mentioned visit of the Governor, who settled the question by granting full liberty to the Director of Cinchona culture to go on in the way begun, and desiring the Administration to interfere no further in the operations with regard to the Cinchona department.

In the Dutch States-general, questions were put to the colonial Minister almost every year about the condition of the new culture, and as a rule there was no lack of complaints about its defects and slow improvement. It was not encouraging to the Director in Java, to be compelled repeatedly to protest that the development could not be forced on, that the young plants demanded time to grow into trees, and that the necessary experiments would take up many years, before all debated points were solved.

Comparisons were made with British India, where Cinchona was introduced later, but was said to be relatively and absolutely much more forward, and further it was stated that the English had profited by the experience gained in Java, and would thus evidently incur fewer failures. On the one side complaint were made of the heavy expense which seemed to bear no fruit; on the other side dissatisfaction at the slow progress made, and whispers were not seldom heard, urging that all these costly experiments should be ended.

As to how far the complaint of "slow development" had any right to be made, or even counted as a reproach, may be learned from the official reports we have quoted; with regard to the cost, the summary of results since 1864, which we shall presently give, will speak for itself.

In the beginning of 1869, the Upper Administration expressed an explicit desire to know, whether the culture could be extended more vigorously; the opportunity for it existed in ample measure at the time, and the exports had only to do with the question as to the stocks possessed. The culture-reports and pecuniary accounts for the Upper Administration could be called satisfactory in every sense, whilst to prove that Java could already turn out produce, and that the future was far from being hazardous or hopeless, there were several hundred kilos of Cinchona bark harvested in 1869, and sent to the Netherlands for sale.

We must here pause for a moment to consider the following facts.

After the abandonment of the establishments Tjibodas and Telaga-Patengan. and the union of Rantja-Bolang with Kawah-Tjiwidei, there still remained seven establishments, two to the north, and five to the south of Bandoeng, which served and still serves as the residence of the Director of the culture. The many and radical changes to which the culture was necessarily subjected, made it urgently necessary that the responsible director should as much as possible himself be on the spot, where the business had to be carried on and regulated. Now it needs no argument to prove, that it was impossible to simultaneously superintend the seven outlying plantations, even with the greatest diligence and the strongest constitution. The staff of superintendents itself, was obliged to accommodate itself to the new order of things, and changes were continually taking place, so that repeatedly the guidance and teaching of novices had to be begun from the beginning. It was thus impossible that the director of the culture, although trained as a chemist, should confine himself to the laboratory, whilst the whole of his time and pains were most of all wanted in the field. On the other hand, the continued debate as to the intrinsic value of the numerous Cinchona barks, obliged him to be especially cautious in the choice of stock-plants for propagation, and it was about that point, in which he from the first sought as much enlightenment as possible from chemical analyses of different material. In these attempts he found his chief support in Heer I. C. Bernelot Moens at Weltevreden, whose help since 1865 has been incessant and disinterested.

Samples of bark were submitted to examination, from trees considered to be of good quality, which promised shortly to produce seed. If analysis proved the superiority of this or that tree, then seeds were gathered exclusively from it, and sown. Were any one were at the present time to go over the analyses of those days, he would come to the conclusion that the plantations in Java had no other individuals than those yielding manufacturer's bark of the best description. Meanwhile this was by no means the case, and it must be accepted, either that Cinchona propagated by seed degenerates, or, that the older analyses do not show the precise value.

We shall here append a few results in elucidation of this; they deal exclusively with *C. Calisaya*, inasmuch as no other species was propagated in Java from seeds for several years after 1863.

Repeated investigations had, up to and including 1864, shown that in the barks from two of the oldest *C. Calisaya* trees at Tjibodas, there was more than 5 % alkaloid, of which about four-fifths consisted of quinine and its analogues. Propagation of these trees and their descendants, was thus wholly justified according to the then scientific standpoint.

In 1868 flowering and fruit bearing trees of the false Calisaya, were examined which afterwards was described as *C. Hasskarliana*, and it was actually when analysed booked as *Calisaya dubia*. In the handsome bark from a tree about seven years old, raised from Javan seed, 4.960 % alkaloid was found, of which 2.845 % was quinine. This amount authorised its multiplication, and at Nagrak in 1870—71 there were large plantings made of this species. Another old specimen of similar age and origin gave 4.030 % alkaloid, 3.320 % being quinine, and a true Calisaya tree, obtained from the first harvested seeds at Tjibodas, and planted in the forest at Nagrak (known as N°. 4) showed an amount of 4 300 %, with 3.080 % of quinine. A specimen of *Schuhkraft* three years old, raised from seed received in 1864, yielded 3.912 % alkaloid, and 3.109 % quinine, (see 1868 Reports). In 1869 again, analyses of flowering trees took place, to answer the enquiry as to which might rightly be propagated. *C. Hasskarliana* of 7 to 8 years old gave 2.714 % quinine, and one 5 year old tree from a cutting of this species, appeared to possess 6.010 % alkaloid, of which 2.331 % was quinine. A flowering *Calisaya* tree of 4 years old, raised in 1864—65 from Javan seed, possessed 7.483 % of alkaloid, and 3.670 % quinine. This little tree stood in the yard of the passangrahan at Tjinieroean and yielded an abundance of seeds which were sown without any scruple. The analyses of 1870 again confirmed the belief that we possessed and were propagating only superior kinds of Cinchona. In specimens of *Schuhkraft* 4 and 5 years of age there were 2.4 % and 4.4 % quinine found, and in a *Calisaya anglica* of $3\frac{1}{2}$ years (the seed was received from Madras in the middle of 1866) 6.3 % alkaloid and 3.3 % quinine was met with.

Many samples were examined in 1872, Moens then finding the average amount from 8 *Calisaya javanica* to be 1.23 % quinine, 1.24 % quinidine, 1.52 % cinchonine and 1.01 % of amorphous alkaloid. This result was not satisfactory, after we had done our best by confining our propagation only to those trees which showed a higher percentage of quinine.

Moens calculated as average figures the following, from 8 *Calisaya Schuhkraft*, (from which during 1865—71 by far the most of the *Calisaya* plantations were obtained) 2.33 % quinine, 0.43 % quinidine, 0.79 cinchonine and 1.34 % amorphous alkaloid. This species had then remained constant, and it might consequently be expected that the great mass of Cinchona bark which those plantations would produce, would turn out to be useful manufacturer's bark.

Nevertheless, experience disappointed our good expectations. Here and there samples of *Calisaya javanica*, *Calisaya Schuhkraft*, *Calisaya anglica*, also *Cinchona Hasskarliana*, were found to be rich in quinine, but taken at random, the barks of those varieties were not suitable to use for the separation of quinine.

Granting that by accident, a small part was propagated from a parent tree of inferior quality, still the fact is not explained, why the bulk of the plantations should yield barks so poor in quinine. The suspicion that actual degeneration arises from propagation, is in opposition to other experience; in each case it can be absolutely demonstrated that there is no invariable rule as to degeneration.

In the report of the chemist Moens, appended to the official statements for 1873, he says: —

> "There is still a very important question; namely, whether there is ground for supposing that the plants which were reared from seed, will vary from the type of the parent-tree, whereby it may be feared that either the species will degenerate, in the sense that is inferior, or will possess less valuable alkaloids.
>
> "Comparison is somewhat difficult, because it may be admitted that the separate determination of each of the alkaloids, was not sufficiently accurate in all the earlier analyses, by reason of the faulty analytical methods employed. Nevertheless facts can be shown, which are satisfactory from that point of view."

I hereby testify that in 1874 I cut out pieces of bark, and gave them to Moens for examination, from several living trees of *Calisaya javanica*, from plantations then 7 to 8 years old, and intended in that year to be harvested in part. The results were of such a character, that we might fairly flatter ourselves that we were about obtain from those plantations, produce suitable for the preparation of quinine. When subsequently samples were taken from the entire mass as harvested and ready for market, they showed lower figures than these of the former analyses, and so we were once more disappointed. These and other facts show that there is still much that is wanting in our scientific knowledge, but at the same time they incite us to continue in methodical investigation.

Whatever was possible to throw light upon this subject, and to ensure the diffusion of plants of good quality, was done.

It is just *possible* that the parent-trees from which seed was harvested, had come under the influence of foreign pollen, pollen that is, of inferior kinds. The strictest watchfulness cannot prevent such an eventuality, when *C. Pahudiana* occurs everywhere by thousands, and it was still more an impossibility to keep all the numerous species and varieties of *Cinchona* isolated.

The question as to the choice of sorts, by the end of the year 1872 was confined to very narrow limits. From that time it has been a fought-out question; henceforth only *C. Ledgeriana*, *C. officinalis* and *C. succirubra* were to be propagated, to the exclusion of all other species and varieties. From that time also, it was possible to lay down stringent regulations, necessarily at the expense of much material, tending to prevent degeneration by crossing.

The near future will show if these regulations have hit the mark, and whether it lies in the power of the raiser to ensure a constant amount of quinine, by a rigid choice of seed.

Distinct from the question if determination of value, the chemist had still to inform us in another direction, when opportunity should serve thereto, by matured material.

We wanted to know, whether the place of growth, relative elevation above the sea, shade, or direct exposure to sunlight, kind of soil, prevailing winds, etc. can be considered to influence the formation of alkaloid.

By continued methodical analytical research, it was further to be cleared up, in which portion of the tree the most valued alkaloids accumulated, and if there were changes in quantity and quality during the different seasons as well as at various ages.

In one word; now that individuals occurred in all ages of development, of all species of Cinchona, at different localities and height, the chemist can and must give a helping hand to the planter, that he may help to solve Nature's enigmas. Now also had the day dawned for tracing out the best methods of harvesting and drying the bark, and for a regular, systematic examination of the parent-trees reserved for future seed supply.

In 1870 the Indian government was disposed on account of all the above detailed motives, to satisfy the urgent want of a skilful chemist to Cinchona culture, and in 1872 Heer J. C. Bernelot Moens, who had already shown himself so disinterested and serviceable was definitely appointed as such. With this gain to the culture a new period was opened up, that brought to light constantly occurring facts, and gave more positive shape and power to their further direction.

Before speaking of the results of chemical examinations, we must now take another subject in hand.

CHAPTER VII.

SPECIES AND VARIETIES OF CINCHONA CULTIVATED IN JAVA.

All that we have previously given of the botanical description of Cinchona, and its introduction into Java, does not release us from the duty of giving a short account of the various species and varieties of Cinchona which are cultivated in Java.

In cultivation there are:

1. *Cinchona Calisaya.* This species which is met with in almost boundless variety, owes its existence in Java to various sources of supply, namely; — to the original plant from Paris; — to seeds, brought by Hasskarl from South America, or sent thence by him; — to seeds repeatedly procured by Schuhkraft; — to the seeds offered by Ledger; — and lastly, to those plants which came to us from British India in 1866. Gradually the plants came to be distinguished by their various sources, as, *Calisaya javanica*, *Schuhkraft*, *Ledgeriana*, and *anglica.*

This distinction however, does not nearly express the characters of the individuals belonging to each section. Both in form and chemical contents the four named kinds vary greatly from each other, moreover each kind displays a diversity in its individuals, which frequently makes this determination of identity very troublesome. Only by experience and close acquaintance with the plants, can their typical form be recognised, now and then without being able to formulate the exact reason.

Fortunately numerous experiments and chemical examinations have done away with much of the difficulty so far, that since 1872 we know that of all these *Calisaya* forms, the *Ledgeriana* best merits propagation exclusively, or at least with decided preference. We have now to devote our special attention to this variety, and its history is so striking in many aspects, that we here append it in its entirety.

* *
*

During the years 1841—58, an Englishman, Mr. C. Ledger, was travelling in South America, with the object of purchasing *vicunas*, an animal resembling the alpaca, which he had undertaken to deliver to the Australian government.

Amongst his following there was a certain Manuel, formerly a *cascarillero*. This man being thoroughly conversant with the Cinchona districts, knew on the best authority that officials as well as natives regarded with district and suspicion all attempts on the part of foreigners to collect Cinchona seed, and opposed the exportation both of seeds and plants [1].

Speaking of this and other things to Ledger, he further asserted that most collectors were misled by good seed being changed for bad, or else the germinative power of it destroyed; he promised however to procure seeds of the best species of Cinchona, if his master desired it.

In 1865 having returned to Peru from Australia about the middle of that year, Ledger received a visit from his old

[1] Concerning this see note on p. 95.

servant, who took the opportunity to hand him a packet of Cinchona seed, which he had collected in the Bolivian province of Caupolican.

By July of the same year Ledger had sent the seeds from Arica to his brother in London, to offer them to the English government. As luck would have it, an opportunity to enter into correspondence with the English government did not soon present itself, and so the greater part of the seed was bought by Mr. J. W. B. Money, the possessor of extensive Cinchona plantations in British India. With the remainder, Ledger turned to the Dutch government, a preliminary deposit of a hundred francs was paid, to which a moderate addition would afterward be added on the germination of the seed in Java, and if it appeared to belong to a good sort; by the advice of Miquel this was accepted.

These seeds then came in December 1865 into the possession of the Director of Cinchona culture, who one year afterwards was able to report, that about 20,000 had germinated. Ledger thereupon received a further sum of 500 francs and was therewith well content [1].

Meanwhile Money had not himself used the seed he had bought, but had exchanged it for *C. succirubra* seed with McIvor, the head of the government Cinchona culture in Madras. The reason for this was, that he considered his own plantation to be situated too high for the cultivation of *C. Calisaya*, under which name Ledger had offered his treasure. On the other hand, McIvor had already expressed himself repeatedly as not prepossessed in favour of *C. Calisaya* cultivation. The Ledger seed was sown at Ootacamund, but produced no plants, at least if any there were, they were not specially noticed or mentioned. From a small quantity parted with to a colleague in Bengal, a few trees were raised in Sikkim which first began

[1] The total sum received by Ledger from the Dutch government was thus a trifle less than £ 24 sterling. B. D. J.

to attract attention, when the fame of the Ledger *Calisaya* spread afterwards from Java[1].

In the months of November and December 1866, about 12,000 young "Ledger" plants, were planted in the open ground at the various establishments. Thus of the sprouted seedlings, sundry thousands had gone to the bad. At that time, we was no reason to suppose that we had come into possession of an especially valuable description of Cinchona, on the contrary we thought we were dealing with the identical *Calisaya* we already possessed, and so the "Ledger" plants were put out in small plantations quite by themselves. This measure of precaution was natural and requisite, having regard to our old *Calisaya* trees which had scarcely begun to bear fruit, and each tiny seed was thus looked upon as an important gain.

The *C. Ledgeriana* plantations at Tjinieroean, Tjibeurem, and Rioengoenoeng were of some importance; the greatest quantity were planted out at these three establishments, at the others comparatively few were planted, and most of those that were, died.

The new nurslings developed into handsome young trees, without any sign, at least on a hasty glance, of showing themselves distinct from the already indicated, indubitable *C. Calisaya*, the offspring of Javan seed.

Several specimens began to flower in the course of 1872; the flowers distinguished themselves by their small size, as much as by their creamy white colour. Samples of bark were cut from the trees, now aged five and a half years, and chemically examined. The results were surprising; the percentage of alkaloid appeared higher than in any hitherto known

[1] The superintendent of the government Cinchona nurseries in Bengal, Mr. Gammie, obtained about 800 plants from Ledger's seed, and made so many cuttings from them, that in 1880 he planted 10 acres of ground with it. Moens who has seen this planting, says that the type is quite like that we have in Java, but the plants had not developed so strongly.

Cinchona bark. A quantity of 260 kilos was harvested, and sent to the Amsterdam market in four cases, as a test. The testers there termed the bark, "average quill, silvergrey", and assessed the value at 240 to 250 cents per half kilo. Samples taken from the whole parcel, showed 7 per cent of alkaloid, from which quite three-fourths of pure quinine could easily be separated. The dealers paid double the assessed price; the reputation of this description of Cinchona was thus assured, and has since splendidly maintained itself at each auction.

Meanwhile the examination of the trees was continued, and whilst the flowers and fruit really gave an evident token of difference from all the other kinds of *C. Calisaya,* it appeared from chemical analyses more and more certain, that we had here to do with a hitherto unrecognised type of great richness. Chance had played into our hands, and with this discovery, Cinchona culture entered into a new period, its third [1].

The answering of the question: "From which species of Cinchona, should we propagate by choice?" was thus no longer difficult. We could henceforth steadfastly maintain that the future must be sought for in *C. Ledgeriana,* that joined to it, for the preparation of quinine, only *C. officinalis* could be noticed and for the production of pharmaceutical or druggist's bark, *C. succirubra* deserves the front rank.

With this idea, in conjunction with Moens it was decided and ordered, that all plants of every other variety were to be turned out of the nurseries. Henceforth, no other kinds than *C. Ledgeriana, C. officinalis* and *C. succirubra,* and we have kept strictly to this.

Howard after accurate examination, has ascertained the typical

[1] In truth, the parties interested in South America are perplexed to this day by reason of the richness of the *C. Ledgeriana* bark, of which they can form no idea by want of their own experience. It is considered that in America no Cinchona tree has been found of so rich percentage, and the surprising results in Java, are ascribed to the influence of climate and soil. We by no means subscribe to this opinion.

form of our new *C. Calisaya* and has named it *C. Calisaya*, var. *Ledgeriana* in honour of Mr. Ledger[1].

Since plantations have been made exclusively of *Ledgeriana*, it has been noticed that the trees showed innumerable varieties of leaf, but proportionately as we became more experienced, we learned to point out with certainty the individuals of the common *C. Calisaya* which had slipped into the *C. Ledgeriana* plantations by repairing gaps. Very seldom any doubt existed where flowers and fruit appeared, and in a few cases, chemical examination settled the question. That is to say, after numerous analyses of specimens which differed mutually both in form and colour of the leaf, it was verified that the quantity of the alkaloid was not always constant, whilst the quality and relative proportions were, and that further, chemistry could accurately indicate the type.

In 1873 the first seeds were gathered, and from them, several thousand plants were reared. Meanwhile directly after the discovery of the treasure a beginning was made of artificial propagation by means of cuttings, which however yielded no results commensurate to the material used.

At first all the seeds were used, because the flowering and fruit setting occurred sporadically, but by choice, when more trees beginning to bear fruit, a careful selection and limitation in seed saving became possible and desirable. The examined trees were accurately marked and registered, so that the raiser was and remains in a position to estimate the richness of his plants, and to try the value of them by comparative examination.

Howard has described the Ledger *Cinchona* as *C. Calisaya*, var. *microcarpa*, and has found different sub-varieties amongst the material sent to him from Java, which differ somewhat in shape and colour of flower and leaf, but the small capsules

[1] Quite recently it has been raised to the rank of a distinct species, *C. Ledgeriana*, Moens; see Trimen's Journal of Botany, 1881, pp. 321—325, with two plates. B. D. J.

and small seeds, may be said to be permanent charactistics[1].

Calisaya Schuhkraft according to Howard belongs mostly to

[1] In the „Pharmaceutical Journal and Transactions" of March 13th 1880, Howard has recounted the following particulars as to the origin of the *Calisaya Ledgeriana* of commerce, which he had described in his "Quinology of the East Indian plantations", as well known in commerce as the finest description of Calisaya bark.

"We are indebted not to systematic botanists, but to the experience and sagacity of an Indian, for our knowledge of the best kinds of Calisaya bark; whilst to Mr. Ledger belongs the whole credit of the exterprise of obtaining the precious seed to which the hope of future success attaches in Java and perhaps in other parts of the East Indies.

I have pleasure in *now* recording the name of the above mentioned Indian servant of Mr. Ledger, Manuel Incra Mamani, to whom was entrusted in 1861 the commission of obtaining the seed of the best Calisaya. At page 48 of my (unfortunately) little accessible "Quinology of the East Indian plantations" will be found many details, but I now quote more fully from Mr. Ledger's original letters. Under date December 22, 1864, I find the following: —

"Manuel Incra Mamani delivered the seed he had collected, in June 1865. He then told me that the best bark trees had not produced ripe seed for four years previously. When the trees were full of flower and most promising, a frost (helada) in April destroyed it all. The inferior sorts had not suffered. He had been cutting bark with his sons and patiently waited for opportunity for complying with my orders, obtaining only the best sort.

"He assured me too, he had seen several parties collecting seed for gentlemen in La Paz; that they did not obtain a single good seed till 1865; and this assertion seems now to be corroborated by result of Schuhkraft's remittances in those years.

"After paying him well, he returned to his home in Bolivia, having engaged with me before leaving to obtain more seeds of the Rojo, the Morada, the Nazanjado, and of the Calisaya of Moco-Moco."

The sequel is a sad one. After relating the particulars of the murder of another servant, (Cabreri) Mr. Ledger says.

"Poor Manuel is dead also; he was put in prison by the Corregidor of Coroico, beaten so as to make him confess who the seed found on him was for; after being confined in prison for some twenty days, beaten and half starved, he was set at liberty, robbed of his donkeys, blankets and everything he had, dying very soon after." (Op. cit. 730).

Ledger further wrote, "Manuel assured me that the greater part of the seed came from Rojo trees, he had brought in one bag the seeds collected from about fifty trees, the harvest of many days." This explains a certain divergence in the forms of Ledgeriana; all belong however to the best Calisaya, which we know at the present time as Ledgeriana.

Howard further states, that the Ledgeriana, especially where it is carefully propagated, yields on an average about 10 percent of quinine. He nowhere the variety *C. Calisaya Josephina*, which was formerly described as a bushy form. Although "Schuhkraft's" indeed shows certain characters that way, still in spite of great diversity, it is readily recognised, and the development of numerous individuals in Java, informs us that the tree-form not infrequently occurs amongst them.

For the preparation of quinine, this *Calisaya* cannot come into prominence in comparison with *Calisaya Javanica*, amongst which Howard noticed some evidently different, although he

finds ground for the assertion, that it has originated spontaneously or by hybridization.

The *Calisaya Ledgeriana*, appears then as the legitimate descendent of the noblest variety of the noblest species of the Bolivian forest, and there occurs also in various forms, differing from each other chiefly in the shape of the leaf, but on the other hand agreeing in a high percentage of very pure quinine in their bark. These plants quite early distinguish themselves from the other varieties of Calisaya, and are regularly recognised in Java by their small white flower, which in South America appears to be very sensitive to frost. The bark has a peculiarity quite its own. The cause, why this variety does not reach Europe in large parcels, appears to be, that in Java very properly the trees of less value are cut down, whilst the best are reserved for later growth. On the other hand there is fear that in British India, many of the best *C. succirubra* and *C. officinalis* trees have already been felled.

Howard is not able to refrain from declaring his vexation, that those who have suffered and striven so much to introduce this valuable tree into India should have been so ill rewarded. Ledger sacrificed his labour, and his servant his life, though the first was as little valued by the English government as by the Dutch.

We must here remark, that Ledger appeared to be content with the purchase money furnished by the government of the Netherlands.

It was not known at that time, that the *C. Ledgeriana* exhibited so high a value, and in every case, the seeds alone could not assure the future; this is seen in British India. Dr. King, director of the botanic garden at Calcutta, visited the state plantations in Java, by command of his government. His report is to be found in the April number of the "Indian Forester" and is commendation throughout. He makes a complete statement, that the English in Sikkim also possess the true *C. Ledgeriana* but he recognises that, actually, in consequence of various influences the bark there does not possess so great a percentage of quinine at that in Java. We can scarcely credit this, and entertain better expectation as to the results from the plants which have been received in British India from Java.

ranked it with var. *Josephiana* but approximating more nearly to the tree-form. He was able, like the rest, to define the characters of *Calisaya vera*, and in Java *C. Javanica* is met with as tall sturdy trees as well as bushes.

Calisaya anglica is strongly divergent from the three descriptions just spoken of, it plainly recalls *C. succirubra* both in shape of the tree and the leaf. It betrays however more of the *Calisaya* type, by substance and surface of the leaf, by the *scrobiculi* there found, and by the flower.

In 1866 Mc Ivor sent to us a parcel of Calisaya seed from Madras. Probably this was obtained from the plants which had previously been received from Java. Within six months, these seeds had yielded strong lusty plants, a success which neither before nor after, from no single batch of any kind of seed, has been obtained[1].

In a few years the plants grew into tall stout trees, and at first glance they showed great similarity to *C. succirubra*. Howard supported our suspicion that we here had to do with a hybrid, originating from the influence of *C. succirubra* on *C. Calisaya*. Analysis of the bark also showed contents between that of both species, less than in the first named, but higher than in the second. However, for the preparation of quinine, *C. anglica* has not proved suitable.

Thus there came into Java four chief kinds, classes we might say, — of *Cinchona Calisaya*, and each separately showed numerous varieties, which were however tolerably typical of each description. All the barks are suitable for pharmaceutical use, though only *C. Ledgeriana* yields factory bark, and this it does excellently well. If systematic propagation of all these kinds were carried on, irremediable confusion would ensue, and private speculators, who cannot busy themselves with special

[1] I here testify with emphasis, on the ground of personal experience and experiment during a series of years, that in Java we have *always* obtained the best plants from Cinchona seeds which were sent to us from South America or British India.

scientific examinations and continual experiments, would not be able to entertain the hope of producing rich Cinchona barks. All sorts must be raised in the government undertaking, that a choice may be made, and there also, exist the will and opportunity for distinguishing and disentangling. Since the superiority of *C. Ledgeriana* has been known, only this has been propagated, and gradually all the other *Calisaya* have been cleared away by harvesting, so that at last no more will be kept, than are necessary to keep the species in existence, the aim here intended being of a purely scientific kind.

2. *Cinchona officinalis.* This species was received in 1865 from Madras. Amongst the plants sent, there had also been distinguished three varieties, *C. officinalis crispa*, *C. o. Chahuarguera* and *C. o. Uritusinga.* Subsequently *C. o. augustifolia* was noticed. After the receipt of this first dispatch, seeds were repeatedly sent of *C. officinalis* from Madras, Bengal and Ceylon, and from these constantly fine plants were obtained. In Java a great difference may be readily remarked, but examination of the bark shows always a relatively rich quinine percentage, so that *C. officinalis* after *C. Ledgeriana*, appears the most suitable for the separation of that alkaloid by the manufacturer.

To obtain manufacturer's bark therefore, quite rightly, the propagation of *C. officinalis* is decreed. Which variety or form contains the most quinine, cannot at present be said decisively. Individuals are found with large, middling, small and even a rolled up leaf, though analyses have not yet been able to show assuredly a distinct superiority of any.

On the whole, *C. officinalis* may be distinguished in each known form even by the novice, from the various kinds of *C. Calisaya.* The tree remains more slender, and displays relatively thin branches which soon show a tendency to droop. The leaf is of a dark green, and glossy, generally smaller than that of *C. Calisaya* and the flower distinguishes itself by its purple or violet colour, from the rosier or whiter hue of the former. The bark has a more or less brown tint, and is strongly cleft (grooved) so that the bark, in the older trees, shows itself by lengthwise, as well as transverse indentations, which divide the cork-layer into noticeable, foursided pieces.

Warsewicz has declared that in America *C. officinalis* grows no higher than 12 to 15 feet, and that it can be treated successfully in the European copsewood fashion. Indeed it shoots quickly and thriftily from the felled stems, and cuttings may be taken from the plant with the best result. In Java there are numerous trees of 7 to 8 years of age, which by measurement, have already reached more than 20 feet in height, and Pavon described the species *C. Uritusinga* discovered by him, as a tree of 60 feet and more.

C. officinalis therefore is a rich species and we may add that it is one of the most ornamental; it appears however especially susceptible to climate and soil, and thrives by preference in the higher districts. For culture in Java on a large scale, it is probably less suitable on account of its delicacy; most plantations remain backward, and were also visited most heavily by disease (Cinchona rust), so that frequently extensive plantations, must be written off as promising little.

Moreover in this species of Cinchona, the assurance has been decisively given in Java, that propagation by seeds does not necessarily lead to degeneration from the type, or from the bark-contents. On the other hand we have to state, that seeds received from British India have always yielded stronger plants, than those harvested in Java. This fact declares the desirability of exchange in regard to Cinchona seeds.

3. *Cinchona succirubra.* The young plants considered originally by Junghuhn to be this species, had no right to the name, later they appeared to be *C. caloptera*, (see under No. 7). The first true *C. succirubra* were received from Bengal in 1862, twelve in all. From 1866 seeds have several times been sent

to us from Bengal, Madras and Ceylon, and in Java *C. succirubra* was energetically multiplied by cuttings with the best results.

No description of *Cinchona* grows quicker or more robustly, or is more readily propagated by cuttings. *C. succirubra* developes itself in 6 to 8 years to a vigorous tree, with thick branches, and large, light green leaves. The flower is pale rose-red. At seven years old, individuals have been measured 34 feet high, by a stem-circumference of eighteen inches to two feet. The oldest tree in 1874 was about 13 years old, 13.260 metres high, and 0.721 round the stem [1].

There is no *Cinchona* bark richer in alkaloids, and though *C. succirubra* from which "red bark" is obtained, is not suitable for the preparation of quinine, because it can only be extracted with trouble and much expense, yet it has a preponderance of the secondary alkaloids.

No better material for pharmaceutical purposes is known, and on that account its propagation is desirable from every point of view [2].

We have learned thus to know the three previously described species of *Cinchona*, which were necessary and best for our culture; they are mutually so easily distinguishable, that there can be no fear of confusion between them.

As the extremes in form, as well as the power of development, we may name *C. succirubra* and *C. officinalis*. The latter remains a slender tree, with thin, drooping branches; the former grows tall and robust, and betrays itself at a distance by its large leaves. The stem of *C. succirubra* is seen to be light coloured, that of *C. officinalis* is relatively darker.

[1] About 43 feet, and 2 feet 10 inches respectively. B. D. J.

[2] It is truly remarkable, that although De Vrij as far back as 1876 had directed the attention of government thereto, the East Indian *C. succirubra* is still not rightly appreciated as an official Cinchona bark. People only know what is familiar to them, the above mentioned barks are not properly known because they are in each case considered to be of inferior quality.

Between these two types, comes *C. Ledgeriana* which offers an endless diversity. Its crown of foliage betrays itself at a distance by its peculiar brown tint, and the colour of the stem is midway between both the other species, whilst the branches grow more vertically, forming an acute angle with the stem, similar to *C. lancifolia*.

Whoever has once seen the three species together, (provided he has no other species under his eyes), has conviction so strongly impressed upon him, that all hesitation in the definition of their identity is removed.

4. *Cinchona Pahudiana* Howard. We have already fully detailed the history of this species. No single private planter has brought it into culture; the species grows exceedingly well, but in mature age yields no better result than when young. Moens found in a 20 year old tree no more alkaloid than as a rule, younger individuals had shown. It will not be soon extirpated in Java, especially as there are still specimens remaining scattered in the forests.

C. Pahudiana distinguishes itself by its coarse hairy leaf, and in outward appearence it approaches nearest to: —

5. *Cinchona Hasskarliana*, about which we have nothing more to say, after our account already given of its origin. It is distinguished from *C. Pahudiana* by a finer leaf, which is also less hairy, and moreover displays the oft mentioned *scrobiculi*. On the whole, the tree grows fuller and broader; whilst its bark contains less alkaloid than the common Calisaya. In 1864 many plants were obtained from cuttings, which grew up into stout trees, the bark of which was of excellent thickness and good appearance. At least two varieties of *C. Hasskarliana* are to be found, one with short thick capsules, the other with long; the former which has also a more shiny and less hairy leaf, is considered the better.

6. *Cinchona micrantha*. One specimen was received in 1862, together with the 12 *C. succirubra* from Bengal. We have

never purposely set ourselves to propagate this, on the ground of the inferior quality of its bark. The shape of the tree is like that of *C. succirubra* but its leaves are tinted brown, and the stem approaches that colour. Amongst the plants which were raised in Java from *C. succirubra* seeds received from British India, many *C. micrantha* were met with. In the early years of Cinchona culture, the English appear to have bestowed little attention to keeping the different Cinchona species separate, and thus degeneration and mingling occurred.

7. *Cinchona caloptera.* In form this is between *C. succirubra* and *C. micrantha; C. caloptera* has also a large leaf, harder and rougher than that of the two species named, and further is to be ranked between both, as regards its colour. Junghuhn had discovered it amongst *C. Pahudiana* (at that time *C. ovata*) and it was brought forward as *C. succirubra.* The same species was obtained in 1870 from seeds sent from New Grenada.

8. *Cinchona lancifolia.* This in America grows at a greater elevation than any other Cinchona, and yields the Pitayo bark so much in demand, and said to possess 2 % of quinine.

Dr. Karsten collected seeds of this species in America, which he was kind enough to send to the Dutch government; this we have already mentioned. *C. lancifolia* developes into a tall tree, whose shape, leaves and flowers, comes midway between *C. Calisaya* and *C. officinalis.* Its growing power in Java does not appear out of the common, though the isolated propagation of this species has not been purposed long, because its bark was not considered suitable for the separation of quinine. It is quite true that examination has shown some very rich specimens, but these were exceptions, and there is every reason to believe, that *C. lancifolia* degenerates by propagation. Howard was unable to recognise some material sent to him, as being of Karsten's species.

With these remarks we conclude our discussion of the species.

Purely scientific botanical descriptions lie outside the plan of this work; those who desire it, may consult the works on the subject given on page 11. Our aims are confined to that which can be called important and useful to the planter and to industry.

We once more emphatically repeat, that seeds from the same tree, as a rule yield plants of very diverse forms; thus we are sure that crossing occurs in very many cases. The habit of young plants however, is apt lead us astray by too hasty determinations; with development of the individuals, the differences mostly vanish, at least the forms sometimes change. Hybrids occur abundantly in all species, and this need not be thought amazing.

Cinchona plantations were really like a pattern-card of species and varieties, and as long as the period of experiment continued, there was nothing to alter therein; it was an absolute impossibility, to strictly isolate iudividuals. In proportion as extensive plantations of the valuable species came into condition, and in these, more trees began to flower, the chances of fertilization with foreign pollen were naturally restricted, and from the oldest *C. Ledgeriana* nurseries, those individuals could gradually be weeded out which were of doubtful parentage, or seen, by means of analysis to be really inferior.

These improvements came by degrees, and by careful selection it was possible to aim at the enriching and perfecting an entire plantation.

Chemical analyses have shown that an intimate connection exists between the form of a tree and the quality of its bark. Consequently by diligent observation in a plantation of a particular kind, the hybrids may readily be distinguished, and these it is well to eliminate betimes, or at least, in case of harvesting, to bring them into the market.

The following statements may give an idea of the comparative development of the plantations.

There were in the open ground, by the end of the years

1863	1864	1865
531,000	813,000	909,000

Pahudiana plants all of which had been raised under Junghuhn's direction. Since 1864, this species has not been propagated, only those which were to hand in the nursery beds, were planted out. Several thousand plants were put out in the open ground at Rioengoenoeng and Lembang.

It happened at the latter place that on account of the poor soil and other reasons, few prospered; at the former, the very few individuals which were planted out, in 4 to 5 years developed into thriving harvestable trees.

After 1865 the *Pahudiana* figures in the reports underwent no change, though it is evident that their accuracy could not be ensured, scattered as the individuals were in extensive forests, where they were continually perishing by thousands, or destroyed by wild beasts, falling forest trees, etc. Permission was therefore asked, and accorded by decree of 15 February 1870, in future to omit all mention of *C. Pahudiana.*

The reports show, that at the end of each year, there were in the open ground as follow: —

	Calisaya	Succirubra	Officinalis	Lancifolia	Micrantha
1864	11,000	81	—	171	1
1865	27,000	341	12	332	1
1866	56,000	792	2,400	418	1
1867	198,000	3.100	9.400	569	3
1868	429,000	12,700	24,000	570	386
1869	564,000	45,000	61,000	797	414
1870	843,000	130,000	120,000	6,400	758
1871	1,009,000	164,000	188,000	16,000	1,050
1872	1,235,000	179,000	262,000	27,000	1.030

With this the third period may be said to be closed, for henceforth the rule has been to propagate *C. Ledgeriana* and

C. officinalis exclusively, and to keep the *C. succirubra* plantations at full strength.

Amongst the *C. Calisaya* figures, the *C. Hasskarliana* are hidden, and amongst those of *C. succirubra* the *C. caloptera*, of which altogether 10,000 must have propagated, whilst the total *C. Hasskarliana* have never exceeded 80,000. Up to 1866 there were not more than 12 true *C. succirubra* noted; the rest, brought forward under that name were *C. caloptera*, raised from cuttings. Good seeds of *C. lancifolia* were harvested first in 1870, of *C. caloptera* already in 1867, though then also were *C. succirubra* seeds received from British India. In August 1866 the first *C. Ledgeriana* were put out, they were then noted as *C. Calisaya*.

In the following statement we now only mention the three principal varieties, which have been, and still are since 1872 exclusively propagated.

	Ledgeriana	Officinalis	Succirubra
1873	10,000	337,000	190,000
1874	44,000	426,000	185,000
1875	105,000	491,000	179,000
1876	167,000	504.000	162,000
1877	197,000	507,000	157.000
1878	353,000	535,000	177,000
1879	355,000	377,009	219,000
1880	498,000	401,000	278,000[1]

The richest parent trees were always reserved for propagating *C. Ledgeriana*, and in proportion as these began to flower and fruit in abundance, it was possible to become more exacting, and therefore the very finest of the best were exclusively reserved for seeding.

If it were still possible that the decendants should seem to

[1] At the close of 1880, there were besides in the nurseries 272,000 *Ledgeriana*, 208,000 *succirubra*, and 80,000 *officinalis*. Furthermore in the open ground, 630,000 *Calisaya* and *Hasskarliana*, 16,700 *lancifolia* and 260 *micrantha*.

fall away from their percentage of quinine, still on the average, rich barks would be harvested. This illusion if it be one, depends upon facts already experienced in other species of Cinchona, and is at the present time, not disproved by the analytical results from descendants of 3 to 4 years old. These indeed do not yet possess the *quantity* of the parent tree, but the *quality* is seen to be identical. Four year old trees are as a rule not developed enough to yield a ripe, mature bark of much consequence. The first thing to be kept in mind, is, to be sure of having the typical form in the offspring, for the qualitative composition corresponds to the form.

CHAPTER VIII.

CHEMICAL INVESTIGATIONS.

In the year 1820 Pelletier and Caventou happened to discover the existence of alkaloids in Cinchona bark, and to separate two of them, which were named Quinine and Cinchonine.

In 1833 Henry and Delondre discovered a third alkaloid, which later become better known through Pasteur's labours, and since then has been termed Conchinine. In 1847 Winckler found Cinchonidine; in 1872 Hesse did the same by Quinamine and Paricine, and in 1879 A. C. Oudemans detected Cinchonamine. Quinamine and Paricine have thus far only been met with in certain *C. succirubra* barks from British India. From the bark of *Buena hexandra* as early as 1845, Paricine had been separated by Winckler. Oudemans found his Cinchonamine in Quinetum, a preparation said to contain all the alkaloids of the bark together, which we shall later on treat of more at length.

Aricine, Cinchovatine, Cusconine, Javanine, and others, are less known alkaloids, which have been met with in certain barks, such as that of *C. pubescens*, and Javan *Calisaya*.

Besides the foregoing crystallizable alkaloids, the majority of cultivated varieties of Cinchona have also some which do not crystallize, termed by the analytical chemist *amorphous* alkaloids. They remain combined with acid in the mother-liquor, from which the crystallizable bases have already been separated, and are thence thrown down by ammonia as a dark-brown, brittle, slightly alkaline precipitate, which fuses below 100° Cent. and is named Quinoidine. It is brought into commerce as a slightly coloured muriate or sulphate, and is extolled by many as a cheap substitute for sulphate of quinine.

Further, three kinds of acid have been met with in Cinchona barks, tannic, quinic and quinovic acids. We confine ourselves at present, to the simple statement; we shall deal with the previously mentioned alkaloids, at the conclusion of this subject in its general bearings. The last word has not yet been spoken by the chemist, and debate has long continued over the nature of the various alkaloids, whilst their number has constantly increased, so that a presentation of the enquiry may as soon bring a still greater complication to light, as a simplification of the existing state of things.

It may be that some alkaloids which are thought to be pre-formed in the Cinchona bark, are merely the results of the chemical treatment of the raw material. Thus Mulder and others allege, that Quinidine as such, does not occur in the bark. Investigation of the living tree must be continued for many years yet; who knows whether we may not find out that Nature changes one form into another? In that case, we may indulge the idea, that under the hand of the manufacturer or analyst, similar processes may come to pass.

Meanwhile it is a remarkable fact, that the various Cinchona types, with regard to their alkaloids, qualitative at least, remain tolerably constant, and thus the planter has to prevent deterioration by choice in propagating.

When the first alkaloids were separated, it was evident that the principal power of the raw material was sought for, and therapeutic experiments confirmed this opinion. Quinine appeared the febrifugal specific, and thus in the treatment of fever patients, it came to supplant the use of the bark in its entirety.

We shall bye and bye devote a special chapter to the use of Cinchona bark and the value of its various constituents. We must now fix our attention on the results of chemical investigations, in so far as they can be called in the first place useful and important to the planter.

In the year 1857, Dr. J. E. De Vrij, who during several years had busied himself in quinological studies, and whose name as a chemist was of high repute, returned to Java as Inspector of chemical investigations. As a fellow worker with the naturalist Junghuhn, valuable results were expected, and for six years De Vrij devoted his rare chemical attainments to the interests of the young Cinchona culture.

The material for an extended investigation, and for methodical, orderly and regular experiments, was up to 1863 limited, and thus even from the most earnest endeavours, there could be no results expected, of real decisive usefulness.

In 1863 De Vrij returned to Europe, and remained there, unweariedly devoting his time to quinological researches, by which, above all, the support of the already more advanced English planters was assured to him.

Simultaneously also, Howard, Hesse, Kerner, Oudemans, Van der Burg, Stoeder, Broughton, and many other untiring naturalists and analysts, were busy about the subject, but no one more so, or more fortunate in opportunity of realising the fruit of his activity than J. C. Bernelot Moens, who from 1864 to 1872 uninterruptedly superintendended all the analyses, which were committed to him by the Director of Cinchona culture in Java, for the appraisement of the imported species of Cinchona. In the middle of 1872, Moens was appointed chemist to the Government culture, since when hundreds of analyses of most diverse material, display not merely the results of his uncommon powers of work, but also decided many pending questions.

This is not the place to follow up the scientific aspect of the plan adopted, or the course of the investigations; we must confine ourselves to showing the results obtained. For so much as this is meant as an indication of the relative value of cultivated Cinchonas, tabular statements of the results of analyses of samples of bark, appear the most suitable to us. All the remaining results we condense into small compass, and we can do so honourably, because before long by Moens's own hand, a work on Cinchona will appear, which promises to give a clear and ample account of the subject, from the present scientific standpoint.

Ledgeriana. 175 samples of bark, cut from the same number of parent trees of this kind, (raised from Ledger's seed and mostly planted in November and December of 1866) were during the years 1872 to 1878, tested for amount of alkaloid. The following summary will give an idea of the composition.

Date when examined.	Number of samples.	Alkaloid. [1]		Quinine.		Average amount.		Number of samples.	
		minimum.	maximum.	minimum.	maximum.	Alkaloid.	Quinine.	Quinidine	Cinchonidine.
1872	7	3.88	9.07	3.35	8.15	7.08	5.58	2	—
1873	20	2.24	14.31	0.65	10.90	8.58	6.06	8	8
1874	29	5.93	12.97	3.82	11.68	9.56	7.37	8	7
1875	14	7 91	12 28	4.39	10.72	9.79	8.26	1	3
1876	52	4.67	13 35	2.57	13.25	8.86	7.23	6	6
1877	19	4.90	13.50	1.67	12.31	8.56	7.06	3	4
1878	54	4.64	11.67	3.22	10.67	8.59	7.34	1	9

[1] At the time of packing, the barks hold about 13.5 % of water. If the percentage of alkaloid in an air-dried state is wanted, the averages must be multiplied by 0.86.

It is quite evident, that the identity of certain individuals in the Ledgeriana plantations was doubted reasonably. The doubt became certainty through the results of the analyses; though these were given in the tabular statements, and thereby the averages are actually not high enough for the genuine Ledgeriana. Before this kind was known in Java, it was considered that American barks with 3 °/₀ quinine were of very good quality; barks with more than 5 % were held to be exceptionally fine. This fact gives cause for consideration. We now know that Ledger's seed was obtained from fifty trees, and the seedlings must thus represent a great diversity of forms. From America however, there was nothing brought into commerce of so rich an amount, and this confirms our opinion that the Cascarilleros bestow too little care upon the selection.

Quinidine and Cinchonidine were found exceptionally in Ledgeriana bark, they only occurred together in three cases; Cinchonidine showing itself the most. Quinine is predominant, and the quantity remains constant in each case; it amounts to 70 or even 80 % of the total alkaloids and is accompanied merely by a little Cinchonine and amorphous alkaloid. It is this proportion which causes the separation of quinine to be so easy and so clean.

From the amounts of the produce in bulk, meanwhile more accurate exhibitions were obtained, whenever the results were compared with the analyses of samples taken from cases and bales. It was quite possible here and there to lay the hand upon a specimen which was not derived from the true Ledgeriana; (indeed for repairing the original plantation, other Calisayas, such as Calisaya Javanica, were used) but although the analyses of such a sample might give lower figures, yet in the bulk of the bark, usually 65 to 75 kilos per case or bale, the few quills of poor quality could not be said to have a considerable influence.

Crop.	Total packages.	Net weight of bark in $\frac{1}{2}$ kilos.	Total Alkaloid.		Quinine.		Average agreed price per $\frac{1}{2}$ kilo in francs.
			minimum.	maximum.	minimum.	maximum.	
1872	4	522	6.72	7 42	5 24	5·48	5.02
1873	23	2,944	6.84	8.58	5.48	6.69	3.87^5
1874	28	4.500	4.5	9.6	3.2	7.4	3.70
1875	28	4,452	5.6	8.3	3.9	7.2	3 86
1876	29	3,925	5.0	8.3	3.9	7.2	8.79
1877	19	2,419	5.1	8.5	4.1	7.0	5.61
1878	66	8,009	6.3	9.6	5.0	8.0	6.31
1879	61	7,850	6.1	8.1	6.0	7.0	4.46—10.51
Total	258	34,619					

In 1878 a trial was made of the outside scrapings (or shavings) from Ledgeriana. The produce was brought to market as scrapings in 12 cases, 1620 half-kilos, and here fetched 9 francs per half-kilo. Two samples contained 9.5 and 7.5 alkaloid, of which 8.3 and 6.7 were quinine. It is therefore of especially favourable proportions, which well deserve attention, against the fact that the Cascarilleros are wont to deprive the thick branches of their epidermis by brushing. Cinchona barks *sine epiderme* have long been shown to be the most costly; in truth however by this brushing the finest portions are lost. For this discovery, as will appear later on, we have to thank the regular methodical investigation of Moens.

In 1879 there were 5 cases harvested, containing 544 half-kilos, of scrapings. By advice of the Examination-commission in the Netherlands, the term *schilfers* (scales) was given to them. Analyses showed 9.1 alkaloid, of which 7.8 was quinine; this time also the highest prices were realised for the scrapings.

Numerous examinations of 3 to $4\frac{1}{2}$ year plants, reared from Ledgeriana seed, obtained in Java, seem even now to lead to the encouraging declaration, that no degeneration, in a chemical sense, has taken place, and that in each case, the plants which most resemble the parent trees, agree most nearly also in chemical composition. The quantity of alkaloid is indeed smaller; but in such young individuals the maximum amount cannot be expected, and the chief and principal thing is, that the quality of the occurring alkaloids should be in harmony with the parent trees [1].

C. officinalis. In 1872 a young tree of four years old was examined, it contained 4.36 alkaloid, 1.75 being quinine. In 1873 the figures of the analyses of 13 trees ran thus: — alkaloid, 3.73 to 8.65, average 6.77 %, and quinine 1.75 to 7.52, that is, about 4.17 %. In 1877 in one tree there was found 3.01 of quinine in 4.05 of alkaloid, and 8 trees examined in 1878, showed 3.39 to 6.05, average 4.77 alkaloid, of which 1.74 to 4 95 or about 3.07 % was quinine.

Cinchona officinalis thus yields a bark of great value for quinine manufactures, and comes immediately after Ledgeriana. Experience has already abundantly shown that the amount of quinine is not lessened in consequence of propagating by seeds; there is no apprehenion of degeneration, either in a chemical or botanical sense. There are many hybrids met with amongst this species, which probably owe their existence to the action of foreign pollen. Their recognition is however less difficult than in Ledgeriana, because through all its varieties *C. officinalis* remains a very characteristic species of the genus.

It is not a specially productive kind; but it may very likely be that the existing plantations are not best adapted for it, as regards their soil and elevation. In general it may be seen as a slender plant, and admeasurements, even of fully developed trees, seem relatively slight. Altogether the *C. officinalis* culture may be said to be the least successful, although in the

[1] From a private plantation in Pekalongan recently there were barks examined at Amsterdam, from 2 year-old Ledgeriana, which appeared to possess 1 2 % quinine, neither cinchonidine nor quinidine, with 0.25 cinchonine and amorphous alkaloid; a result indicating a very pure type.

government plantations, many handsome specimens may at all times be met with, and certain plantations were developed fully and advantageously.

The following summary confirms the foregoing statement.

Crop.	Total packages.	Net weight of bark in 1/2 kilos	Total alkaloid.		Quinine		Agreed price per 1/2 kilo in francs.
			minimum.	maximum.	minimum.	maximum.	
1872	8	814	more than 4 % alkal. of which 50 % quinine				2.01
1874	6	665	6.6		4.6		?
1875	18	2,021	5.7		4.2		about 2.59^5 6.25 and 3.23^5
1876	32	3,751	4.9	5 7	3 5	4	(in 2 auctions)
1877	34	3,347	4.8		3.0		about $2\ 98^5$
1878	25	2,702	3.7	4 8	2	3.1	2.41 to 3.30
1879	30	3,365	5.3	6.8	1.2	4.6	2 41 to 5.94
Total	153	16,665					

If now a comparison be made of the crops of Ledgeriana and Officinalis barks given on pages 104—5, then the far poorer returns of the Officinalis culture will be plainly apparent. When at the close of 1866, the first Ledgeriana were planted out, to the number of about 12,000, we had it is true only 2,400 young trees of *C. officinalis*, but that figure was already increased to 24,000 in 1868, and by 1870 to 120,000, whilst the propagation of the Ledgeriana first acquired significance in 1873. Up to and including 1879 there were not more than 16,665 pounds of Officinalis bark harvested against 34,619 of Ledgeriana, and moreover it must be remarked that of the original Ledgeriana plantation of more than 12,000 trees, to the present time about one half remains untouched. From this half, at most single branches have been taken.

The raising of *C. officinalis* is not deprecated here; it is effected both by cuttings and seeds, and the trees produce a handsome bark, readily distinguishable, relatively rich in quinine, and it fetches a high price. We were not fortunate at the commencement of the plantations, but where good soil is reserved for it, and a suitable elevation above the sea is chosen, (it grows by preference in the highest regions) the results will be satisfactory; riper experience of recent years guarantees this[1].

C. succirubra. No description of Cinchona grows more quickly, thriftily, robustly and seems to require less actual needs as to soil and position than this; there is also no other which has more alkaloid throughout. Amongst these, however quinine occurs in relatively so insignificant a quantity, that the bark is unsuitable for the preparation of that alkaloid. On the other hand, amongst the many varieties of Cinchona, there is no plant known which is more advantageous to cultivate, or has so quickly found and surely held its position for pharmaceutical purposes. It is needless to give a statement of repeated analyses, they all indicate high figures which run from 6 to 10 %, in a single case remaining below the minimum, but sometimes exceeding the maximum. McIvor showed that the amount of alkaloid, especially the quinine, can be increased by covering the stem with moss, also by partial stripping of the tree, in whose renewed bark an enhancement, of even higher proportion, has been ascertained. Meanwhile, in spite of the increased quinine percentage, the improved bark must remain less in demand for manufacturing purposes, so long as the manufacturer can manage to get material in which the quinine predominates; the equivalent greater bulk of secondary alkaloids makes the separation of pure quinine, troublesome and costly.

The following statement displays the quantity produced and the value of Succirubra culture in the government plantations in Java.

[1] It may probably be worth while to plant *C. officinalis* between *C. Ledgeriana*, and when fairly developed, to make use of the latter first.

Crop.	Number of packages.	Total alkaloid.		Quinine		Quantity of bark dispatched in $^1/_2$ kilos.	Market price per $^1/_2$ kilo in francs.
		minimum.	maximum.	minimum.	maximum.		
1872	5	—	—	—	—	724	1.14 to 1.16
1873	36	9.19	9.46	0.74	1.5	4.425	1.07^6 throughout.
1874	109	6.1	8.6	0.5	0.8	14,249	0.85 »
1875	125	6.2	9.2	0.6	1.1	16,502	1.43^5 »
1876	290	6.1	8.6	0.6	1.0	38,769	1.62 & 1.30 throughout. (two sales.)
1877	293	6.0	8.7	0.7	1.4	38,188	0.86^{37} –
1878	349	6.4	8.6	0.9	1.2	43,525	0.97 to 2.55
1879	199	6.0	8.0	0.6	0.9	25,207	1.30 to 3.62
Total	1405					181,509	

If the statements on pages 104—5 showing that the planting of *C. succirubra* which in 1868 first attained any importance, 12,700 plants being then in the open ground, amongst which however, *C. caloptera* was still included, be again referred to, it will be seen that no variety of Cinchona can be cultivated in Java, with better prospect of speedy and ample production. If it were certain that good prices would be maintained, then without doubt, preference should be given to the culture of *C. succirubra.* But as long as quinine is wanted, and it is not supplanted by the secondary alkaloids, or frequently replaced by them, so long can there be no satisfaction in cultivating *C. succirubra* to the exclusion of all other kinds. The market may easily be oversupplied with the so-called pharmaceutical or druggist's barks, to which *C. succirubra* belongs, so that the heavy fall in prices thence resulting, would make the profits of this culture very questionable[1].

[1] De Vrij has remarked that the *C. succirubra* barks which are brought to market from private plantations in Java, are less rich in alkaloids than those of the government plantations, and he very justly wonders at it, because the private

In our analytical tables we have not taken up the relative amounts of *schilfers* (scales), the uppermost and richest part of the bark, *gruis* (dust), waste, mostly of inferior quality, *gemoste* (mossed) or *geregeneerde* (renewed) bark, which seems richer than the original, uncovered bark, and the root-barks, in which as a rule, more alkaloids are met with than in the stembark. The figures cited have thus relation to normal barks.

In the case of Ledgeriana, the root-barks attain the highest prices because they are the richest. Dust and waste fetch the lowest prices, not only because they are mostly of inferior quality, but also because they can with difficulty be selected by the eye.

What we have hitherto enumerated concerning the three chief varieties of Cinchona, is sufficient to give an estimate of their value. There is not a single planter who has taken up the culture of the remaining varieties imported into Java; so that we have not to deal with them in detail, and as to the latter we can complete it with a tabular statement of the results of the analyses of samples drawn from various crops.

estates in British India do not share in that decline. We here note, 1st That private planters in Java probably strip their trees while young, and 2nd That *C. succirubra* raised from Javan seed are usually more or less deteriorated. Since it has been practicable to harvest seeds from extensive, fully developed enclosures, the danger of deterioration is certainly lessened. It is a fact, that by far the most Succirubra barks, which the government has brought to market to the present time, were harvested from trees raised from British Indian seed, and cuttings from them.

Crop.	C. javanica.		C. Schuhkraft		C. anglica.		C. Hasskarl-iana.		C. caloptera.		C. lancifolia.		C. micrantha.		C. Pahudiana.	
	alkaloid.	quinine.	alkaloid.	quinine.	alkaloid.	quinine.	alkaloid.	quinine.	alkaloid.	quinine.	alkaloid.	quinine.	alkaloid.	quinine.	alkaloid.	quinine.
1873	2.41	0.28 1.43	2.42 2.43	0.37 0.47	5.28	0.86	5.74	2.05	. . .	. . .	. . .	. . .	. . .	. . .	1.4	0.16
1874	. . .	. . .	. . .	. . .	. .	. . .	1.5 5.0	0.2 2.1	5.6	0.7	. . .	. . .	. . .	. . .	1.2	0.2
1875	2.2 4.6	0.3 1.7	3.2	0.4	5.9	1.7	2.0 4.2	0.5 2.0	. . .	. . .	. . .	. . .	3.7 3.9	0.1 0.1	1.4 1.7	0.2 0.3
1876	2.5 4.0	0.2 0.5	2.1 2.7	0.2 0.5	. . .	. . .	2.8 4.5	0.9 2.0	3.6	0.4	. . .	. . .	. . .	. . .	. . .	. . .
1877	0.9 4.8	0.2 1.7	1.9 2.8	0.3 0.6	. . .	. . .	1.3 4.1	0.3 1.2	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
1878	1.7 4.9	0.4 1.2	1.5 3.9	0.3 1.1	4.8	1.0	2.4 3.8	0.2 1.2	2.0 3.8	0.4 0.9	4.3 7.2	1.0 1.8	. . .	. . .	1.5	0.3
1879	2.8 4.4	0.8 1.6	1.9 3.6	0.4 1.1	4.6 6.1	0.7 1.3	2.4 4.4	0.4 1.8	. . .	. . .	. . .	. . .	. . .	. . .	1.5	0.3

It is plainly apparent that amongst these species, *C. Pahudiana* lags behind all through, whilst *C. lancifolia* excels all the rest. As the latter is of particularly robust growth, its propagation should be taken into consideration.

C. Hasskarliana produces an excellent druggist's bark, and by careful selection, it would yield plenty of material even for quinine manufacture. Javanica and Schuhkraft run close together. Of Anglica the same can be said as of Hasskarliana. Meanwhile all taken together, there is no more room for doubt or hesitation, and most properly, *C. Ledgeriana*, *officinalis* and *succirubra*, were chosen for exclusive and regular culture. It is remarkable that principally in the eight inferior kinds of Cinchona, the greatest percentage was found in the bark of the roots.

In Ledgeriana and Officinalis bark, quinine is always the prevailing alkaloid. Quinidine occurs in some specimens of the former, but is not always indicated in Officinalis, and was virtually absent from Succirubra, with the exception of a few barks from stems which had been covered with moss. On the other hand Cinchonidine is constant, and in considerable measure in Succirubra and Officinalis; in Ledgeriana it is, as with quinidine, not continously met with, but much more often in the latter. Root-bark of Ledgeriana contains less quinine than the stem-bark, though it has more Cinchonine and often Cinchonidine also. In Succirubra and Officinalis, the root-bark as a rule appears richer in alkaloid, and sometimes even to have more quinine than the stem-bark; the amount of Cinchonine is in *all* root-barks greater than in the stem-bark.

The following results, of importance chiefly to the planter, were obtained by experiments extending over many years. Moens himself owns that they are not decisive in every point, and that methodical examination, systematically pursued on the living trees, has yet to confirm or throw more light upon certain phenomena.

Time is essential for the formation of the full quantity of alkaloids in Cinchona bark. Under a certain time, in conjunction also with individual development, the normal typical percentage of alkaloid in the tree is not formed; beyond a certain age, having regard to the degree of development, the percentage does not increase.

This fact may be ascertained by analyses of various trees of different periods, and on barks of similar origin, but of different ages.

Certain full-grown trees were divided into similar pieces, and these were separately subjected to examination. By this method, in the first place, the age of a bark would be ranked the younger, in proportion as it was taken at a greater height from the stem, or thinner, newer branches.

In 1872 Moens examined a *C. succirubra* tree, 6 metres in height, which was sawn into six pieces of equal length. The bark from each piece was separately powdered, and a sample of that powder analysed. The bark of the entire stem and its large branches, weighed, when dried in air, 1.68 kilograms, of which:

0.44	kilo	yielded	by	the	lowest	1/6	part	of	the	stem.
0.33	„	„	„	„	„	2nd	„	„	„	„
0.28	„	„	„	„	„	3rd	„	„	„	„
0.23	„	„	„	„	„	4th	„	„	„	„
0.11	„	„	„	„	„	5th	„	„	„	„
0.05	„	„	„	„	„	6th	„	„	„	„
0.24	„	„	„	thick branches.						

The total percentage of alkaloid of the three lowest portions, therefore to three metres from the ground, appears sufficiently equal; as also the amount of quinine, although the portions could not embrace the same period of life, for the third metre was positively fully two years younger than the first. Insensibly the percentage of alkaloid decreased as it neared the top. The fourth and fifth portions have very much of a mutual agreement. Up to and in the youngest portion, the *nature* of the alkaloids is identical, and in it, even relatively, as much Cinchonidine found as on the oldest pieces. The bark of the branches agrees most with that of the youngest part of the stem. There were found:

	Water.	Ash.	Total alkaloid.	Quinine.	Cinchonidine.	Cinchonine.	Amorphous alkaloid.
In the lowest portion . . .	11.71	4.69	7.23	0.85	2.35	2.94	1.09
second.	12.28	3.14	7.55	0.76	2.95	2.74	1.10
third	13.63	2.90	7.01	0.83	3.09	2.07	1.02
fourth	12.03	2.97	6.38	0.58	2.38	2.58	0.84
fifth	12.12	3.51	5.95	0.58	1.87	2.60	0.84
sixth	12.67	4.12	4.49	0.39	1.48	1.59	1.03
seventh (branches) . . .	13.06	5.89	3.83	0.23	1.22	1.30	1.08

Quinidine was not indicated; in normal Succirubra this alkaloid which in therapeutic value is sufficiently similar to quinine, is not met with.

In 1879 Moens took a still more accurate test with a 13 year-old Ledgeriana of 9 metres height. The results are combined in the following statement.

	Total alkaloid.	Quinine.	Quinidine.	Cinchonine.	Amorphous alkaloid.
Bark from the thickest roots	7.67	4.85	0.11	2.32	0.39
Barkscrapings from the same	2.42	1.74	. . . . .	0.66	0.02
Bark from the thin roots	10.—	8.31	0.27	0.85	0.57
Stem-bark					
1 decimetre above the ground	8.65	7.63	. . . . .	0.61	0.41
5 » » » »	9.25	8.17	. . . .	0.74	0.34
1 metre » » »	10.60	9.04	. . . . .	1.04	0.52
1½ » » » »	10.26	9.10	. . . . .	0.54	0.42
2 » » » »	9.04	8.32	. . . . .	0.41	0.51
2½ » » » »	9.48	8.87	. . . .	0.30	0.31
3 » » » »	8.50	7.83	. . . . .	0.52	0.15
3½ » » » »	8.12	7.62	. . . . .	0.30	0.20
4 » » » »	8.11	7.59	. . . . .	0.32	0.20
4½ » » » »	9.05	8.45	. . . . .	0.35	0.25
5 » » » »	9.91	9.24	. . . .	0.38	0.29
5½ » » » »	8.48	7.93	. . . . .	0.41	0.14
6 » » » »	7.13	6.33	. . . . .	0.60	0.20
6½ » » » »	5.71	4.76	. . . . .	0.80	0.15
7 » » » »	2.65	1.72	. . . . .	0.72	0.21
Bark from the thickest branches	8.49	7.40	. . . .	0.42	0.29
» » » medium »	5.34	4.63	. . . . .	0.64	0.45
» » » thin »	1.09	0.64	. . . . .	0.27	0.18

Thus was confirmed, that in this species the amount of Cinchonine in root-bark increases greatly, whilst quinine diminishes; the latter remains even to a great height up the stem, as an important factor. The bark of the thick branches is similar to that from the stem, whilst that from the young branches approaches more to that of the stems of younger trees. In 1879 the two-year shoots (new stems) which had grown from the stump of an eleven year old Ledgeriana previously felled, were examined There were found in this still very young bark, 4.8 % alkaloid, of which 2.86 % was quinine, 1.43 % cinchonine and 0.6 % amorphous alkaloid. In plants of three and four years of age, raised from seed in Java from the Ledgeriana originally planted, there was found 10.55 % alkaloid, and 7.69 % of quinine.

Numerous young descendants of parent trees whose percentage was known, were examined, and the analyses have yielded the satisfactory result that no fear need be entertained of any decrease in percentage. It is true that many young plants gave comparatively low figures, but in most cases certain divergencies from the form of the parent tree might be remarked in the individuals themselves. The careful and experienced raiser can very well avoid the danger of mixing rich barks with the poor ones.

If it is now undoubtedly made out that the amount of alkaloid in the different portions of the stem, is more or less diverse according to its age, not the less sure is it, that the amount does not regularly increase with the age of the bark, that is, certain limits cannot be exceeded, and normally developed trees, from six to eight years old, will have formed their maximum contents. With regard to *C. succirubra* it is belived to have been observed, in Java as well as in British India, that after a certain period, the quinine decreases rather increases, or else remains stationary.

Experiments were made as to the influence exercised by the different periods of the year on the contents of the bark.

Several series of trees of similar age and origin, were during a twelvemonth, regularly each month, with that object, deprived of a strip of bark of the same breadth, and at the same height on the stem. These experiments have not led to absolute conclusions It may be presumed, that it would be during the rainy season, and towards its end, that the maximum would be attained.

Some researches concerning the influence of light and shade on the amount of alkaloid, gave still less grounds for a settled decision. They only confirmed the supposition that in bark of the selfsame stem, cut out at the same height, a great difference may be met with, a difference however that can in one sense be ascribed to the greater or lesser degree of light to which the bark was exposed.

Still as little can this question be answered, whether in the amount of alkaloid of flowering or fruiting trees, a considerable, or transitory alteration arose. Such alteration can in no case be important; the analyses show that quite clearly.

The elevation above the sea appears to have but little influence upon the amount of alkaloid, at least within the limits of the government Cinchona plantations, 1250 to 1950 metres[1]. Barks were examined from trees which were reared at no greater elevation than 150 metres, even these showed no important discrepancy. Trees of a known type give, both in the highest as well as in the lowest nurseries, a bark which in quality and quantity of alkaloid, is entirely satisfactory and corresponds to the typical amount.

Moens has directed many analyses with the view of deciding in various varieties of Cinchona, what may be the difference of the alkaloid percentage in various portions of the bark. It is made out distinctly that the outermost rind (primary layer) is richer than the innermost (secondary layer) The comparative figures declare that plainly. The taste of Cinchona is partly bitter,

[1] 4100 to 6400 English feet. B. D. J.

partly astringent; the outermost layers excel in bitterness, the innermost in astringency. Not only are the inner layers poorer than the exterior in total alkaloid, but it is chiefly the better known febrifugal bases which greatly diminish, whilst cinchonine prevails in relatively large quantities in the layer situated close to the cambium region.

Older trees are apt to lose the bark-scales (rhytidomata); this is especially seen whilst the barks are in course of drying. We have already on an earlier page remarked, that the best American barks, are sent most improperly into the market without covering, the outer bark-layers having been rubbed or brushed off and thrown away. For this and other reasons, together with the conviction that cork and other trees, submit very readily to deprivation of their upper corky layers, Moens brought it to the test on a large scale.

The question was, how to harvest the largest quantity of quinine-containing bark layers by scraping, without injury to the Cinchona tree. We shall bye and bye recur to the harvesting operation; for the moment we had to ascertain the fact, that the chief seat of the quinine first of all, is really to be found in the outermost layers of the entire Cinchona bark.

The question as to whether sun heat exercises injurious influences on the drying of the bark, is quite settled. Even before the first real harvest began in Java, we determined this matter by comparative experiments. Since then Moens has dried the rich bark-scrapings in various ways, and made it certain that neither the quantity nor the character of the alkaloids, undergo thereby any change or damage.

A particularly noteworthy series of experiments now deserves our attention. The most skilful, and the earliest director of Cinchona culture in India, Mr. McIvor, hit upon the happy idea of increasing the produce of his Cinchona trees, and enhancing their value, by partially stripping them, that is to say, to cut out small, vertical, long strips of bark alternately, and let the bark renew itself on the exposed parts of the stem. That such a renewing soon takes place, experience both in British India and in Java had already taught, where so frequently pieces of barks had been cut out of the living tree, to ascertain the value of the various kinds of Cinchona, and in individuals of one and the same species.

By these experiments it was already known, that the renewal takes place the quicker and more completely, in proportion as the superficial layers only are cut out, and the strips of bark taken are narrower.

McIvor however did not merely strip, but he covered the exposed parts of the stem with moss, and covered also entire stems with the same material. After a certain time, about a year, in those parts covered with moss, the barks appeared actually richer in alkaloid, and the renewed bark had gained considerably in bulk. McIvor experimented principally upon Succirubra trees.

After his example, in Java so soon as 1864, there were a hundred young trees of various kinds, covered with moss. At that time however our attention was still too much confined to Cinchona culture as a whole, to allow us to stir heart and soul in a direction which at that time was only of secondary importance. It may be partially ascribed to that, that many trees under the mossing-process languished and died, whilst on the other hand, the results of the analyses which Heer De Vrij instituted on mossed and exposed Javan barks, did not induce us to give more attention to it, or to really follow it up by experiments.

Moens caught up the subject with avidity, though in the meantime the English authorities, Broughton, King and Howard, did not seem to be infatuated with McIvor's continuance of the practice, and I, on my part, continued to maintain and urge, at all times, the great difficulties against the mossing-process. Moens quickly remarked that the virtue did not consist in the moss itself.

In Java, this material can only be got in sufficient bulk with great difficulty, and in consequence a trial was made in the use of *indjoek*, the thick, strong vascular-fibres of the Areca palm, with entirely satisfactory result. The outcome of the experiments supported the opinion of Mc Ivor.

The barks of *C. succirubra*, *C. Hasskarliana*, *C. micrantha* and *C. Pahudiana* by 1878, after having been one year covered with moss, had really made more alkaloid, especially quinine. In 1879 the experiments were repeated. On the whole this time the outcome was less satisfactory, because the renewed bark did not, as always has been the case in *C. succirubra*, appear to be appreciably better than the original. The conclusion arrived at, is, that the renewing process is not applicable to inferior kinds of Cinchona.

The *character* of the alkaloids remains in the renewed bark, as a whole, just the same as in the original; only the quantitative proportion changes. This change is peculiar to the renewing, and hardly at all [1], sometimes not in the least dependent on the kind of covering material used.

It is principally *C. succirubra* and *C. officinalis* which seem to fabricate a richer bark by this process. The amount of quinine is considerably more, that of cinchonidine is diminished, and in *C. officinalis* in most instances entirely suppressed. Quinidine also increases, whilst cinchonine remains about the same.

For science in general, and plant-physiology in particular, these and many other results are all important. We consider it none the less prudent, especially in practice, to see no fixed rule in the results obtained to the present time. They are in our

[1] Following the example set in British India, in the last months of 1880, an experiment was tried by covering with *alangalang*, (*Imperata arundinacea*) which wild grass, is in most places only used for forage. Meanwhile Moens was able by personal examination in British India to state, that the prejudice against Mc Ivor's system has no foundation, and the prediction that the partially stripped trees would speedily die, is triumphantly disproved by an experience of seven years. We rejoice in this fact, that thereby the crown and completion is set to McIvor's work.

opinion, data which must be followed up for years, and be fully carried out, before they can fulfil the requirements of a substantial and regulated decision. How often have we found ourselves disappointed; how frequently have we been deceived, by a series of independent phenomena and experience, to follow those things which must afterwards be again doubted! We rejoice beforehand, rather in the actual perseverance with which the scientific method is carried out hand in hand with practice. They offer to our view, the disclosure of still very many secrets of nature, and we must wait upon their positive declarations, before we pass to a decided course of procedure, which may bring an entire industry into danger.

An examination, both scientific and supported by facts, was accomplished in 1879 by Moens and Scheffer, commissioned thereto by the Indian Government, led to the decision, that by application of the scraping-method on fullgrown Ledgeriana trees, a kilogram of superior bark could annually be harvested from each.

The first great scraping experiment had yielded really excellent results; one year later however, it was found that the doctrine of proportions did not come into play here. It is the invariable practice in natural science to build upon a long, linked series of facts; or else, from one independent fact, by logical consequences to reach a desired conclusion. Although the bark renewed in one year of the second scraping, had almost the same thickness as the original, the new tissue did not seem to be so rich in alkaloid as the former, and thus it was deemed advisable, to allow a period of two years for the renewal. In quality as well as in quantity the result thus miscarried; whilst in the first experiment the trees had apparently not suffered, in this regard also, the second time gave a less favourable return. It is true, that this time scraping had been done during a different season, so that now it was judged, that the trees would best bear the operation in the dry weather; the experiment thus has not quite run its course, the value of the process is not yet known, and it has not been practically applied. Under the direction of a man like Moens, this highly important question, will no doubt be decided in the near future [1].

Each unaccustomed wound to a tree must lead to its injury, and if continued, result in its final annihilation, therefore an important thing is the *modus quo.* It is now quite evident, that whilst the scraping-process can be effected one or many-times with good returns, under the actual superintendence of the skilful, in no case can the operation be called an every day ordinary, careless, crude affair, as will soon be known if the matter is given over and entrusted to underlings aud labourers.

In giving these hints we do not wish in any sense to decry the value of this process. On the contrary we are delighted with the earnest attempts towards attaining this most desirable end; but we would impress this axiom, that continous application, with accurate observation of phenomena, must speak out, before the practical man can enjoy the prevailing desire, which *a priori* and on good grounds, is therein sought and may hereafter be discovered.

Original Ledgeriana and Succirubra barks are light coloured and have a greyish-white exterior, the consequence of lichens growing thereon. By mossing these seem to die, and the bark obtains a darker look, whilst here and there little knobs project, which present themselves as large lenticels. Bark renewed after partial stripping of the tree, likewise possesses a darker outside; its entire surface is smoother than that of the original

[1] According to the Report of 1879, the second scraping gave 20 % less produce, which in general contained less quinine The expense of scraping is relatively slight, and we are of opinion that a special worktool should be prepared, to ensure the success of the operation, such as the special knife which McIvor had previously contrived for stripping. In 1880 the scraping of certain trees, Ledgeriana, Succirubra and Officinalis, has been continued, though this time merely one half of their circumference, by which the chances of a consequent injury are naturally less.

bark which remained longer covered, but the above mentioned knobs are much more numerous. Lastly, the bark which is renewed after scraping, is likewise darker in colour, though smooth, and without knobs.

Bark which has altered under moss-covering appears more brittle than usual, but not so brittle as renewed bark. The cause of this lies in a lessening of the vessels in the bark, against an increase of cellular-tissue, and seeing that this latter is the principal seat of the best alkaloids, so the mossed bark is richer than original, and renewed again is superior to the first.

The bark renews itself more readily after scraping than after stripping. We have quite recently shown that, in direct proportion as the stripping is superficial, and in smaller strips, the renewal follows more surely, quickly and completely. Yet further it appears, that young trees submit best to stripping, or at least recover quicker from their wounds.

Succirubra renews itself after scraping less quickly than does Ledgeriana.

I can assert with tolerable certainty that the Succirubras on which the experiments were made, were younger than the Ledgerianas which served the same purpose, or at least, that the upper layers of the latter, were more developed, more characteristic and easier to remove.

Moens and Scheffer made diligent use of the microscope, in comparing the anatomical structure of the various kinds of bark. The results thence drawn, full of industrial importance we shall produce later on. At present we must deal with the proper cultivation of Cinchona, and especially the raising of plants; the propagation by art, as well as by seeds, will be brought prominently forward. As regards clearing the land, commencement and maintenance of nurseries etc. in general, we have sufficiently touched upon that when treating of tea and coffee-culture [1].

[1] See the author's 'De Oost-Indische cultures', vol. I, pp. 1—111. A portion has been translated and will be found in chapter xii of this volume. B. D. J.

What has there been said on the subject, holds good in most cases also for Cinchona, but the especial requirements of the latter will not be passed unnoticed.

CHAPTER IX.

THE CULTIVATION OF CINCHONA. PROPAGATION BY SEED.

On page 36 we have given a short description of Cinchona seed, and the results of the first sowing in Java. This having turned out very unsatisfactory, when Junghuhn harvested germinative seeds for the first time in 1858, he tried many methods of germination, that he might find out the best plan. From 200 well developed seeds, sown broadcast upon well prepared beds, there was hardly one healthy plant obtained. Junghuhn ascribed this misfortune to the fineness and lightness of the seeds, which were there exposed to all the caprices of wind and weather, and further pointed out the dangers without number, which existed also from the first sprouting in the beds. Now that the field of experience has become wider and clearer, we know also that the quality of the first harvested seeds, must in part be blamed for the bad returns at the outset. On well prepared, carefully kept, and shaded beds, it is proper to expect a fair return from good developed seed, sown broadcast. The beds however must at first be kept in semi-darkness, and the soil must be neither too moist nor too dry, and not alter much in its condition.

In Cinchona plantations there are often found under the seed bearing trees, abundance of young plants, the spontaneous result of the seeds which had fallen upon the earth beneath. On the estates of Tjiomas near Buitenzorg, such little plants were found in thick masses under the oldest trees, which were there planted in 1865; they were afterwards found also at Nagrak and other districts, in some places in great abundance. The circumstances however must be very favourable; amongst other things, the soil must be more or less clayey, and not be too thickly covered with weeds.

In the old, extensive government plantations, amongst the millions of seeds which fell upon the crumbly, little disturbed soil, it was exceptional to find any developed, and when these were met with, it was only near felled tree trunks, or at the base of old stumps, where the seeds had found a natural shelter.

Meanwhile, the results of simply sowing broadcast upon beds, as a rule had not been brilliant.

Junghuhn now ordered the seeds to be sown in pots. For these he took thick pieces of bamboo, about nine inches long, a bottom being made by thrusting in some *indjoek*. These cases or little pots were filled, with purified, finely sifted wood-earth, or else with a mixture of this and a fourth part of black volcanic sand, composed of felspar, hornblende, and magnetic or titanic iron, where this was obtainable. After this the filled pots were placed close together, on covered beds, arranged in amphitheatre fashion in the mountain clearings. In the first experiments, each bamboo pot served for the reception of a single little seed, afterwards two or three were put in; this was done in a small superficial pit, made by pressure of the finger in the loose soil in the centre of the pot, which was then sprinkled with the black sand just mentioned, to a thickness of $^1/_2$ or at most 1 millemetre [1] to hinder the seed being blown away, and to prevent it being dried too much by the air. From this time the soil in the pots was kept constantly moist, by means of a very fine water-pot.

According to Junghuhn's observations, under favourable con-

[1] A millemetre is only $^1/_{25}$ of an English inch. B. D. J.

ditions, good seed and good soil, the majority germinated in about six weeks. In a few cases he observed growth after 22 days or even 20, but never after 100 days. By germinating, Junghuhn understood the visible breaking out of the rootlet, which at first crept on the surface of the soil, but in less than 24 hours secured itself thereto, and after the course of two to three days the tiny stem shot forth, on the top of which the two seed-leaves might be observed. As soon as germination had taken place, growth was kept up by sprinkling, so that directly the young, tender rootlets had obtained a hold, progress might go on without hindrance. After eight or nine months the plants had reached a height of six inches, and were fit to be transplanted into the open ground. The nature of the covering of the nursery beds, lying as they did on the edge of the mountain clearing, naturally supplied the young nurslings with sufficient light only on one side, and thus gave rise to an evident inclination to grow up in a slanting direction. To restore the balance, the pots were turned half round every week.

From this description it will be seen that neither pains nor expense were spared, yet we have every reason to believe that in spite of all this, the results for a long time were not so brilliant, as might have been expected from Junghuhn's representations. When in March 1864, we took over the direction of Cinchona culture, we found a hundred thousand Pahudiana seeds sown as previously described; for three months the superintendents had vainly looked for plants therefrom, and the out-turn was thus obliged to be considered a total failure.

Seeds which are not properly ripe when harvested and dried, in damp earth become black and mouldy. Nothing hinders germination more than alternate drought and moisture; therefore waterpots with the finest roses must be used, or spray from a syringe, for even the weakest, slightest stream of water may disturb the extremely light seed, and do harm to the tender seedling.

We acquired a method of raising from Heer Teijsman, which we have described in our 'De Oost-Indische cultures' vol. i, p. 63, and quote as follows; we have strictly kept to this plan [1].

Unglazed, baked earthen pots, common flower-pots, rather broader than deep, are filled two-thirds of their depth with sand, on which is spread out a layer of loamy soil, properly moistened, of about a few centimetres in thickness. On this prepared soil the seeds are scattered, as thickly as possible together, but taking care not to heap them up.

Tha pots are then put into saucers filled with water, by which means, quite a sufficient quantity of moisture is drawn up by capillary attraction, whilst the sprinkling of the seeds is made unnecessary. In sprinkling or watering the limits of the desired moisture may easily be overstepped, moreover the seeds themselves may be damaged, and sometimes be dislodged or removed.

It is quite clear that favourable conditions for the germination of the seeds and development into plants cannot be sufficiently ensured in the open ground, and thus it is necessary to have well devised propagating houses. These are simply indispensable where artificial propagation is aimed at, and we here testify plainly, that an intelligent Cinchona planter must devote himself to directing the propagation, that he may guarantee the maintainance of his typical descriptions

The erection of the propagating houses will be described in chapter XII.

If the seeds are treated as we have described, they will germinate in eleven to fourteen days, old seeds take longer time, but after forty days all hope may he given up. Here is apparent the advantage of the improved method, over that

[1] We put the seedpots on saucers Since then the pots have often been put into hollow trunks of trees, bowls or troughs, and then complaints have begun about the amount of mildew. Our seed-pots and saucers belonged to each other, and were delivered together by the potter.

followed by Junghuhn. The present mode is moreover very inexpensive, because there was always a great amount of space lost, by the room which the non-germinating seeds took up.

Before the seeds are sown, they are steeped some hours in water. Putting out each seed, one by one, after a little practice, is and rapidly easily done, by help of a flat-pointed piece of wood or bamboo, by which the seeds are picked up.

Germination betrays itself by swelling, and the appearance of white points. As soon as these show themselves, the development goes on quickly; white threads spread themselves over the surface, straighten themselves up, two little leaves unfurl, and on one of then is seen the husk of the seed, sitting like a little cap.

After twenty to thirty days, they have formed four leaves, and now the delicate plants whose rootlets do not penetrate into the clayey soil, but lie outstretched thereon, must be separated and transplanted, pricked out as English nurserymen call it; this is easily done, by using a flat-pointed bit of wood or bamboo. One by one, the tiny plants are carefully taken out of the pot, and then shifted into common flowerpots, filled with prepared garden soil. In doing so, it must be especially seen that the roots are put perpendicularly in the earth, for which purpose a little hole is made, and when the plant is put in, the earth is pressed together again with the fingers. According to the size of pot used, each takes from 5 to 20, or even more, depending upon the room in the nursery, and the number of plants and pots at command. The seedlings often were actually planted out on well prepared and protected beds. If these are kept closed at first against wind and rain, and above all against direct light, then the results are satisfactory, but it is much the best plan, in the first instance to make use of pots in the manner just described, and to keep them a few months in the propagating house. Here they can be put close together, all harmful influences seen and provided against, with more care and success in the requisite watering, and in a word the whole thing may be watched continuously and without fatigue.

During the first few weeks, but little progress can be noticed, the reverse seems rather to be the case. The backward tendency is however scarcely visible, once begun, development goes on apace, provided in the first place, a moderate sprinkling be given, and a steady regulation as to the amount of light. After four to six months the plants are so much grown that they stand in one another's way. They must now be separated and potted singly, or else transplanted into nursery beds, which demand most careful watching during the first few days, so that the transition may be felt as little as possible. In the beds they are planted at mutual distances of eight inches; from here they can afterwards be lifted with a good ball of earth, embracing the entire root-system. In nine to thirteen months after the sowing of the seeds, the plants will have attained a foot in height, and whilst in these beds, are not allowed to branch; they now only await a favourable moment for transplantation into the open ground.

In the introduction to our 'De Oost-Indische cultures' we have fully dealt with nursery work as a whole and hence do not consider it necessary to go further into the subject. Undoubtedly *perishable* pots deserve great recommendation; it needs scarcely to be said that the soil in the pots must be as clean as possible, that watch be kept against immoderate moisture, against insects, etc. The use of cutting instruments in the propagating houses and in the beds, should be avoided as much as possible, and the surface soil should rather be kept open, cleaned and crumbled with the fingers from time to time

This method of propagating must not be reproached with being too expensive or giving too much trouble. If there be unlimited command of seed, and if it does not matter if 50 °/₀ and more be lost, then the seed may be sown broadcast upon well prepared beds, and it is right to say, that those plants which win in the struggle for life, will be even stronger than those procured by the former method.

Meanwhile we are immoveably convinced that we should never have obtained the priceless Ledgeriana in Java, if we had spared ourselves in any way, trouble, care or cost. What results have been obtained in British India, from the other half of Ledger's seeds? Little enough, and certainly a less careful treatment is to blame for it[1].

CHAPTER X.

GATHERING AND KEEPING THE SEED.

Cinchona flowers at all seasons, quite as coffee does, another introduction into Java. As soon as the trees have attained maturity that is to say, have reached a certain development, they begin to flower, and show henceforward, constantly flower-buds, blossoms, or fruit, some all three at once. Under the influence of shade, flowering takes place later, and always in more scanty measure.

Young trees of four years of age or even less, sometimes shoot into flower; where this appearence presents itself, it is not considered a favourable sign, but as surely indicative of an unfavourable condition.

[1] In 1864—65 we tried at many times, and in many ways, to artificially awaken or help on, the germinative power of old Cinchona seeds. It was all in vain, for no single method gave evidently declarative results.

Seeds which swell with difficulty, as in *Papilionaceae*, are shaken up with sharp powdered-glass; the hard outer skin receives scratches, which readily take up water, and thereby help on germination. This means however has no signification or application to Cinchona seeds.

As previously remarked in America by Warsewicz, it was confirmed many times in Java, that the twigs which have flowered and borne fruit, for the most part die; in every case the extension in growth is hindered by flowering, and thus it happens, that from a plant which bears flowers on its summit, no further development can be fairly expected. It is of no use cutting away the flowerbuds; if the tendency has once declared itself in an idividual, it cannot be repressed [1].

Although flowers may be seen thoughout the entire year, yet it seems in the high mountain districts of Java, that the true blossoming period in some measure coincides with the end of the west monsoon, say about the months of January to March. About ten to twelve months after the buds began to appear, the fruit ripens. All fruits in an inflorescence do not attain complete development, still less do all the seeds in the capsules. For seed-saving, the handsomest, strongest trees are selected, and especially amongst those whose superior value has been ascertained by chemical examination. Disappointment is inevitable where the eye and botanical characters alone are made use of and trusted to; the whole issue depends upon the certainty that varieties rich in quinine are exclusively propagated.

The choice being made, there is something else which must not be neglected; it further behoves us to be perfectly sure that the tree is not fertilised with foreign pollen, that is to say, pollen of an inferior tree or variety. We know that Cinchona readily hybridizes. Darwin, Hildebrand, Muller and Kuntze maintain that plants with *dimorphic* flowers, are dependent upon crossed or mutual fertilisation; that the latter seldom occurs from its own pollen, and even then, with little success. The *cascarilleros* had previously noticed that Cinchona distinguished itself by dimorphic or heterostylous flowers, and

[1] If cuttings are made of the shoots which are inclined to flower, they are often seen to bear blossoms. The true Ledgeriana appear only by exception to arrive at this stage, before their fifth or sixth year.

they named the flowers with short styles, *Macho*, — the flowers with long styles, *Hembra*. *C. Ledgeriana* shows both forms, though the *hembra* prevails, and from this the conclusion can be drawn, that nature here assists in the fertilisation of both.

Experience meanwhile has fully shown that plants can be raised from seed, which both in botanical and chemical aspects, equal the parent-tree. Trials were made purposely, in the government nurseries, as to artificial fertilisation. Calisaya flowers were touched with pollen from Caloptera, and *vice versa*. In the plants reared from the seeds so obtained, the type of the parents in various degrees could be recognised. The proofs were thus amply made out; besides, there may be seen trees by hundreds in the plantations, bearing the mark of the influence which the parents experienced from others. Principally in the Officinalis nurseries the unmistakeable hybrids occur, now recalling Succirubra, then again Pahudiana or Calisaya, and chemical analyses have over and over again shown that the percentage in the barks, agrees with the botanical characters, and thus regard must be had to the typical percentage of both parents [1].

Although it is quite possible, that by careful selection and crossing, in the long run new varieties may be called into existence, decendants at least of superior value which have taken up the chief virtues of both parent, yet it remains most advisable for the planter, that he should as much as possible withdraw the trees he has selected for seed-saving, from the influence of other trees of doubtful value. If only one species is possessed from the same origin, then there is naturally no danger, although it is readily understood that all individuals do not possess the same amount of alkaloid; chemical research decides in that case. When a tree flowers, from which seed

[1] It had been remarked in previous years, and again in 1879, that various insects prey upon the Cinchona flowers, and may thus play an important part in fertilization, by transporting the pollen.

is desired, the proper thing is to cut away all flowerbuds in the neighbourhood, from those individuals which cannot be depended on. This is the method which has been followed for years in the government nurseries to guard against degeneration. In spite of every care, however, a complete isolation could not be assured to the selected trees; against it were the numerous species and varieties, together with the great dispersion and extent of the nurseries, which difficulties were not to be overcome.

As soon as the fruits begin to turn dark brown or black, the best plan is to envelope the entire inflorescence, or truss, in a gauze bag. Light and air can pass in unhindered, whilst loss is guaranteed against, when the capsules eventually spring open.

When the largest fruits of an inflorescence are plainly ripe, that is, darker coloured, and on the point of bursting, then the truss is out off and hung up in a dry airy place, to prevent mould or rot. When it is wanted to gather the seeds, the fruits are laid spread out on paper for several hours, in a sunny spot. They then readily spring open, and the seeds may be winnowed or sifted, and after carefully picking out the pieces of capsule and rubbish, are separated quite clean. Well dried seed preserves its power of germination for a considerable time, provided it is kept airy and dry. Hermetical sealing is unnecessary, even dangerous; dispatches are best done in cartridge paper, when in large quantities preferably mixed with powdered charcoal.

CHAPTER XI.

ARTIFICIAL PROPAGATION.

It appears from the statement of the first years of Cinchona culture, that from the commencement, attempts were made to multiply by cuttings: Teijsmann succeeded in striking a cutting from the first Cinchona tree obtained from Paris, and from that plant again, to raise a living progeny. The history of the two oldest cuttings has been given on pages 44—45, it tells us that Cinchona may be propagated by cuttings; but afterwards many disappointments were encountered, which may chiefly be imputed to less careful treatment, and restricted disposition of excellent material. In the years 1864—65 we were obliged to apply ourselves heartily to artificial propagation, because the trees which then were reputed to be the best in Java, still failed to produce fruit.

We were not very fortunate, although our trouble and care were not unrewarded. From the seedling Calisayas, which later on appeared Hasskarlianas, we raised by cuttings in 1864, those which at that time already distinguished themselves from all other, similarly named sister plants, also got from cuttings. The Hasskarliana cuttings yielded handsome plants which grew up at Tjinieroean to tall, thick trees, and in 1876 there were still hundreds of them noticed in full vigour. In 1871—72 from these trees, then seven years old, there were sent away fully 1500 kilos of bark of handsome and bold appearence, in slender silver-grey quills.

When in 1865—66 cuttings could be got from young, robust seedlings, the results were at once more favourable, though by this time there were more and more seeds harvested, and thus cuttings were thrust into the background (nevertheless artificial propagation of Succirubra and Officinalis continued, with the greatest success) until in 1872 a new start had to be made, after the discovery of the splendid quality of the Ledgeriana, of which at that time, no seeds were to be had. Thousands of plants were obtained by cuttings, but thousands also, in the open ground, came but slowly, or not at all, to development.

New regulations were repeatedly tried in the hope of better results, though still they fell short of expectation. The best returns were always got from the shoots which sprang up from the stems of Ledgeriana trees, which had been sawn down for the bark-harvest. The shoots were taken off with a *heel* from the stem with care. Otherwise the cutting is usually a twig of 9 to 20 centimetres in length [1], which is cleanly cut horizontally below an *eye*, and should possess two or more eyes, one of which is put into the soil, and lightly pressed therein.

Experience has taught, that it is not a matter of indifference, in what season, or from which plant cuttings are made. By similar treatment, under circumstances in other things identical, widely varying results were obtained, at different times of the year.

The formation of the root in a cutting is explained in the following way. The eyes above ground, under favourable conditions of warmth and moisture, bud out; too much moisture being avoided. The young shoot thus in activity and elaborating sap, sends this below, where it exudes or oozes out, and produces a knob or *callus*, which is the medium of producing the rootlet, from which this appears to grow at the proper time. From this period we have a complete plant, which however is still very tender, but when further developed and hardened off, and brought into the open ground, will continue to live.

The course of this process gives us information of the earlier

[1] Three and a half to eight inches. B. D. J.

noticed fact, that frequently disappointment was experienced from cuttings, which in the propagating houses seemed perfectly fresh and growing. Many cuttings which remained several weeks in the propagating house, and presented a healthy appearence, when taken out of the soil, showed at their base a hard knot, instead of a gentle swelling. The exudation may sometimes be so excessive that decay sets in, and for this reason, subsequently cuttings were provided at their foot with a little pellet of clayey soil, which absorbed the too rapidly exuding sap [1].

This way of artificial propagation succeeds better with soft, than hard wood, as a rule; so therefore, Succcirubra and Officinalis permit of being increased more easily by cuttings, than Calisaya. In every case the raising of cuttings must be done in propagating houses.

Trials have also been made with *layers*. Layers have really a surer chance of good results than cuttings; on the other hand, they demand more care, and as a rule are not used in Cinchona culture.

When in later years it was possible to devote to the culture, a superintendent who had been trained as a propagator in Europe, a new phase was entered upon, which promised better results, and whereto we must devote our particular attention.

Instead of propagating by cuttings, we now began by grafting the noble Ledgeriana on young stems of Succirubra, thus quickly multiplying it, and keeping it true to type; we know that Succirubra grows the most readily and thriftily.

In 1866 already were Calisaya and Pahudiana grafted by the so called *cleft-* or *crown-grafting*, and the trials turned out successful, they were however not continued, as soon Calisaya seed could be had in abundance.

[1] Artificial propagation in this manner has always been carried out with most satisfactory results at the establishments at the highest elevation, where only *C. officinalis* is grown. Each of the cuttings was provided with a little claypellet at its foot and the consequent advantages could not be doubted.

The technical question thus being answered in a satisfactory sense, there now remained the question, whether the *stock* (the stem on which the graft is made) exercises any influence upon the *scion*, in other words, whether its growing on, and retaining its own tissues, would also form a corresponding amount of alkaloid. As far back as 1679 Mariotte had shown by ingenious experiments, that plants do not merely take up nutriment, but that they also digest this according to their wants, and the vigour of their structure; it was possible however, that trees which were cultivated for their fruit, might behave quite differently to those raised for their bark contents. The cultivated pear, grafted on a wild pear tree, brings forth cultivated pears. If now a wild pear branch be *worked* on a shoot of the cultivated pear, then it will bear no other than uneatable fruit. The same sap in the trunk, thus show itself in each shoot from the graft to have different proportions.

The analyses which Moens in 1873 directed on the previously mentioned Cinchona trees, which had been grafted in 1866, have brought to light the natural vigour in relation to Cinchona, at least so far shown, that therefrom the best hope may be entertained for practical results. The Calisaya graft seems to possess the normal percentage of alkaloid for the species; the stock-Pahudiana stem, seems however to have felt the influence of the scion, so far that is to say, that the quantity of alkaloid exceeds the normal amount; the quality remaining unchanged.

From these trials and analytical results Moens deduced the following, that the nature of the alkaloids, which are seated in the bark of the various species of Cinchona, is dependent upon the special tissue of the bark, each sort for itself.

This conception gave support to the idea of making trial with grafts of Ledgeriana on Succirubra stems, a trial, which began in 1879, and commenced well. Moens hoped by this not only to be able to propagate the best parent-trees by artificial means, but moreover in some sense to make the Ledgeriana partakers of the strong, rapid growth of Succirubra.

Grafting is continued to the present time with satisfactory results, the worked plants grow unmistakeably much quicker and stronger than cuttings. The advantages are so obvious, that we must place in the foreground, what has been actually accomplished during five years by means of chemical analyses, that the scion attains to the chemical contents of the parent-tree in practical completeness. Succirubra plants can easily be raised in unlimited quantities, seeds may be harvested in abundance and without intermission, and the plants thrive quickly and robustly. Young stems of Succirubra can thus always without difficulty be had ready for use, and when once command is had over several hundreds or thousands of developed Ledgeriana trees, there will be even less want of scions prevalent [1].

Moreover, in the government Cinchona nurseries, there are hundreds of Ledgeriana trees already analytically examined, the specimens of highest percentage of alkaloids are there known, and can be specially reserved for propagation. Gradually as plantations were made, possessing exclusively individuals of superior worth, and as they increased in numbers, so those of

[1] The following communication is not uninteresting, and is in each point well worth considering.

An American nurseryman, Henderson, recommends a new method of making cuttings. He breaks or cuts the branches, of which cuttings are to be made, ten or twelve days before, so that a portion of the vascular tissue remains connected with the plant itself. The cuttings by this slight connection obtain sufficient nutriment, and root much quicker than would otherwise be the case, whenever they are put in.

Henderson alleges, that in the previous autumn, he had made 10,000 cuttings of tricolor Pelargoniums in this fashion, with a loss of hardly 1 per cent., whilst previously 50 per cent. miscarried.

Such cuttings root within ten or twelve days, unless they are over-watered or too much exposed to the sun.

In this way, a number of plants and vegetables can be treated, such as Bignonias, Carnations, Heliotropes, all sorts of Cactus, Oleanders, Pelargoniums, Geraniums, etc. This plan has this further advantage, that the parent-plant itself is less weakened, and that new shoots arise from below the branches which were broken off, which can afterwards be used as cuttings.

smaller worth have been cleared away, and the prospect is held out, that bye and bye, only Ledgeriana containing 10 per cent and upwards, will be reared.

As only the best are kept of that noble sort which we possess in the Ledgeriana, the latest descendents of those fifty different trees, from which Manuel collected his seeds with so much intelligence, will in Java, appear to be the very pick of the choicest kind.

The method of grafting which was introduced by the skilful superintendent Veulemans, and is continued with reasonable success, bears the name of *side-grafting*, and is an operation which is in constant use in the European nurseries, applied under various modifications. The assistant-director of the government Cinchona culture, R. van Romunde, has given us an accurate description of the system followed in Java, and has made it quite plain by a clear sketch of Veulemans, which will be found at the end of this volume. For scions, young twigs of Ledgeriana trees are taken, those with one joint are large enough, though as there are no reasons for extraordinary economy, it is better to use tops of branches with two to three joints. The woody stem of a young Succirubra plant serves as a stock, preferably a seedling, because cuttings usually possess a less developed root system. Succirubra stems, as thick as a lead-pencil, offer sufficient surface; stronger stems may perhaps supply more nutriment to the scions, but it is an advantage on the other side, that the diameter of stock and scion should agree, that the opposed barks may be united as completely as possible.

A slanting incision, is made with a sharp knife (*D*) in the stem, (*B*) of the stock for about $^1/_3$ to $^1/_2$ its length. The scion (*C*) is cut wedgeshaped, and so placed in the incision in the stock, that so far as possible, the bark may touch on both sides, when it is in a slanting position in the divided portion of the stock (*f*), against which the tongue of the graft

V. L. M.

J H de Bussy, Amsterdam.

is pressed, as if to make one single being with the Succi-rubra stem[1].

Next comes the fastening, or tying round with soft string which will not cut, the best being that from unravelled *gunny-bags*, see figure *A e*. The pots (*A*) in which the operation is performed, are next put into frames, closed by glazed lights, in the propagating house. They are carefully watered, and in dry weather the frames are kept close, usually a little air is left on by leaving the upper edge of the light a little way open. In this way the air is kept sufficiently moist, to make watering unnecessary. After 10 to 14 days the pots can be taken out of the frames; the closing of the wounds, the union of stock and scion, will then have ensued. The greater part of the lower leaves of the scion are cut away, and it is a good sign if the remaining portions fall away of themselves. If on the contrary they remain hanging, stiff and black, that appearance betrays sickness or death. It happens just the same when trees are transplanted, if the leaves fade and remain hanging, instead of falling off, the conclusion may be drawn that the trans-plantion has not succeeded.

From the frames the pots are put out into the propagating house, where they are now stood upright, after the plants have been cleared of the possibly still adhering, useless leaves and half-perished stipules. If the Succirubra stems themselves after a fortnight should have so developed, that they rob the graft of light and air, then they are shortened back, by topping. Some weeks later, whenever it appears quite evident that the graft has started into growth, the ties are slackened, and the Succi-rubra stems are again shortened as may be needed. A month

[1] The part of the stem which is cut open, shown by *f* in the sketch may be entirely taken away. In this case the scion *C* is only cut on one side, thus not wedgeshaped, and then pressed with its cut surface against the wound of the stock. The scion is supported on the base of the cut surface of the stock, and the operation will succeed in proportion as the dimensions, agree more perfectly, permitting a more complete union of the barks at the foot as well as over the entire length.

after the loosening of the ties, the Succirubra stems are cut away above the union of stock and graft. If there is plenty of space under glass, then the pots are allowed to stand as long as possible in the houses. The appearance of the grafts is sometimes deceptive, and if exposed too soon to the free air outside, with all its uncertainties, the apparently strong grafts may still frequently disappoint. When brought into the open ground, the grafts should beforehand be habituated to this transition, or preferably be prepared thereto, by remaining some time under care in covered cradles, where the winds and direct beams of the sun would not cause real injury.

Once fairly in the open ground, the grafts sometimes show themselves still very sensitive, and many die outright, in spite of the best care. Under favourable conditions we say that they grow half as fast again as cuttings or seedlings. Taken one with another, although a practised workman will graft 300 plants in one day, still we cannot say that the results leave nothing to be wished; more than half the grafts seem to miscarry; the operation is not of the greatest simplicity, and demands much time and space in the propagating houses [1]. We should be glad to see the experiment repeated by *crown-grafting*, now that a skilled staff is at command. Succirubra trees of six years old, at a decimetre above the ground, usually to have a circumference of 0.3 to 0.6 of a decimetre [2]. If these are sawn off at that height, an ample crop would be

[1] In our opinion, the disappointments must in part be ascribed to this, that in Java propagation goes on uninterruptedly almost the whole year round. The good results of grafting are dependent upon the choice of scions. The twig must be *ripe,* and not too young. The best scions are those which are cut in the transition period between the East and West monsoons, after the trees have enjoyed a period of comparative rest, and are about to enter on a period of renewed, robust vital functions. The tops of the twigs which may then be got, are certainly the most suitable, for the young, green, sappy portions of the plant can give no hope of the best results. No direct sun-light should penetrate into the frames, and they must be kept fully moistened, avoiding however such an extreme as would lead to the plants damping off.

[2] From one inch to two and a quarter at nearly four inches above the ground. B. D. J.

obtained, and on each stump 3 to 4 Ledgeriana grafts might be inserted. By the same operation it would be possible to call a Ledgeriana plantation into existence, under the most favourable conditions, established without loss of ground, and with the least cost or trouble, provided ample supplies of strong grafts are at hand. That good results are possible in this fashion, in the open ground, and free air, our experiments in 1866 on *cleft-grafting* have shown. Providing shade, is moreover not an impossibility, still less an overpowering difficulty. For many years all plants which have been turned out into the ground, have been shaded by a bottomless basket, made of plaited bamboo, 0.5 metre in height and 0.4 metre in diameter. Since then this careful provision has been deviated from, and it cannot be doubted, that the increased number of deaths, and slower development, are the consequences [1].

If artificial propagation be taken in hand with the hope of good returns, it is essential to ensure the help of a skilful experienced staff, and on a large Cinchona undertaking, the appointment of a clever propagator cannot be too strongly recommended.

We cannot here go into details, but it is certain that in the briefly described method of *side-grafting* (which with the drawing appended needs no further explanation), can be modified in many ways, and that abundant experience and practice are necessary to make a good choice of stocks and scions, to unite these together, to watch over them, and constantly to regulate the proper degree of light, air and moisture.

[1] The Succirubra trees intended for crown-grafting must not be allowed to grow too thick, the young trees should be thinned out as soon as their bark is fit to harvest. It is recommended to cover the cut surface of the tree stump with grafting wax, after inserting the graft. Commonly the stump soon sprouts out, and all the shoots should not be cleared away, until the grafting is seen to take A further recommendation, is that trial deserves to be made after grafting to bury the whole tree-stump, that is to say, if need be to cover the whole with an enclosure of soil.

In connection with the foregoing, some good hints must here be given, for which I am indebted to the able director of the Royal School of Horticulture, "Linnaeus", Heer Krook.

In the Catalogue of the Brothers Dittmar at Heilbronn in Wuerttemburg, amongst other work tools the following are mentioned, which seem capable of the most extended use in working Cinchona.

N°. 18. *Spaltpropfmesser* [Graftingknife]. Mark 1.60.

N°. 25. *Copulir* or *Veredlungsscheere* [Grafting shears] by which the stock and scion are sufficiently shaped to each other at one operation. Price 7 marks.

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* *

Grafting wax for use on a large scale.

One kilogram of yellow rosin, and 0.11 unsalted hogs' lard[1], are melted together in an iron pot, and thoroughly mixed. After being stirred sufficiently, the mass is poured into a tub of warm water, and as soon as it has cooled to permit of being conveniently handled, it is briskly kneaded with the hands into balls, which are afterwards thrown into cold water to complete the cooling; they can then be preserved wrapped in paper.

For use, one of these balls is melted, and the stock, on which budding or grafting is done, is smeared with the fluid wax by means of a small brush. The temperature of the wax must not be higher than needed to make it flow.

Grafting wax for use in small quantities.

Under the name of *Kaltflüsfiger Baumwachs* a special grafting wax of excellent quality prepared by the firm of Theine and Leibig at Hannover, is sold put up in small tin boxes. [A similar preparation known as *Mastic l'Homme Lefort*, or French cold grafting wax, is sold by nurserymen in England. B. D. J.]

[1] These proportions are roughly as 35 to 4. B. D. J.

The scion or bud is smeared all over with the grafting wax, which secures it from all damage or harm which might come to it from outside influences, and the bursting forth of the buds through the thin layer of grafting-wax, is neither hindered nor delayed.

*
* *

To graft, bud, inarch, etc. with success, it is essential that the stock be in active growth, whilst on the other-hand, the buds of the scion must be in a dormant condition. In the tropics, where plants are always growing and flowering, it is not always easy to remark the periods of strong activity and of comparative repose. In order to ensure good scions, it is recommended, that the selected tranches of a tree chosen to supply them, be cut off, and kept moistened in a shady spot, so as to compel them to rest. In dicotyledons, an eye, visible or invisible, is found in the axil of each leaf, and when the leaves of the severed branch die and drop off, the sap causes the eyes or buds to push, a matter of everyday observance among propagators.

Scions having one eye *in* the cleft, and one *above it*, two buds in all, give the most certain result.

The whole process of grafting depends on the fusion of the *Cambium*, a very loosewalled cellular-tissue, and thus it is not essential that the outermost corky layers should come into contact with the scion, so long as care is taken to bring the similar formative layers, the *Cambium* of each, together.

*
* *

The best expectations are justly cherished of grafting that splendid scion Ledgeriana, on the stumps of Succirubra trees. This method has the advantage of requiring no propagating uses, and moreover can be put to use after cropping an inferior Cinchona plantation. For splitting the stumps, the stocks, and inserting therein the scions, use may be made of the grafting-knife previously mentioned as N°. 18 on page 148.

CHAPTER XII.

ERECTION OF PROPAGATING HOUSES AND LAYING OUT BEDS.

Propagating houses for a Cinchona speculation, are not luxurious erections. Whoever spares the cost of these, practises an economy which will permanently affect his interests, and upon them are entirely dependent the seizing and confirmation of the opportunity of propagating by art, the choicest, best and richest Cinchona plants, and continuing in this path, to provide exclusively the best types. Propagating houses have already been most strongly recommended for increase by seeds, whilst without their help, an earnest, successful artificial multiplication is scarcely to be thought of. The arrangements have for aim, the assurance as far as possible, of an equable temperature, with the exclusion of all atmospheric and other disturbing influences.

The expense can be confined to a minimum by a suitable construction of Junghuhn's contrivance, which we have steadily kept to as follows.

On the spot which has been chosen for a propagating house, an open trench or passage is dug in the earth, with upright walls, to a depth and breadth of about four feet. The upright walls are faced with rough planks, to prevent the soil bulging out or giving way. These are instead of dwarf walls of masonry, which in the high, distant mountain districts would be too troublesome and costly to build, not only on account of the necessary transport of stone and lime, but also because of the want of skilled labour. Wood as rule is made use of; rough planks can be cut by every native, and for the entire simple timberwork, there is only need of one carpenter, who for this propose, need not be particularly skilled in his trade.

Thus the propagating houses are actually built in the ground. In the trench which has been dug out, there is ample room for movement, and the nursery-pots are accommodated on the common soil, right and left of the passage, as far as can be reached with the hand. Glazed lights form the roof, the ridge running parallel to the length of the house, and is raised six or seven feet above the bottom of the passage, borne by wooden pillars, which are placed at suitable distances in the direction of the length of the trench. The length of the propagating house is optional; the longer it is, however, the more choice there is of an even temperature. One end is entirely closed, up to the roof light, at the other in the closing wall, is constructed a little door, which gives admission to the trench by a gentle slope [1]. A simpler and less expensive propagating house can scarcely be built; the main cost lies in the glazed lights and putty. These are best ordered from the factory, where they are prepared by machinery; or they may be obtained more or less weather-beaten, which will serve very well, and be bought cheaply. Attention has many times been given to an iron framing for a roof and lights, woodwork naturally being less lasting (though it is a fact that by careful choice of wood, a well built propagating house will remain six years in good condition), and the erection, the placing if necessary of it properly framed, over an already executed trench, should cost a minimum of time and labour. But, — iron is not indestructible; more especially where it is exposed to the changeable influences of the weather in the high, moist mountain regions; and were defects once remarked, the means would be wanting for promptly

[1] When the propagating house is of great length, we use a door at each end.

remedying them. Experience in Europe has also taught, that the panes of glass are exposed to more injury by breakage in iron lights than in wooden rabbets, because the former are more liable to expansion and contraction than the latter.

The glazed lights forming the roof, are provided with moveable blinds, which are best made of a wild reed *Kassoh*, (*Saccharum spontaneum*) or of split bamboo, with *gemoeti* cord prepared from *indjoek* as binding material.

By day, whenever the sun's rays would burn by too direct influence, the blinds are allowed to roll over the frames, so that the sun's rays are partly kept off, and always broken.

Really if we wished to describe a model propagating house, we do not know how to improve upon the foregoing. Full account must be kept of the circumstances to which the planter must submit, far from the help which art and industry could offer him, and destitute of skilled labour. As to its shape it matters nothing, the chief thing is to create an enclosed space, in which the changeable influences of the weather are as little felt as possible, and so that the propagator has sufficient room to move about in easily.

Cleanliness and method must prevail in a propagating house. Strong currents of air must be guarded against, but on the other hand care must be taken to renew and change the air. In a propagating house, much water is used for sprinkling the plants, and in that narrow pent-up space, the atmosphere may soon become mouldy and musty, and fungoid growths find a fruitful field. In soft and quiet weather the door can now and then be set open, otherwise the ventilation is regulated by small moveable frames.

The nursery beds are laid out at a breadth of about six feet, and about six inches above the trodden ground, to secure good drainage. Both sides of the beds must be kept free, so that their entire surface may be within easy reach.

For covering, use is made of *alang alang* (*Imperata arun-*

dinacea, Cyr.), or *nipa*, (*Nipa fruticans*, Thunb.), as may be most easily be locally procured. As regards the direction of the beds, the construction of the covering etc., no fixed regulations can be prescribed, because so much depends upon local considerations. The plants in the beds should by preference, enjoy the morning sun, and in every case as much as possible be sheltered from the wind.

All regulations which apply to raising and rearing cultivated plants in general, hold good also for Cinchona, and therefore we have no need to go into further details.

CHAPTER XIII.

CLEARING THE GROUND. COMMENCEMENT OF NURSERIES.

With regard to clearing and laying the foundations of plantations, Cinchona demands nothing more than do Tea and Coffee culture; we quote from our 'De Oost-Indische Cultures' the following passage, for any further information reference can be made to that work itself.

> "In clearing we have to reduce to regular culture, that is, making ready, or preparing to plant, on waste lands, which at the present time only show the natural vegetation, or which after a temporary use, have again returned to a condition of wilderness or jungle. Such waste lands are covered either with virgin forest, scrub, or wild grasses.
>
> If we have to do with a thick forest, the trees must be felled and cleared away as much as possible. Big trees are not grubbed up, the expense would be too great, and not seldom at least in the mountain clearings,

it would disturb the covering of earth too much to tear them up.

If the giants of the forest are of considerable diameter, they are by preference, cut over several feet above the ground. This spares much labour, whilst the stumps which remain in the ground, do not much interfere with the planting of the entire estate, or at least only a few feet occasionally. In exceptional cases it may be best to grub up such hewn down trees. They gradually waste away by continual exposure to the atmospheric influences, and their roots also, rot away little by little.

The felling of the forest is best done in the dry season; moreover, the axes used by the natives are difficult to use in rainy or damp weather.

The masses of wood are burnt where possible, to economise room as well as labour and time If the combustion is effected with care, there need be no fear of actual loss of humus. On the other hand, there is gained a fertilising ash, mixed with plenty of charcoal, and the only thing required, is that these remains are not suffered to stay heaped up, but are spread equally. By this firing, the estate is purified from weeds, and from injurious animals, larvae of insects and their eggs.

The felling of big forest trees is no common cooley work; it demands experience and management. Before giving the first blow of the axe, the tree must be examined, to see whether it has any tendency to fall in a definite direction, in consequence of growth or top heaviness. The felling is begun on the side where the tree must tumble; thereafter, when a half or one third part cut through, a beginning is made on the opposite side.

If the trees on the cleared land are close and regular, then much labour is saved by merely cutting down a certain number, as may be pointed out, on one side only.

By felling the trees on the boundaries, these will in their fall, drag down also their neighbours.

Scrub and bushes must be grubbed up, not only because it does not want extraordinary labour to do it, but also because by simply cutting down to the stump, they would readily spring up again, and threaten to create a wilderness a-new.

So also must herbaceous and grassy plants be uprooted, thrown into heaps, and after sufficient drying, be burnt. If these precautions are neglected, a new plantation will soon demand uncommon vigilance.

Level and hilly lands require special treatment.

If an estate is deprived of its natural covering, then it must, if level, or slightly inclined, be regularly ploughed in its entire extent, or worked with the *patjol*, or mattock. The deeper and more thoroughly this is done, the better; the plants to be thereon cultivated will soon show their gratitude. In proportion as the soil is stiff and more tenacious, it requires to be more repeatedly gone over, either with the plough or the *patjol*, and these operation are conducted in proper turn, so that the maiden soil may have opportunity by the alternation of light and air, to prepare itself to nourish cultivated plants.

According to the destination of the cleared and worked land, it is parcelled out into regular compartments by larger and smaller roads or paths, as it were to cut it up. Such a systematic division, at a later period, simplifies superintendence and management. It permits of an accurate apportionment of labourers, and indication of maintenance, and thus gives a desirable uniformity and order in all actions, as well air in the administration.

Level lands of certain extent, are easy to work, and to divide regularly. They have this disadvantage on the other hand that they can hardly be irrigated. A good supply of water may be ensured by a system of channels which for the most part, can follow the paths, and whose capacity can be estimated for, in regard to the nature of the soil and its situation.

On sloping lands, water may cause damage by too quickly or readily running off. The soil being washed away, natural channels are formed which expose the fertile crust to constant harm and loss. If the slope be planted, then the removal or denudation of the earth will cause, in one place an uprooting, in another an earthing up. Mountain slopes which are taken into cultivation, are continually liable to the loss of their fertile soil, and though the injury to a plantation may not be noticed immediately, yet the danger is great, that after a few years, it will be necessary to write off that land as valueless.

Many planters rest content with giving to each plant separately, a little surface in the slope, a scooping out. The maintenance of a plantation arranged in this way, is difficult, and is seldom unattended with damage. Besides, the little plateaus or hollows become reservoirs of water or filth, which is heaped up and injures the plant.

But there is a sufficient means of preventing the injurious consequences which tilling or planting the slopes may have or draw after them. That, is by the laying out of terraces, which levels the arable or worked surface.

By steady labour very steep slopes may be made suitable for regular cultivation. In proportion as the slopes are steeper, the terraces must have a narrower breadth, and it is wholly unnecessary, moreover frequently it is impossible, that the breadth should be the same over an entire terrace.

The soil cleared of its covering and rid of jungle and stumps, is traced out by means of lines which are accurately levelled along the slopes. The grass and weeds are heaped up alongside these lines, having been cut down by a hatchet or light use of the *patjol.*

The labourer places himself below the row of weeds and begins to work upon the ground above him with his *patjol,* and in such a way, that the first spit comes to rest upon the weeds, and gives the necessary solidity.

Thus he goes on, the upper spits and clods being constantly turned over upon the preceding, for the entire space between the two successive traced out lines, until it has lost its inclination. As soon as this rude commencement is made over the whole estate, a slight slope is given to the steep sides, (which must in no case have erect walls, by which the terraces would degenerate into canals) and made tolerably even.

After this, the terraces themselves are worked over with the *patjol,* sparing the edges, because these must possess a suitable solidity.

On wooded grounds, the working up of the soil in its entirety may precede the forming into terraces, because these soils are by nature already loose and friable. Previous working is often quite necessary, on account of the endless hindrances which present themselves on the cleared estate, and the workpeople in the actual, previous beginning of the terraces, would be in the way.

The direction and breadth of the terraces being wholly dependent on the nature of the soil, it is evident that the terraces cannot be arranged for any premeditated culture, but on the other hand, that which concerns the order and space for plants, must be ruled by them.

The edges and slopes (*talus*) of the terraces are allowed to be grown over. The weeds thereon developed can be kept short, but it gives solidity, and rather than attain this by pressing together, use is made of some such plant as *antanan*, (*rendeng* or *pagagan*) [*Hydrocotyle hirsuta*, DC.] to replace it.

This way of beginning has for a long time found strenuous opponents. The plan has been said to be expensive, but on the other hand it may be said briefly, that if a permanent or a lasting plantation is to be made on mountain declivities, the costs of terracing can better be met, than constant expectation of great, irreparable disappointment.

It has already been stated that on steep slopes where foundation of terraces requires in some cases to be deeply dug out, a barren subsoil may be dipped into, wherein the plants can thrive only with difficulty. If planting must be done, either in a medium which cannot be considered fertile soil, or which cannot come into that category within a certain time, is surely better not to plant at all. Excess in any direction is punished, so also in the choice of lands for clearing. Meanwhile the alleged danger is as a rule, fanciful. To whatever depth the soil may be stirred, the fertile upper layers are not thrown aside, but simply replaced. By mingling the poorer subsoil, with the richer surface soil, and the whole being weathered for a sufficient time, there is no risk run of improverishment, but on the other hand, the conditions for favouring the remaining plants must be considered to become more favourable.

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The subsoil may be either, vegetable *humus*, clay, loam or sand; it cannot offer sufficient nutriment, unless it is properly exposed to the aforesaid influences.

By mixing surface soil and subsoil, or else by exposure of the latter, a fertile crust is created which defies disappointments. Of course all considerations restrain one, where the subsoil may appear so unserviceable, that it would be foolish to destine that estate for clearing.

On sloping ground, a regular division into similar plots or gardens becomes difficult. The paths to be laid out, cannot follow the shortest line; for they would then serve as water-channels. Continual damage and loss of ground would be the consequences, and to prevent these, the paths are laid out on the slopes in a diagonal direction, zig-zag fashion. A gradient of one in a hundred, seems to be the most that can be recommended, so as to secure a sufficient fall but not too much. As much as possible the paths are allowed to be overrun with grass, it gives them fixity and cohesion, and alongside them are dug the channels in which the superfluous water can run off, which is contributed to by the gutters which are laid out across the terraces, as may be necessary.

As a free or unrestricted choice is not always obtainable and thus one cannot voluntarily arrange matters on this or that mountain slope, so it does not always profit one to know which declivity with relation to its aspect, is most advantageous for cultivation. It may be well to stop operations, and institute comparisons, so as arrive at proper knowledge. Many allege that the slopes which are turned towards the equator, come under the most favourable climatic influences; after that, the eastern and western follow. Others are of opinion that plants in leaf require the morning sun, on the other hand fruiting plants want the evening rays.

In a country covered with mountains, no fast rules can be laid down on the subject. As we have to treat of the climatic conditions of the East Indian Archipelago, it is quite evident, that the relative situation with regard to the aspect, is a very weighty question. The local currents of air with their own characteric features, vary greatly and in some measure determine the temperature and moisture.

There are however other considerations which compel respect when clearing away primeval forests. It is to be remembered, that the local temperature and moisture must undergo an important change at least for a time, by the disafforesting over a large area. The cleared ground is more quickly warmed than the soil which is covered over with a thick leafy canopy. By continued exposure to the heat of the sun during the dry season of the year, especially if assisted by violent winds, the upper layer of the soil is brought into conditions unfavourable for vegetation. If the surface is quickly and strongly heated by day. because unprotected, it will also by night quickly radiate and cool. Sudden transitions are the causes of sickly conditions which although mostly transient, may disturb the more delicate subjects of cultivation.

Constant exposure creates barrenness in the arable surface. It seems certain that even the thickest layers of the cultivable soil cannot hold out against the pertinacious working of a high degree of heat. If it is not shaded by vegetation, it dries up and offers only sustenance to grasses like *alang-alang* [*Imperata arundinacea*, Cyr.]. Such land will not regain its ancient fertility, until again covered by a plantation, which will prevent those quick and powerful alternations which we have previously described. This possibly supplies the reason of the often remarked phenomenon, that it is very difficult in old plantations to get the "repairs" to do well. The incompletely sheltered superficial ground is sacrificed to a too powerful chemical action, and it wants a sufficient time under favourable conditions to regain its original qualities. Frequently also great difficulty is experienced in getting a new plantation to do well on lands once cultivated.

Experienced planters know full well the dangers to their plantations, which exist in exposure to violent currents of wind. Circumstances compel earnest care in the clearing of forest-lands, and as a rule it is desirable to leave considerable strips of forest untouched.

For laying out roads, terraces, etc. a certain instrument deserves recommendation, which as we are informed by Heer O. von Winning of the Dutch East Indian army, is made by Böhme of Berlin. This surveying instrument consists of a case with the theodolite, box-compass, and quadrant, so proportioned, that they are carried on a single-footed staff. With this simple and handy combination, by which the contriver has done good service to forest-clearers, all requirements are readily and amply met. With proper explanation and some practice, nonprofessionals readily work with it.

The future is assured by suitably beginning the permanent maintenance of the fertile surface; this need not be done so regularly for Cinchona as for Coffee or Tea, which by periodical cropping are kept within definite bounds, whilst Cinchona is regarded more as forest-culture; — order and regularity must reign in every case, not the least to facilitate control, and to excite and further pleasure in supervision and maintenance.

Previous to the year 1866, the government plantations were not actually in every case laid out in terraces. At that time in some places they were wholly unknown, and superintendents as well as labourers had a prejudice against them. The transition from forced to free labour, and many other burning questions of paramount interest, compelling the consequences of not plunging into all requirements at one time, brought matters to a focus. In the government reports for the years 1864 and 1865, the methods were described whereby the clearing and founding of estates took place in those years. The director gave explanation and account of both one and the other; his actions were not of free-will, but were regulated by circumstances.

The forests were cut down, with the exception of certain handsome forest-trees[1]. The felled trees were deprived of their branches, divided into as many pieces as were necessary, and then heaped up into rows, at regular distances of 25 to 30 feet.

In this fashion they formed high, broad galangans, between which the Cinchona plants were put out, and enjoyed a certain degree of shade. Whilst there was thus no foundation of terraces, all fear of loss of the fertile soil by its being washed away might be said to be abandoned, because of the stacked up masses of wood. The wood piles slowly rotting, formed after a course of years a considerable layer of humus, which was then equably spread over the gardens, whilst the scanty pieces of wood still remaining intact, yielded a fertilising ash after burning. From that time terraces were as much as could be, formed, and most certainly in its entirety the ground had lost nothing of its fertility, but rather gained. At the establishment Nagrak, the felled masses of wood were heaped up, not in rows, but heaps, which might be regarded as rubbish heaps, from which the rains washed out and distributed through the plantation, the perishable soluble portions. From 1866 onward, cutting down was strictly kept to terracing the clearings, though no one will wonder that in consequence of the dislike which prevailed among certain superintendents and workfolk, the terraces were not constructed as they should have been.

This one thing is certain; care and pains were devised against any loss of the fertile soil, which then occurred but seldom, and since then only to an insignificant extent.

[1] On page 82 it is mentioned that the "Western department" protested against the disafforestation. Governor-General Sloet, visited the Cinchona establishments in May 1865, and acquainted himself with the furthering of the culture, and the new direction of it, though he urged none the less, that exposure of the Cinchona plantations was probably going too far. We were of the opposite opinion; and gradually went even to a complete clearance.

When large tracts were cleared and planted, on the other hand it was not seldom to be feared, that too great opportunity was afforded to the influence of wind and sunheat, and first of all at Tjienieroean in November and December 1866, in the plantations of Ledgeriana, there were actually shelter plants put out. Some years later these companions were cleared away, when they began visibly to hinder the Cinchona trees.

We always thought it possible to defend the position, that in the long run the soil might even gain in fertility if loss were guarded against; weeds, fallen Cinchona leaves, etc. being allowed to remain, and turned into the ground in a general clearing up. Our hope was established on this basis, that on the same land, Cinchona should continuously remain, and our system of exploiting Cinchona was thereon projected.

In practice difficulties seem to have arisen, which here demand a closer consideration, and can be conveniently spoken of, under the very important question of spacing the plants.

CHAPTER XIV.

THE SPACE BETWEEN THE PLANTS.

After numerous comparative trials, we had as a rule resolved to plant out, *Cinchona officinalis* at 4 feet, *C. succirubra* at 7 feet, *C. Calisaya* and the remaining Cinchonas at 6 feet distances each way. If the plants develope well, after 6 to 8 years they will meet, and the want of space must be met by thinning out. Thinning is now adopted as a regular harvesting, and in proportion as the gaps occurring had been filled up, and the supplementary plants have become the greater, the original plants are gradually removed; according to this view, uninterrupted use and profit can be made of the same land.

In 1869 the first exploitation took place of several plantations which had been laid out in the immediate neighbourhood of the establishments. From that time, harvesting was regularly continued and the old nurseries made ready anew for the reception of other, preferentially the richer Cinchona sorts. The results of the new plantings, still at that time mostly on a restricted scale, were not bad, and at least gave no reason to fear that repeated planting on the same land, would in the long run end in disappointment.

In the first place it must not be forgotten, that the first plantations were still more or less sheltered by the original forest trees, which were spared when clearing; in the second, that at first the maintenance, when the planting was still restricted, could be carried out with greater care than, when later on, the nurseries were considerably extended, and a complete staff of labourers could not always be obtained. The latest nurseries stood moreover quite open and exposed, therefore at their commencement the land was entirely cleared. Where the Cinchona grew immediately, it was able more or less to protect the soil from the direct sunrays. On a few grounds however, the development left much to be wished, that being where the growth was very slow, and where effectual superintendance could not take place by want of labour power.

For two years past, complaints have again been made, that in many places where the first Cinchona plantings have been exploited, those following will have a difficult task to succeed [1].

[1] In British India about this ample experience has already been obtained; the same sort of Cinchona does not thrive again, on the old, worked grounds. The land is therefore continually changed, and for that purpose, a great reserve of land is held in Bengal It deserves remark however, that most of the lands which were destined for Cinchona culture in India, had already been cleared and worked by the natives. This makes a difference between it and primeval, virgin forest-lands, which must not be lost sight of.

Endeavours were made to trace the causes, and to attain a tenable hypothesis by means of logical deductions; possibly the hypothesis did not agree with the actual results of examination, and in every case experiments may go on for years, before it can be raised to a firm natural law. Nature is jealous of her riddles and secrets, and does not disclose them except after earnest enquiry and continued attempts.

Cinchona holds in one sense a different position to Coffee, Tea and other constant crops, whose regular harvests continually withdraw a large amount of nutriment from the soil. The cultivation of Cinchona approaches more to the case of timber-culture, and of original or natural forests, where a constant, undisturbed development, requires constant nutriment from the soil, without however exhausting it. It seems that the disposition of the ground, its defence, so to speak, can keep pace with the development of the forest, which is not regularly carried off, and withdrawn in bulk; on the contrary, all the fallen leaves, fruit, wood, etc., remain on the soil, and add to its fertility.

Certainly, timber culture seems to rob the soil so little, that the reasons for unfruitfulness cannot be found in that impoverishment. At the end of the 16th century, Van Helmont instituted an experiment which as ingenious as decisive, removes all fears on this score.

He planted a willow cutting of five pounds weight, in a pot with 200 pounds of dried soil. After five years, the cutting of five pounds weight, had developed into a tree of 169 pounds, whilst the earth had not lost more than two ounces in weight. The loss was thus not worth mention, and there now exists no single reason to suppose, that Cinchona is more exigent that the willow [1]. The direct impoverishment of the soil, thus cannot

[1] Dr Van Vlaanderen at our request in 1869, examined certain Cinchona barks as to their percentage of inorganic constituents, and found in Calisaya bark, 2.332 % of which 0.728 % was lime In no single case was lime wanting in the different samples of soil, taken from the Cinchona nurseries.

be the cause of the phenomenon, that a new planting of Cinchona appears to have no actual chance of success, on the same ground whence similar plants of 8 to 10 years old have been removed.

But there is still another plea against the notion of exhaustion.

If a Cinchona plantation of 8 years standing be harvested, all the trees dug out, the soil worked anew, young Cinchona plants brought in, still, — the young nurslings will sometimes refuse to thrive.

If an old plantation be harvested, but the trees cut over and not dug out, what happens then? The stumps again sprout out, forming new stems and new trees! For this development as much nourishment was necessary, as the young plants require, as far as we can see. If the opinion be held, in the first case that exhaustion of the soil was the cause, the second directly and fully contradicts it.

In coffee culture the same phenomenon is to be seen. Whilst cutting over, close to the ground in old plantations which have ceased to yield fruit, forms new trees or bushes, it has long been known that planting afresh in those plantations is not profitable, unless the ground is used for other cultures for some years. Supplementing old nurseries simply leads to disappointments. The old trees, whether coffee, tea or Cinchona, continue to grow quickly and strongly, and experience nothing of declining nutriment from the soil, whilst on the other hand, the young individuals placed between, show themselves unable to develope properly. With these supplementary plants, truly, the opinion may be held, that, between the old trees and the young ones, which must draw their nourishment from the same medium, the struggle for existence must end disastrously for the latter. It may also be thought that the shade of the old trees, hinders the young tender nurslings, although shade is by some considered useful, by others necessary.

All these phenomena put together, and logically reasoned out, with an eye on the nature and action of the cultivable soil, added to the influences from within which act upon the soil, we arrive at the following hypothesis, which we put forth not as an axiom which we wish to announce, but which we, after deep study and consideration believe to be the most plausible.

In the Introduction to our 'De Oost-Indische cultures' we have shown how a chemical action constantly prevails in the cultivable soil; for details reference may be made to pages 12 to 16, etc. Most of the forest-lands of the high mountain ranges where Cinchona is planted, are mainly composed of humus (or leaf-mould) and sand; clay is seldom preponderant. The latter holds the soluble portions, and where the soil possesses sufficient clay, the chance of soluble material being washed out, or carried deep down, is slight. Therefore we believe that the disappointments mentioned in replanting, mostly if not exclusively, are to be feared and felt on lands which are poor in such constituents as clay, which possess great power of absorption, and able to form the oft-mentioned Zeolithic masses. In some Cinchona plantations, as at Nagrak and Rioengoenoeng, where substantial terraces must be laid out on the mountain side, and the more clayey subsoil mixed with the rich humus of the surface, there very probably the second planting will succeed very well, because the disposition, the constitution of the ground, is less likely to be disturbed by the loss of its constituent elements.

In most primeval forests the humus is almost always predominant, and that is equally important as the clay, but by clearing, the upper surface is exposed to the direct action of the sun's rays, and the continual working of the ground, constantly exposes fresh surfaces to those influences. Now these influences are powerful, as we have mentioned in the Introduction to our complete work 'De Oost-Indische cultures', the humus being soon destroyed, this decomposition breaks up the union of the cultivable soil, and under circumstances tending thereto, even makes of it waste steppes, and barren sandy deserts, where only the *alang-alang* can find a home.

Soils cleared some years since, and rich in humus, give indeed many times, after long protracted drought, the impression of a dried up, crumbly mass of sand. Under such circumstances the rains have free play; the soluble parts of the earth not being kept or held together, sink into the lower layers, and may under unfavourable conditions of the ground, even be washed away, and be wholly lost. In each case the upper layers are actually robbed, and it is evident that young tender plants cannot root therein, at least cannot find the food so necessary, within their reach. It is not so with the already *developed* trees. As young plants, the latter found a still rich maiden soil; they throve apace, both above and below the ground, and the root system keeping pace with the development, followed the nutriment in the soil, or had the power to keep it within reach.

Where a first planting throve from the very first continuously, and whose leafy crown quickly covered the ground with its own shade, there we consider, the soil will not be too decomposed, and a second planting will thus have less to do with changed conditions when rooting. However it is not usual for plantations to start away from the beginning. At one place the young nursery stock was perhaps not strong enough, at another, the soil itself was not particularly fertile, at a third, the outward influences worked unkindly.

In our annual report for 1870, we wrote: "Unless a detailed and strict superintendence and arrangement is possible, the result probably reached will be, that one fourth will be in bad condition, one fourth will give but little hope from the beginning, and the remaining half, can be said to be partly satisfactory, partly very favourable. No cares avail against such a diversity, there is generally an equal amount of good and bad, they may be seen next to each other. The origin of the dissimilar development of individuals of the same variety may be in the original differences in the young plants as much as in the diversity of the ground, for very important local differences occur in the latter, in mountain lands of volcanic quality."

Of late years, the system of closer planting has been adopted, chiefly on the proposal of R. van Romunde, Adjunct to Cinchona culture. Van Romunde recommended that Ledgeriana and Succirubra should be planted four feet apart each way, and Officinalis at three feet. The alleged advantages were, that the plantation would be sooner obtained with a closer growth, shading the soil by which the development of weeds would be hindered, and the maintenance correspondingly lightened, — that losses by death would be less noticed, and filling up would not be necessary, — that bastard plants could be "rogued" out as soon as seen, without leaving too wide gaps, and finally, that by close planting, straight stems would be formed, which would not readily branch, and entail the otherwise too early necessity of thinning.

All these advantages were fully recognised; if an abundance of young stock is at command, close planting is the best, although it is not always possible to call a regular plantation into existence on sloping and cleared lands.

Experience must teach, whether grounds on which a thin planting with difficulty comes to maturity, we should say it points out, that a thicker planting undoubtedly assures better chances. As the young plants from the nurserybeds are put out at 6 to 7 feet apart, they seem to have superabundant space, a similar impression however is given by planting at 3 to 4 feet apart. If the plants meanwhile grow thriftily without disturbance, after six or eight years Ledgeriana and Succirubra appear to stand far too close to each other, and must be thinned out or shortened back, so as to cause a further healthy development. If on the other hand, the growth has been small, or else, if the plantation has to content with injurious influences such as disease, then there will be ample space for eight or ten years to come.

Whenever things go on prosperously, after a few years thinning must take place, whether planting has been done at 6 feet or 4 feet intervals, in the latter case, two years sooner. Where the development leaves much to be desired, the plantations still have abundant space, however thickly they may have planted. The principal question is, whether a thick plantation really offers more chance of actually good undisturbed development, than a thin one. In this case also, the answer can only be given with respect to easy maintenance. The chances are in favour of this system; the nearer the plants stand to one another, the sooner will they support and shelter each other, and shade the ground with their leafy canopy. It is also easier to thin a plantation, to give more space air and light when wanted, than to fill up or supply the empty places in a thin plantation.

In this too, the thinning of a young plantation is not a total loss, or waste of valuable material. Analyses of three to four year-old Ledgeriana have shown that the quinine contents of such young individuals, are already fit for the manufacture of this alkaloid.

Thus there are indisputable advantages arising from close planting, but foresight must be exercised, greediness must be guarded against, and the requirements of timely thinning borne in mind. Indeed, the thicker the planting, the more spindly the plants grow up, and the proportions as to length and circumference of stem, will be too slight and slender. To amend this condition, thinning out must not be delayed too long; the uniformity once broken cannot be restored. The long spindly young trees do not quickly recover themselves, but appear weak, susceptible to influences from without. The thousands of Cinchona trees which were planted out in the thick woods, and were many years afterwards admitted to the light by felling the original forest-dwellers, have shown this.

In 1870—71, on account of want of ground ready for plants at Rioengoenoeng, there were thousands of Succirubra put out at distances of 4 feet instead of 6 or 7 feet, and of this planting it cannot be said, that within the same time, it yielded as strong trees as the thin plantations. Even after thinning, still the question remained, whether the trees would outgrow the damage inflicted by the want of space at first.

At the same establishment the first Ledgerianas at the end of 1866, were put out at mutual distances of 6 to 7 feet, and we have never seen a plantation of handsomer or stronger trees. Every plant in six years, grew into a vigorous tree, whilst on the contrary the Ledgerianas planted at the same time close together at Tjinieroean, against all instructions at four feet apart, at ten years of age were still very poor in comparison.

Numbers of examples might again be given, to show that it is well to plant Cinchona with ample space, when a quick and strong development is aimed at; we meanwhile willingly recognise that very much may be said for close planting, and as a rule, after the experience gained during the last few years, it well deserves recommendation, provided there is ample command of young nursery stock.

It will happen in exceptional cases, that a plantation, whatever distances may be taken for the plants, grows up regularly; the nursery-plants themselves in germination show more or less stronger development. If close planting be done, in the first place it may and should be that those young trees which remain backward or wanting in vitality, should be rejected, and at the same time also, these individuals which may be thought of less value, by their difference of botanical structure.

In each case 3 to 4 feet is quite enough for *C. officinalis.*

This species is more slender than others; it does not form thick stems, still less thick branches, and so, as in *C. Ledgeriana* it comes about, that the bark is not the most handsome to look at, although it will continue to be destined for manufacturing purposes [1].

It is quite otherwise with Succirubra, from which a handsome bark is wanted, and this can be with difficulty produced by young slim trees, which receive but little light on their stems.

It therefore happens that the more robust growth of *C. succirubra*, which are planted at 6 to 7 feet, under normal circumstances wholly cover the ground with their own canopy of leaves.

CHAPTER XV.

MAINTENANCE OF CINCHONA PLANTATIONS.

In close connexion with the subject of our last chapter is the question of maintenance.

Our directions were strict, we required a continual superintendence and maintenance. As soon as a certain height was reached the weeds were to be cut down. Twice a year it was ordered, that the entire plantations should be deeply dug, and

[1] First one thing and then another induced us to allow the *C. Ledgeriana* plants to remain at 7 to 8 feet, but to place between them *C. officinalis*, which could be harvested first, and whose slender growth not only required less space, but would not seriously hinder *C. Ledgeriana*. In 1873—74 we laid out a plantation at Rioengoenoeng of Ledgeriana cuttings, and the nursery was filled up by *C. officinalis;* Van Romunde writes to us that this has developed very thriftily, and according to his system a simultaneous rearing of Ledgeriana and Officinalis, is likely to turn out excellently.

the weeds buried. This rule could however be applied to the full extent of the planting but merely by exception.

There were so many things without number to be done, that the means and power available often fell short of the wants. By constant extension the old nurseries were frequently left to themselves longer than was proper; but in no case was the delay harmful. Fresh weeds on good soil, which increase by seeds, grow quickly and die away, cannot be, in our opinion injurious to the soil, and still less be of direct hindrance to the young plants, so long as the latter are not covered, or thickly grown round. It was a different matter when the ground was covered with noxious weed such as *alang-alang*, as it was at Lembang, as noted on page 69.

No establishment has demanded greater expense in management; we have patiently expended really extraordinary care and cost, to see what could be obtained from a more thorough working of the ground. The result of this long continued deep tillage and burial of the weeds, has surpassed our expectations and even struck the attention of the native foremen. The plantation, because of its barren soil, and unfavourable aspect, exposed to the full fury of the winds, had remained in a backward state for years, but it recovered itself under the hearty attempts towards improvement, and according to the later reports, the progress appears very satisfactory. At Nagrak, where things went on very calmly and orderly, all performances could be adapted to the want, and the results have not remained without observation.

We have always found that, where the natural conditions were favourable, the plantations developed themselves advantageously even when the care was not too abundant; where these conditions did not prevail, in spite of extremest care, some of the nurseries could not be raised out of their low backward condition. This will be shown plainly by figures which are given further on.

The original Ledgeriana plantation consisted of about $8^1/_2$ bouws[1], and was laid out at the end of 1866. Up to and including 1879, there were thence harvested 179,500 kilos of dry bark, and at least an equal quantity was still to be expected from the remaining trees. Results more brilliant are difficult to imagine. The most exigent can hardly expect in thirteen years from $8^1/_2$ bouws, to harvest more than 35,000 kilos, that is on an average more than 2000 kilos per bouw, or about 154 kilos per bouw annually. The results from the Succirubra plantations have not been less favourable; on the other hand the Officinalis nurseries have well nigh continually disappointed.

If deep broad plant-pits are dug, then the whole ground may be covered thickly with grown up weeds, whilst the plants themselves are still free. The deeper and cleaner the soil is worked, the longer it remains free from weeds and we consider that it is no injury, for the young plants to be shut in with the surrounding weeds, at certain distance round the limits of each pit, for the soil is thereby kept from being dried up, and the plants themselves, in no small degree are protected from wind and the fierce rays of the sun.

At the present time weeds are considered injurious, and after the example of some English planters, the absolute clean state of the nurseries, is thought to be one of the first requisites for the good success of a Cinchona plantation. Then too, the great use of deep broad plant-pits is no longer regarded, and the cost of these can be spared, if the ground is merely well worked in its entirety. Naturally this new doctrine is connected with the system of close planting, and we do not venture to predict the result until experience becomes ripe, with the results of the harvest, but we fully recognise the good that is contained in the new elements. Meanwhile the danger is, that the labour and means may frequently fall short of completely

[1] See note on p. 78. B. D. J.

and continuously keeping the young plantations at the absolutely clean state required, will presently not be less troublesome than the earlier ways [1].

We learn from the course of the history of Cinchona culture, first and foremost, that the prescription of fixed rules may be abstained from, or rather the establishment of a programme, which furthers unconditional maintenance. "To keep the land, constantly and completely clean, is an excellent principle" cannot be declared, only because once and for a definite time, unusual results have been remarked from it.

Elsewhere no such rule was observed, and the results were in no sense worse; the reverse held true also. Experience is not sufficiently attained by the practice of single years in restricted plantations, but must, to be of practical value, embrace all plantations, and under various circumstances, during as many years as may be needful to institute a comparison with regard to the crops. If the land is kept absolutely free from weeds, then it is absolutely exposed to the operation of sunheat, and the fear of that harmful factor must not be underestimated, meanwhile not taking it *a priori* forcertain that the plantation will actually very speedily shield and shade itself.

Circumstances must always direct the rule of conduct of work, and the more extremes are avoided, the less chances are run of acting against the true interests of the culture.

The management of the ground is a chief essential in every culture, because the plantation must supply continuous nourishment. But the plantation itself needs watchfulness and super-

[1] We consider deep plant pits altogether unnecessary where the soil in its entire extent is deeply stirred. Digging deep pits is a compromise between deep tillage and none at all. In India as well as in the Netherlands and elsewhere in the world, the richest results may be expected from the remaining plantations in proportion to the depth of soil worked. If the ways and means do not permit of deep working, then we show that broad and deep plant pits are a substitute that cannot be spared, and will make a reasonable return.

intendance. Harmful influences from without have to be guarded against, and amongst these, gusts of winds do not count for the least. Should shoots show themselves from the stems, they must as soon as possible be removed. As a rule though, they show themselves in an abnormal condition, either of disease, or injury to the plant. Branches bruised or broken off, are cut clean away, and particular care must be taken against hurting or damaging the stem, which has to yield the bark, and the healthier and sounder in appearence the better.

When the Cinchona plantations are once so far developed, that it is possible to more freely under the leafy roof of the trees, then there is little more to attend to. On the soil no weed can grow which can do any harm and the trees give mutual support and shelter, when the allotted space is filled up there is no more need for close attention. If however the space is limited, the branches growing amongst their neighbours, then the light cannot penetrate beneath, and the lowest branches pine and die.

It will be proper to cut these away, because intentional lopping and felling, alone should cause gaps. For the rest, the planter has little more to do in such a plantation; he intends it for the production of bark, and harvests it according to circumstances, more about which anon.

Where the Cinchona trees do not normally develope, or else make branches too soon, thus hindering the formation of good stems, pruning may be necessary. In this case the operation is confined to (sleunen) *thinning out;* the lowest branches are cautiously removed, not so high up however as to break the proportion. In like manner those branches mostly secondary which close up the head of the tree, are to be taken away, they would hinder the development of the principal branches. For pruning or thinning, sharp tools are of course used.

Care for proper irrigation, to keep up the condition of the fertile soil, and other purposes is not less important in

Cinchona culture than in the cultivation of any other crop.

In poor plantations it deserves recommendation to dig ditches wherein the weeds are collected, or if practicable, manure is put into them. The earth dug out is spread about the plantation. This plan has frequently achieved excellent success[1].

CHAPTER XVI.

DISEASES AND ENEMIES.

Junghuhn, during the first few years, had to contend against the attacks of a small beetle, which he took to be a species of *Bostrichus* or *Dermestes*. The insect, black in colour and no bigger than a pin's head, bored horizontal holes through the bark and wood of the stems and thicker branches, quite to the centre. From there it made vertical passages, up and down, so narrow as hardly to admit a thread or a needle. Only by means of a magnifying glass could the opening which gave admittance, be seen, but by accurate examination there might be perceived also a reddish, very bitter-tasted fluid, which hardened on the surface after oozing out. The beetle laid its eggs in the bored holes and died thereafter. After the young brood have lived through their larval and pupal conditions, making many tunnels and great cavities in the trees, and have themselves developed into beetles, they seek to quit the tree by these newly bored openings, to repeat their destructive work or another tree.

The attacked and relinquished tree soon begins to languish, and now there may be discovered on the stem, short streaks of tiny, yellowish white fine sawdust, that pours out of the bored holes.

[1] These are termed "renovation pits" in British India. B. D. J.

In consequence of the small total of Cinchona trees possessed at that time, each one destroyed was a heavy loss, and thus it may be understood that Junghuhn did everything he could to obviate the mischief, but no single means availed. The boring beetles chiefly attacked the transplanted trees, and from this fact, as well as the circumstance that in later years we have rarely been troubled with them, we conclude that this kind of beetle visits sickly trees by preference.

More damage, although relatively of less significance because it was soon noticed, and showed itself sporadically, we experienced with a large brownish-yellow larva, of what family we have not been able ascertain, but only its appeearence. Attentive observation in developed plantations, more particularly of *C. succirubra*, will reveal at a certain height on the stem, a ringshaped swelling of light yellow colour, and warty exterior. More closely examined, the stem seems to possess a broad opening from which the ringshaped appearence is gnawed away, so that the finely masticated fibre presents itself as a ring composed of moist sawdust. If this be removed, the stem shows itself "ringed" to the wood. If the "ringing" be complete, the portion above must die, and the best thing to do, is to saw off the stem, under the ring. If it be not complete, then the tree may live and recover itself, provided that the cause of the mischief is removed. This, the larva above mentioned, developes, if we are not mistaken, into a large black beetle. With a bit of iron-wire or sharply pointed piece of *rotan*, the opening of the stem is probed, by which means the larva, called by the natives *oelam-pahit*, may be brought to the outside, or else pressed to death.

Where the effect of the gnawing has already proved harmful, it betrays itself at a long distance off; stem branches and leaves have then a dry, reddish look. The tree then has very little vitality left, it will be well to cut it down and burn the affected parts, to prevent the increase of the insect.

However, the destructive work should not be suffered to go so far. Moderate attention on the part of the labourers, will detect the foe, and it can be killed before the damage is irreparable.

In the propagating houses, in the beds, and in the nurseries the plants are exposed to all sorts of danger; diligent attention, however, will by prevention, guard against great loss occurring.

A blackish-grey larva which lives in the ground just below the surface, in certain places, and seasons, ravenously devours the crown of the roots of the newly planted stock. The natives call it *hiled orok.* If fresh planting is going on daily, then the existence of the larva is soon betrayed by single plants, broken off and lying down. The insect may soon be found, by carefully feeling in the soil with the hand round these young plants. When the plants have once a firm hold with their roots, these larvae seem to do no further harm, in every case this plague is never of such great significance, that it cannot quickly be overcome on its first appearence in a new plantation.

Actually and seriously we only dread one disease or plague in Cinchona culture, (which we may therefore style *Cinchona disease*) known as Cinchona rust, it seems to have the same origin as the so-justly dreaded tea-rust.

In the year 1868 the first Ledgeriana plantation, at Tjinie-roean, then about eighteen months old, became diseased, and the same mischief so soon showed itself in other plantations at all the establishments, under such various circumstances, that we could find no explanation of the case.

The disease manifested itself in the leaf. An abnormal increase of the cellular tissue here took place, the epidermis becoming thicker on the spots attacked. When the morbid swelling is full grown, the epidermis becomes corky or suberified, and thereby locally hinders the further development of the leaf. The surrounding parenchyma continues growing, and the leaf puckers up, whilst at the same time it is covered with rusty knobs, which afterwards break through. The malady proceeds to the young tops of the plants, which are seen to die off, when wholly corky. If broken across, inside they appear still fresh and green.

Only a few plants succumbed to the evil, which since 1868, has occasionally shown itself and again disappeared, bringing fear and hope, but each time leaving behind it deep traces of partial damage, which injured the shape of the plants, and prevented lusty development.

In the year named, Teijsmann and Scheffer visited the plantations, and the latter thought be discovered little eggs on the parts of the plants attacked; the idea was then that insects were the cause; however no insects could be detected.

In 1869 the disease showed itself in greater force, although still confined to certain plantations and certain varieties of Cinchona. More and more it was ascribed to the action of insects, it appeared also that the older, developed plantations, had not suffered from it. On the other hand, extensive young plantations were so heavily harassed, that it was in consideration to root them up, and commence afresh.

Plants which seemed quite fresh in the evening, by the following morning were badly attacked. The leaves of these plants looked as if burned, withered, covered with brown dots, spots and inflated patches, whilst the young tops of the stem and branches seemed dead and suberified, though internally still wholly green, fresh and sappy.

What experiments were not made to restore the plants, and to check the evil! If the diseased parts were cut away and burnt, the new shoots were not free. Decoctions of tobacco, solutions of sulphate of lime, etc., were profitably used for sprinkling; but whenever it was thought that good results were to be seen, then it happened that some individual which had not been treated, came round by itself and at the same time. Thus there was no nearer approach to a decision, with regard to the causes and remedies.

At last was tried the plan of working the ground to an unusual extent, and severely cutting back the plants attacked. We here aimed at improving the conditions for sturdy development, and to strengthen the power of endurance of the plants We certainly found some good in these measures, the evil was stayed for a time at least, and when it again showed itself afresh, the same means were employed against it.

On my proposition, made to the Government, Heeren Teijsmann, Bernelot Moens and Scheffer, came in 1871 to observe the disease. Teijsmann continued to ascribe the cause to insects; his fellow-commissioners by microscopical research, came to the conclusion that the disease revealed itself by a cryptogamic growth, a species of fungus, situated on the surface, no *mycelium* being found within the plant. On the whole, the commission considered the evil less serious than was supposed, in so far as the greater part of the plants was not attacked.

Thus the examination did not give definite knowledge, still less a specific for restoration or prevention. The plan of pruning and stirring the ground remained therefore the indicated preliminary means. At one time it seemed by this proceduce to diminish, even to disappear entirely suddenly, however it showed itself again, and thus it remains at the present day, inspite of all regulations and temporary illusions, in spite too of the complete knowledge of the causes, for which we have to thank Moens.

In the report for 1875, the first which Moens made, we read:

> "The Cinchona trees are treated by pruning, and it seems always, that by this the disease, which for so long has shown itself, now in one, then in another plantation, is so restricted, that it does little permanent harm. Very skilful tea-planters are of opinion, that this malady is the same as occurs in the tea-shrubs, and that the cause lies in the puncture of an insect belonging to the order

Hemiptera. It has not yet been possible to completely confirm this [1]."

In the year 1876 pruning was still recognised as the best method of preventing the injurious results of the disease, except that it caused the plants to grow bushy. Repeated pruning, however useful it might be in this case, remained an heroic remedy, to that degree that it could never be heartily recommended.

In 1877 the appearences presented themselves in especial strength and on an extensive scale, and Moens ascertained it to be due to the influence of an insect, the same indeed, which causes the *tea-rust* and was described in British Indian Journals, as *Helopeltis theivora*, or Tea-bug, but is termed by Snellen van Vollenhoven, *Helopeltis Antonii.*

This insect, which according to Moens, when fullgrown is about 0.011 metre [2], sticks its proboscis through the upper epidermis of the young leaves and tops, and thence sucks out the sap. The inflammation which is the consequences makes the spot in the circumference of the puncture to become discoloured and black, and the tissue dies. Only the unattacked portions develope themselves further, by which the leaf puckers up in all directions and grows into itself. The same happens with the young tops.

The discovery of eggs in a fertile female was an important find. These eggs are white, $1^1/_4$ millemetre long, and provided at their smallest extremity with two thread shaped appendages. Eight to fourteen eggs were met with in each female. These were laid by means of the ovipositor, in the ends of the branches and the leafstalks. They lie therein entirely hidden, so that usually only the threadshaped appendages are visible, and found with difficulty. When the young are hatched, they are wing-

[1] The honour of first calling attention to this insect, belongs to Heer Meijboom, the planter, at Bandoeng in Java.

[2] That is not quite half-an-inch, a fraction less than $^7/_{16}$. B. D. J.

less, and thus confined to a restricted dwelling place, they find in the neighbourhood of their birth place the food intended for them, the sap of the young parts of the plants, and it is these newly born creatures, which chiefly cause the worst devastations. Although the insects may be found in various phases of development the whole year through, the young are most abundant by far in the months of May, June, July, whilst after that time they slowly disappear, and are only met with in single specimens [1].

After the causes of the evil were completely known, cutting out still remained the best remedy. It was now strictly followed, and the prunings burned, so as to destroy the eggs as much as possible. As to capturing the perfect insect, which occurred by millions, that was not to be thought of in the extensive plantations. In small nurseries of Ledgeriana cuttings, to whose unimpeded growth most value was attached, it was applied however, and that with good results.

For 1878 it was stated, that the *Helopeltis* had again caused much damage; it again showed itself in strong force, notwithstanding the severe pruning of the previous year. That the young plantations might as far as possible be rescued, it was resolved, that the insects should be taken by women and children, a means that is reputed to be the best in the large tea estates.

The thousands which were daily captured and killed, of course could not follow out their work of destruction, and where they were thus checked, the plants recovered themselves all the quicker. In the Malawar mountain range, eight-tenths of the *C. officinalis* plantations had to be written off as

[1] In the report for the fourth quarter of 1880, is it stated, that this insect has shown itself for the first time in a new plantation which was laid out and managed with the greatest care, possessing plants obtained by grafting, and of whose handsome and speedy development there had been thus far no reason to be otherwise than satisfied. It appears from this, that the insect cannot be kept back by the extremest care of the planter, nor are the strongest saplings spared.

worthless, having suffered the most for some years, from the repeated attacks of *Helopeltis*.

Now that the nature of the disease is known, and the relationship of its originators, more than previously, it is to be hoped that some complete remedy may be found. Short of an entire stamping-out of the insect, which is hardly to be thought of, chance only offers us the discovery of other plants which the insect would possibly prefer to Cinchona. *Helopeltis* having once obtained a footing in a Cinchona plantation, it is hardly conceivable that the enemy can be hunted out; where it has not as yet entered, careful attention must be given, so that at the very first appearence, it may be immediately dealt with, by burning or other means, to frighten away the immigrant and drive it back.

All other troubles and maladies in Cinchona culture are insignificant compared to this; and are probably due to unskilful, awkward management of the planter himself.

CHAPTER XVII.

HARVESTING THE CINCHONA BARK.

When is a Cinchona tree fit for stripping? This question repeatedly put whilst the history of the tree in its development was yet unknown, and at that time remained without satisfactory answer, now finds us fully prepared to reply, since regular cultivation has informed us of its power of growth, and chemical analyses have thrown light upon the formation and amount of the alkaloids. We can at present definitely say that the question resolves itself into a pure speculation, within the discretion of the planter himself, from the moment when the tree is fully developed, that is to say, has formed its different layers, ranging from without inwards as, cork, parenchymatous layer and liber [1].

Under favourable circumstances of soil and climate, and with unimpeded development, Cinchona plants may be stripped with advantage in six to eight years from being planted out; so far at least as then the maximum percentage of alkaloid is formed by that time.

The maximum percentage of alkaloid however has nothing to do with the maximum production of bark; naturally this increases with the age of the plants, and so it is a considerable advantage for Cinchona culture, that its cropping is not obligatory upon fixed, periodically recurring times. For instance, if the coffee berries are ripe then they must be gathered without delay, and within a short margin of time; negligence in this would lead to loss. In most cultivated plants this is case, but not so with Cinchona. An exploitable tree loses nothing by delay in harvesting; on the contrary, having here to deal with the bark, when the tree has reached its maximum percentage of alkaloid contents, the bark itself increases in thickness and quantity, in proportion as it is allowed to grow on. The great difficulty lies in the choice of the genuine plants, and progress in propagating and rearing them. When the tiny plants have become actual trees, then they require little more attention or expense, and a Cinchona tree eight years old, which may yield a kilogram of dry bark, gives every promise (certainty even, if the plantation is not disturbed in its development) of producing 25 to 50 % more at ten years old. The value attained by the process of nature in eight years, is doubled in the four following years; thus if the planter is not forced to realise, he acts foolishly in beginning to harvest too soon. This truth

[1] For accurate knowledge of the anatomical structure of the Cinchona barks, Oudeman's 'Handleiding tot de pharmacognosie van het planten- en dieren-rijk', may be consulted. [Also Howard's 'Quinology of the East Indian Plantations'. B. D J.]

needs no further comment. The harvest once begun, it can be carried on systematically, proportioned to the nature and extent of the planting. If a fullgrown tree is smitten by serious disease, and its life is endangered, then it is evident it should be stripped; the bark is not easily stripped from sickly or dead trees, and they never yield regular handsome pieces.

What system should now be followed, to ensure the exploitation on the same land, as long as possible? If close planting has been done, then the trees are thinned out as required. Each thinning yields a crop, and gives more room to the remaining individuals to progress towards healthy development. There will be about 4500 plants in each *bouw,* if planted at 4 × 4 feet, and if undisturbed in their growth, after four years, they will interfere with each other. Then one half should be removed, to give the other half the chance of stronger development. When the first thinning has to do with comparatively young trees then it does not produce much; besides, the full amount of alkaloid has not yet been reached. However, *C. Ledgeriana* of four years old contains already so much quinine, that its bark can be considered fit for the preparation of that alkaloid. It is the same with *C. officinalis*, and *C. succirubra* of four years will yield a product that as regards alkaloid contents, has already a high pharmaceutical value. This first thinning therefore assures a financial profit, but has chiefly for aim, to bring the remaining trees under more favourable conditions. Two or three years later, these will appear to stand far too close to each other, and once more, half are taken away, which will give a good quantity of bark, and this time pretty nearly with the full percentage. Now then we have 1200 trees of seven to eight years of age left, and in two or three more years, the thinning can be repeated, until the point is approached when by the superabundant space, the creation of a new planting must be taken into consideration. The following harvests will generally yield a product of similar quantity, although each time the *number* of trees is 50 % less than at the previous thinning.

That so regular a course is to happen constantly or even frequently, must not be expected. It is but seldom that a plantation grows on without disturbance. When the mischances are within moderate limits, it is satisfactory; it diminishes the amount and the value as a whole, or the after welfare of the trees, if a less uniform thinning leaves here and there some in mutual relationship not to be desired. A plantation cannot develope itself so advantageously, but that certain individuals will always give out, whatever may be the causes or influences, and the plants themselves may vary much from each other, even when derived from seeds from the same parent tree; it is therefore well to attend to these when thinning.

Without being a skilled botanist, the experienced and attentive observer recognises the typical forms, and those individuals which show a strong divergence therefrom, should be removed as soon as their removal can be useful to the plantation as a whole; the product hence derived must be treated by itself and offered separately. If these regulations are strictly kept to, then after several years, the plantations will possess trees exclusively of a high percentage, and at the same time the chances of a progressive degeneration are more and more diminished [1].

With close planting such we have just spoken of, the first and perhaps the second thinning also must be done by completely digging out the trees. A stump cut over, would soon throw out shoots, though the new branches would not succeed, because a thrifty development could not take place in such insufficient quarters.

By digging out, the entire stem is obtained and use can be made also of the rootbark. If the stump is cut or sawn over,

[1] It should be considered when removing these, whether it is practicable to cut over the trees and to graft better sorts on the stumps. By this the risk which is inseparable from filling up, is avoided.

then a partial crop is obtained, but the chance remains of new produce within a few years. Of these two systems which is *a priori* the best is more than can well be answered. All depends on local conditions and surrounding circumstances. The stock of plants in the nursery, is the first thing to be asked; a second, is the chance of success in filling up. The soil may have become quite unfit to ensure a new planting living and thriving. In this case the right way is to cut over the stem, so that new stems may be obtained from the old tree. Then again, ground which seems unable to support a second crop, after having given one, must have a change, so that the constituents of the soil may be restored. The planter who works with foresight and deliberation, so regulates his planting and harvesting, that he can proceed uninterruptedly, and does not trust to one card turning up trumps, by which a temporary, possibly years-long stagnation would be the consequence.

In the government Cinchona culture, we were driven to various methods, not only to arrive at the most profitable and handiest method by means of comparisons, but also chiefly because of the great diversity of our varieties of Cinchona. Originally indeed, the regulation of planting was founded in the just described plan of thinning. Since however the actual value of the different kinds has become known, we were obliged to follow another direction. When in 1872 it was made certain, that for the production of manufacturer's bark, only *C. officinalis* could thought of after *C. Ledgeriana*, naturally the fiat went forth, that all planting of the less valuable kinds were now to be methodically grubbed up, to make room for *C. Ledgeriana*.

After the new kind become available for enriching and extending the undertaking, room had to be found in the most profitable way to be start new nurseries. These were found in the plantations of the old common *C. Calisaya*, *C. Hasskarliana*, *C. caloptera*, *C. lancifolia*, etc. whose propagation was given over for good, and thus they were removed in succession, as soon as they were fit for exploitation. Dug out, roots and all, these gave the double advantage of an entire crop, and a freed plantless soil, which otherwise must have been cleared in the virgin forests, at the sacrifice of much expense and time.

Whilst this was being done to the great mass of our Cinchona plantations, the original Ledgeriana nursery had on the other hand, another, and wider significance and destination; therein lay the whole future of Cinchona culture, because it must yield us the seeds, as well as the cuttings for multiplication. Therefore the crops, which have been obtained annually since 1872, were taken from the pieces of the tree sawn off the stump, or else from single, lopped thick branches. The stumps gave numerous shoots, which offered excellent material for artificial propagation. Some were merely allowed to grow to obtain new stems, it would have been a great blunder to let *all* remain, because they would have hindered each other's development, partly by want of sufficient space, partly by their manifold requirements in taking up nutriment. At best the result would have been a bush with many small stems, each remaining thin and weak. By cutting or sawing out thus, a tree is not sacrificed, and at the same time a rich source of material is created for propagating. The thicker branches are sawn off by choice, cutting causes some loss of bark, and there is also more chance of damage.

Thinning by cutting over did not always take place in regular alternate order. Indeed, the most valuable parent trees had to furnish seed, and flowering individuals which seemed on chemical analysis to possess excellent qualities, were spared in every case.

For years the government Cinchona undertaking has been an experiment on a large scale; the fixed rules and systematic methods, the fruitful sequence of this, come chiefly to the profit of the private planters who are travelling on this road by help of the government.

Whether thin or close planting be adopted, in both cases a time comes when the original planting requires thinning, and then for the first time a crop is reaped, which at the same time, tends to improve the planting. At the first thinning, the choice has to be made between uprooting or felling to the stump.

Another method can be applied to the remaining trees; they are standing at sufficient distance, and will soon offer stems of considerable dimensions. Upon these can be tried the plan already mentioned of partial stripping or shaving. So also may attempts be made to enhance the amount of alkaloid, by temporary covering (one year or longer) with moss, *indjoek*, or other materials at hand, such as *alang alang*.

We have always had a prejudice against partial barking, *stripping* as the English call it; that is, the cutting out of long strips of bark. The tree may bear the operation well enough, if it be done with care, but they are none the better for it, and as soon as it is applied on a large scale, the labourers can not be kept under strict supervision, and therefore the chances of damage to the trees are considerable.

C. officinalis is of a kind too slender to be subjected to the stripping process. However small may be the strips taken from it, the cutting out would harm the relatively thin stem.

The stems of *C. succirubra*, tall, and stout, with flat, smooth bark, offer more favourable conditions, but the newly formed, so called regenerated, or *renewed* bark, is less attractive to the eye, and so long as the more restricted shop or druggist's material is bought, its outside appearence has great significance, according to which in part its value depends.

The stems of *C. Ledgeriana* at the same age are seldom as tall and as thick as *C. succirubra*, and its bark for that reason, also because as a rule it is less even, smooth, and thick, is not so easy to strip off. Morever it is this variety in particular, which deserves preference for Moen's method of *shaving*, above the plan of partial stripping, the more so as *C. Ledgeriana* is not so certain as *C. succirubra* to possess a higher percentage of quinine in the renewed bark. The bark seldom renews itself completely, that is to say, the exposed portions of the stem, are wholly covered again; on the contrary sometimes considerable wounds remain visible. Young trees recover quickest and most completely.

In the ordinary course of things, more or less derived from the normal, simple rules in force, too much trust should not be reposed in the average native labourers; this fact only should be full in view, that when an estate is far enough advanced to allow of it, then regular harvesting, repairing gaps, filling up and planting afresh, as a rule making use of no artificial means to hasten it, but strictly confining oneself to taking the crop by thinning, either by digging up or cutting down to the ground. It is possible that by this plan, chances of enriching the stock may be missed, but on the other hand the danger of damage is escaped, and it is quite sure that the handsomest produce is to be got by a regular stripping of natural, original bark from entire intact stems.

Briefly, and for as much as we have not already treated it in chapter VIII, 'Chemical investigations', we will here mention the conclusions to which Heeren Moens and Scheffer come, at the end of their course of investigation in 1878.

The microscopical examination concerned *C. succirubra* as well as *C. Ledgeriana.* For mutual comparisons of both, there were taken: — original barks, — barks which had been some time under a covering of moss, — and finally barks which had been renewed both after partial barking by longitudinal strips, and after shaving off the uppermost layers. The last named, shavings, were further distinguished, as having been covered with moss or *indjoek.*

These barks, derived by these various methods were very easy to distinguish from one another by the look, as we have already stated on pages 127—8. Under the microscope the recognition is instant.

The original *C. succirubra* bark possesses sap ducts plainly visible. The cells of the outer and inner bark (parenchyma) are arranged in tangential rows, and extended in the same direction. The cells of the medullary rays have an altogether different direction.

After remaining fifteen months under moss (every other harmless covering seems to have the same effect, so long as it excludes light and air) the bark had become perceptible thicker than the uncovered bark of the same tree. The bark vessels were very slightly increased in number, the thickening occurred almost entirely in the cells of the inner and outer bark, or from the outermost portion of the entire bark. No wonder therefore that chemical examination detected a higher percentage in *mossed-bark*, and that it obtained a higher price in the market.

By the uneven augmentation of the cellular tissue, the vascular layer was surrounded by a thicker row of cells, and the former farther separated from the circle of sap ducts. The medullary rays are far more easily seen than in the original bark, and after the outer bark has enlarged to a great extent, an abnormally vigorous increase of the cells takes place.

The barks renewed after partial *stripping* and covered with moss for thirteen to sixteen months, under the microscope have quite a different appearence to the original. Firstly, in the samples examined, almost all the cells of the inner and outer bark were found to be arranged in radial rows, by which the renewed bark is recognisable at first glance. These cells, which are longer than they are broad, always have their greatest length in a radial direction: Secondly, in the new growth no ducts were observed, and lastly, the vascular layer is very small, hardly amounting to one fifth of the entire thickness of the bark.

These vessels however are placed very close to each other, and are merely separated by very small medullary rays. The absence of ducts may be observed in barks of various species, especially in full grown specimens, and as these latter, in quality and quantity of alkaloids rank above the younger, the alkaloids certainly do not reside in the ducts, and the want of these in the renewed barks, is consequently no token of inferior quality.

From the anatomical structure of renewed bark, it might be already inferred that it is richer than mossed bark, and analysis confirms this idea.

In the examination of bark renewed after *shaving*, it appears that whenever a portion, however small, of the original bark remains seated on the cambium layer, the renewing commences anew in the cambium, the thin inner layer which remains after shaving being thrown off like cork.

This layer forms then, a protecting envelope round the cambium and the renewed bark. On the contrary, if the shaving is more superficial, so that a thicker layer of the original bark is left, then it is not thrown off, but the new growth takes place from the medullary rays, towards the outer side of the vascular layer of the bark. The structure of the bark renewed in this way, is the same as that arising after partial stripping and mossing.

Examination further showed, that bark which was renewed on the lower extremity of the stem, possessed more bark-vessels than that which had re-covered the higher portions of the stem. Chemical analysis had already suspected the existence of a difference, by finding a larger amount of Cinchonine in the lower portions of the stem.

If a piece of bark is cut out of a stem, then the formation of new begins, first and quickest from the edges of the cut, but it has been observed at many places independent of each other, to take place over the entire exposed portion of the stem. Where the cambium layer is not in the least interfered with, that is, when the shaving has not gone through to the woody portions, the renewing naturally takes places most quickly and vigorously.

The bark of *C. Ledgeriana* under the microscope, has an entirely different appearance to that of *C. succirubra*. In neither of them, either in the original or in the renewed bark, were crystals discovered. (Howard thinks he has seen these in various other species.)

Sap ducts in original bark, were found in only very few cases, in renewed bark, not in one single case. Where they were met with, they appeared much smaller than those of *C. succirubra*. The cells of the inner bark are always in original bark arranged tangentially, in renewed bark in radial rows.

After shaving, the newgrowth takes place in the same way as in *C. succirubra;* here also it proceeds from the cambium if a little bark is left. Newly formed bark again is much poorer in liber-cells than the original. Renewing takes place much quicker after shaving, than after partial stripping.

In original Ledgeriana bark, besides the usual cells, there occur three other forms which deserve particular mention. Two kinds are thin walled, and possess an opaque substance. One of these, quite filled with this substance, occurs in the original *liber* portion of the cellular tissue, and like it, is very strongly tangential in original barks, in renewed barks it stretches radially quite as strongly. The second sort, whose contents are much less than the cell-wall, occurs in the deeper layers, between the parenchyma of the bark, and is somewhat round or square. Both sorts were found in all the barks examined, most abundantly in the renewed. The cells of the third description have an entirely different appearance. By Howard they were termed *resin-cells*. They possess a very strongly thickened wall, with very evident canals, sometimes, but rarely with branched pores. The circumference of the cells is more angular or square than that of the surrounding cellular tissue; from the latter they are, besides their larger size, easy to be recognised by different contents. These are opaque, insoluble in boiling absolute alcohol; are coloured dark brown by iodine, not blue, and only partially fill the cell. The cell wall itself, like the wood vessels, is coloured light yellow by iodine.

The thickening of the cell-wall is frequently very irregular. In all original barks these thickened cells are only found in one or two layers of the outermost bark, immediately under the suberous or corky layer. Very rarely there are two or three close together, and their number is small.

In bark renewed under moss or *indjoek* after shaving or stripping, these same cells were large and extended in a somewhat radial direction. Furthermore they are irregularly scattered through the entire cell-layer, although they always leave off where the cortical vessels begin. From the occurrence of these cells, not only immediately under the cork-layer, but in the whole breadth of the parenchyma, the barks renewed under moss or *indjoek* can at once be distinguished from original. This renewed article, has in anatomical structure, great resemblance to the *Quina roja* of Mutis, figured by Howard in his 'Nueva Quinologia', n°. 26; the agreement is seen both in the broad layer of resin-cells, and in the want of sap ducts. Only the cells of our renewed barks are arranged radially, and there the cortical vessels appear much less numerous.

Some have connected the presence of resin-cells with the lower qualities of the Cinchona barks. In *C. succirubra* they do not occur in its entirety; they do, in *C. Ledgeriana* but then with simultaneous increase of cellular tissue and decrease of bark vessels. As to the inferior quality of *C. Ledgeriana*, — there is indeed no reason to complain as to that!

Ledgeriana bark renewed after shaving without being covered up, is almost as thick as the original, the resin cells however, here hardly occur in the same degree and in the same place, as is the case with original Ledgeriana barks. The quantity of bark after shaving, thus remains the same, whether it be covered with moss or *indjoek* or not; the anatomical structure is however, different, and chemical analysis has still to make out, which treatment is best. So far as relates to *C. succirubra* it appears meanwhile fully made out, that covering has a very favourable action upon the formation of quinine.

If we have dwelt in some measure unduly on the anatomical structure of the barks, as they are formed in the living trees under different conditions, we intended chiefly to show how Moens was led by purely scientific examinations and inductions to the harvest-method of shaving. The first trials have confirmed the economic use of it. The shavings contain a greater percentage of quinine than the bark as a whole, and therefore command a higher price in the market. It is evident that a raw material such as this, has a special value for the quinine manufacturer who will desire the uppermost layers of the Cinchona trees by preference, provided he can perfectly rely on the care of the producer, and the conscientiousness of the salesman. There is this against this method of cropping, that it must be under good control and be conducted with prudence, also that it has not been applied long enough to warrant the declaration, that in the long run it will deserve preference. Continued experiments during a series of years, must yet show whether the trees can really bear repeated shaving without injury. If this appears to be the case, then it will be that the tall, lusty trees which remain after the completed thinning of a plantation, will bear a periodic, say biennial, shaving, and in the meantime between them a new plantation can be laid out.

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How much produce can a Cinchona tree readily yield within a certain time? That is the question which each planter puts to himself and on the answer to it, his financial position is largely dependent. Less than with other plants of cultivation, can the production be estimated beforehand on the whole with certainty. We shall meanwhile give what experience has taught us to the present time.

In 1869 the first crop was taken. From 220 *C. Pahudiana* trees of seven years old, which had grown up in the forests in thick shade, we then obtained 125 kilos of dry bark. The freshly peeled bark lost 71 % by drying. From 255 four to five year-old *C. Pahudiana* trees at the same establishment but from cleared ground and thus developed in full sunlight, we got 192 kilos of dry bark. The loss of weight in drying here barely reached 58 %. These figures speak for themselves, they show that planting in full light assures far quicker and ampler return.

110 four to five year-old *C. Calisaya* trees, raised from seeds, bushes from two to four metres high, grown on open ground, yielded 199 kilos of fresh bark, which lost 62 % in drying, and thus gave a net product of 110 kilos.

29 eight year-old *C. Hasskarliana* trees which from 1861 to 1864 had stood in the thick shade of the primeval forests, though afterwards they had enjoyed more light, in consequence of thinning out the forest trees, produced 57 kilos of dry bark; here the weight lost amounted to 61 %.

At a visit from Governor-General Mijer on 22 September 1871 to the Cinchona plantation at Nagrak, four trees were grubbed up and peeled under the eyes of the Council of State. One tree of *C. Hasskarliana* nine years old, yielded 7.85, one *C. Calisaya* seven years old, 6.10, one *C. succirubra* of six years-old, 4.10, and one *C. Pahudiana* of seven years, 2.85 kilos of dry bark.

These trees were selected at the same establishment, and give no support to the opinion that all trees of similar kind and age, will yield an equal quantity of bark, but a hint may be drawn from the ideas here given, the good development of a plantation being taken for granted. The tabular statement which we have given on pages 104—115 of the crops of *C. Ledgeriana, C. succirubra* and *C. officinalis,* give further a more detailed view of the produce to be expected. We wrote in our report so far back as 1864, that in Cinchona cultivation a period of eight years growth must be reckoned on, before the trees can be harvested successfully, with an eye to the development of their alkaloids, and that to a certain extent one may reckon upon as many half kilos of dry produce, as there were plants originally. We still believe that a calculation on this basis, will obviate disappointments.

The plants of the same plantation, even if not very extensive, rarely grow equally quick and strong. Many remain in a backward state; some are susceptible to harm, others do not perceptibly progress. By disease and other influences, individuals are constantly perishing, or are hindered in their development. The law of averages, when computing a future crop, can find no foundation in the results of trials on single trees. In the same nursery, say for example, of 8 years old, a tree may be seen which will yield upwards of 4 kilos of bark, whilst another will give barely four-tenths of a kilogram or even less.

From the introduction of Cinchona culture, every quarter, measurements have been taken of several trees of each description, so as to ascertain their power of development. The last measurement taken was in December 1876 and may give an idea of the relative vigour in development. The tables never had any wider application than to show the general development of Cinchona trees in Java, under favourable conditions. For this purpose the handsomest trees were not carefully selected; still less was a choice made of these which grew under abnormal circumstances, or whose development might be disturbed by noticeable causes.

Numbers.	Locality.	Description.	Height at end of 1875.	Height at end of 1876.	Girth of stem at end of 1875.	Girth of stem at end of 1876.	Age in years.
			metres.				
1	Nagrak . . .	C. Calisaya	13.980	13.980	0·704	0.705	15
2		succirubra	12.750	12.950	0.650	0.670	14
3		id.	10.030	10.430	0 710	0.720	12
4		id.	11.390	11.590	0.630	0.650	12
5	Tjibeurem . .	Hasskarliana	8.200	9.200	0.760	0.770	15½
6		id.	10.600	10.600	0.630	0.640	id.
7		Pahudiana	10.500	10.500	0 440	0.440	id.
8		Ledgeriana	6.700	7.500	0.415	0.450	11
9		succirubra	11.800	12·200	0.625	0.700	9
10	Tjinieroean .	Calisaya	9.700	10.170	0.500	0.370	11½
11		succirubra	9 270	10.010	0.670	0.750	9
12		lancifolia	9.000	9.100	0.350	0.360	12
13		micrantha	8.900	9.570	0.550	0.580	10
14		Pahudiana	11.700	11.700	0.640	0.645	19½
15	Rioengenoeng	officinalis	7 300	7.700	0.390	0.410	10

To exhibit as far as it is possible the developmental power in the first years of the plants, we here append a statement, which was furnished in the report for 1868.

Growth of certain plants in the new plantations.

Description.	Plantation.	Numbers.	Planted.	Height at the end of 1866	Height at the end of 1868	Girth of stem at the end of 1866	Girth of stem at the end of 1868	Explanations.
Calisaya.	Tjinieroean .	1	May 1868	1.530	3.380	0.090	0.180	
		2	»	1.240	2.550	0.080	0.155	
		3	»	1.110	3.100	0.060	0.180	
		4	»	1.730	4.070	0.065	0 105	
		5	»	2.000	3.300	0.100	0.260	
		6	» 1864	2.400	3.750	0.070	0.120	
		7	»	2.450	3.550	0.075	0.125	
		8	»	2.050	3.800	0.085	0.130	
		9	»	2.250	3.700	0.075	0.160	
	Nagrak. . . .	10	Febr.1865	2.440	4.650	0.150	0.360	
		11	»	2.020	3.400	0.150	0.330	
		12	»	2.000	3.220	0.170	0.350	
succirubra.	Tjinieroean .	1	May 1865	1.280	3.600	0.065	0.200	
		2	»	0.890	2.500	0.045	0.100	
		3	»	1.800	4.700	0.110	0.260	
	Nagrak . . .	4	Sept 1865	2.320	4.900	0.170	0.400	
		5	»	2.170	5.420	0.160	0.400	
lancifolia.	Tjinieroean .	1	May 1864	1.740	3.270	0.060	0.130	
		2	»	1.800	3.700	0.060	0.120	
		3	»	1.900	3.700	0.060	0.115	
officinalis.	Rioengoenoeng	1	May 1866	—	3.020	—	0.120	
	Tjinieroean. .	2	May 1865	—	2.800	–	0.150	

At Rioengoenoeng at the end of 1868 there were measured:

Ledgerianas planted in August 1866, the first of this kind, 2.800 in height and 0 135 in girth.

Calisaya anglica, planted in January 1867, 2.570 in height, girth .0170. (We can give no instance of quicker or more vigorous development.)

Calisaya javanica, planted in January 1867 height 1.950, girth 0.090.

Succirubras raised from seed from British India, and planted in March 1867, height 2.540, girth 0.130.

N.B. It is worth notice, that in general the plants obtained from seed received from British India and Bolivia, developed far quicker than those from seed of our own harvesting in Java. The exchange of seed with foreign parts, thus seems advisable as regards Cinchona culture. History has already taught us, that the original Ledgerianas were much earlier harvestable than their progeny. Had it been otherwise, in 1880-81 we should have already received important deliveries of Ledgeriana bark from the plantations of 1873—74.

CHAPTER XVIII.

STRIPPING AND DRYING THE BARK.

The crop may be taken in any season, but for drying it, the rainy season is not favourable. Day after day, sometimes quite suddenly, the rain comes down, each time interrupting and hindering the drying process, and moreover it then requires more attention, care, and labour. On the other hand, the vital functions of the Cinchona trees in this and the transitional seasons, appear to be most vigorous, and therefore the bark is easier to remove.

As a rule, meanwhile, it will be well to complete the periodical, main harvest, during the prevalence of the East monsoon, but that does not prevent utilising the produce throughout the entire year, when thinning the plantations of trees for one reason or another.

The stripping of sound, healthy stems and branches requires but little trouble; the more sappy the bark is, the more readily it comes away. Longitudinal incisions are made as far as the wood with a sharp knife, and afterwards, circular cuts at definite distances, naturally dependent upon the dimensions desired for the bark.

The bark is then carefully turned up along the first named incision with the back of the knife, and so on, until it is liberated. If the stem is provided with knots or other inequalities mostly caused by old wounds, bruises, or the sprouting of branches, then the bark clings more tightly to its seat, and more care and patience much be employed [1].

[1] Knives of bamboo or buffalo-horn, shaped like a paper knife, are made use of for peeling. Iron or steel knives might bruise the bark when loosening it, and also discolour it by the action of the tannic acid upon the metal.

At first we cut the Java barks, 0.2 metre long, and 0.05 broad. The fresh strips feel like damp sole-leather, but are very brittle, especially that from Ledgeriana, on account of their short vessels. If handled roughly the danger is run of breaking the regularly cut piece.

By circular incisions on the stems and branches thus, the bark is perforce taken at the required length; the breadth as may be convenient, which may be ascertained after peeling.

The breadth we at first fixed upon, 0.05 metre, was not without reason. In a fresh condition the bark strips are flat; in drying they bend, and show a strong tendency to curl inwards, forming quills. Now a width of 0.05 metre, forms after complete drying a close quill; the longitudinal edges of the strips just meet each other. If the strips were taken broader, then the quills would be less regular in shape, or else curl up too much, and they would then be awkward to pack, because they should be filled up with thinner quills, which again gives fresh difficulty, and necessitates moreover a strict sorting.

The planter directs the industry according to local circumstance. Drying, sorting and packing the produce, must be done on the spot. A building is erected on the estate, where there is space for the drying arrangements, and where constant supervision can be kept. Drying on the spot itself, would reduce the weight and bulk of the product for transit, but the necessary care can hardly be expected in the different plantations, not to speak of the great number of sheds or roofed erections that would be wanted there because of the uncertain or changeable state of the weather. Stripping on the other hand, is preferably done in the plantations, the transport of the entire trees would be too expensive and troublesome. From the nature of the principles which stand in the foreground of exploitation, it is evident that the planter as a rule, himself should mark out the trees which are intended for stripping.

Whether uprooting or cutting over be adopted, the work must always be done by a gang of trusty workmen. The trees being felled, are deprived of their branches on the spot, and these together with the stem, are transported to a central point in the plantation, where the barkers or shavers have come together in a shady spot, so that during the hours of labour the direct sunheat may not be overpowering.

Having regard to sorting it is now advisable to keep quite separate the barks taken off at various heights of the stem, as well as those from the thick and the thin branches. We know that the contents of the bark varies in proportion as it is met with higher or lower on the stem, and diminishes much upwards, that is to say, towards the younger portions. The same is the case with the relative weights of the barks, and sorting may very well be done after drying according to its thickness, but it seems to be a safer rule for the estimation of its value, to keep separate directly after stripping, the barks from the lower, middle, and upper portions of trees of similar age. Indeed from one tree the middle bark may be as thick as the lowest from another, so that the age and quality, are not always strictly defined by relative thickness.

This method of immediate preliminary sorting, is moreover easier and surer, because it has not the least to do with valuation, and thus can be entrusted to any one.

Accurate sorting is of very great importance, if the analyses are remembered which were performed on the bark at different heights on entire trees. For the quinine manufacturer the bark is more suitable and valuable, in proportion as it contains a preponderance of quinine. At a certain height on the stem, this alkaloid diminishes noticeably in quantity; also the weight of the bark is less than that taken lower down; though mixed with so much that is richer, the mass as a whole is poorer as to percentage.

The case may present itself, that the bark from a tree which is only considered fit for pharmaceutical use, by good selection and picking over, may yield its quota for the manufacturer.

When the daily task is completed, the labourers take the peeled bark in baskets to head quarters, where the produce is received by men thereto appointed and regularly laid out on light, oblong squared racks of plaited bamboo. The filled racks, placed on rough frames to a height of $1^1/_4$ metre above the ground, remain in the open air exposed to the direct action of the sun's heat. In foggy or wet weather, and towards the afternoon or evening in the mountains regions, when it becomes cloudy and moist, the racks are brought into a shed or under cover. Very soon the fresh strips of bark begin to curl up; thereupon the opportunity offers to unite the masses on two racks in one, and gradually more drying room is available. In the meantime, the original sorting is strictly kept to, and care is especially taken that the produce of different kinds and from various plantations is not mixed.

In favourable weather the drying is complete in a few days. When the barks rattle on being heaped up and have lost their pliability, a simple practical proof of their air-dried state may be taken. A piece is put upon a block of wood, and cleft across the middle, by a violent blow of a hatchet. If the clean cut pieces spring up briskly, then the drying process can be considered complete, and it is now ready, to be preserved in its dry state. To this end it is stored in dry airy warehouses.

Whether the stripping be done in the plantations or at head quarters, it is most essential that the barks of each kind of Cinchona of similar origin and age, should be kept by themselves, and be sorted according to their station on the stem and branches. To sort strictly and to cut in regular uniform pieces, are actions of the highest importance, which cannot be too closely observed. How and where the various operations take place, matters nothing; the planter must guide himself as to these, with regard to circumstances which concern the economic and practical importance.

Peeling the branches is naturally slower and less easy than doing so to the stems, and still more troublesome is barking the roots. From the later, only bits and broken fragments can be got, and no regular pieces. The workmen must be forbidden to wash off the earth adhering to the roots; they should instead, be provided with stiff brushes.

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Comparative trials have repeatedly shown, that no harm accrues to the contents of the bark when dried by summer heat. Artificial drying demands costly contrivances, and moreover, damage to the outward appearance of the produce may soon be done, not to speak of the chances, that in dealing with large quantities, a remnant of moisture might be overlooked. One cannot be sure of equal drying, and by too violent a heat the contraction of the outermost layers of the bark may be so great, that the produce may outwardly seem quite dry, and inwardly be still more or less green and wet. If there should be a single piece of bark in a bale or chest, which is not completely dry, it might spoil the entire mass. It is well therefore to keep a sharp look out, so as not to include any suspected pieces when packing.

The case may occur, that small parcels of bark, gathered for some reason at other times than the usual, must be artificially dried. Then an enclosed but well ventilated place is selected, merely taking care that the barks are not exposed to the smoke, and still less to the direct heat of the fire, the action of which would then be hard to regulate.

Succirubra barks, which are usually termed 'red bark' in trade, are seen in section and inside plainly red, and this colour is probably enhanced by slow drying and temporary scalding of the fresh bark, by which it is longer exposed to the influences of light and air. At the auction of 1879 a small parcel of scalded bark was offered, but the results of the sale have declared nothing decided. Even less did a parcel of Succirubra bark, which had been covered with moss, attain a higher value. This last bark was distinguished by its deeper colour and its brittleness.

CHAPTER XIX.

SORTING AND PACKING.

What we have just now said as to sorting and its consequences, must be considered more at large in this chapter. The trade in Cinchona barks divides into two principal categories, whether they are destined for the preparation of quinine, or else in pharmacy and industry as raw material for decoctions, infusions, extracts, powders, tinctures, wine, etc. The latter are termed pharmaceutical, druggists, or shop barks, the former manufacturer's bark.

The value of manufacturer's bark entirely depends upon the amount of quinine, and that can only be determined by chemical analysis. We now know that each description of Cinchona possesses its own special composition, which agrees with the typical form of the tree and the anatomical structure of the bark, but it is seen quite as clearly, that, whilst the quality of the alkaloids remains constant, the quantity may vary in individuals of the same kind and origin; this is not yet explained.

In other words, while the producer can give the most positive assurance, that he is offering Ledgeriana bark and nothing but Ledgeriana bark, without previous chemical examination he is not in a position to state the percentage of quinine in his produce. Of course he knows, that his bark must possess abundance of alkaloids. and that quinine prevails among them.

Indisputably it is of great importance for the producer, that he should be able to tell the chemical value of the produce he brings to market. First, he can thereby approximately estimate the money value, but also, the merchant whose confidence he has won, will deal with him more readily, because he can confine himself to a definite control, and is not obliged to get analyses made with substantial accuracy of each parcel offered.

The value of the manufacturer's bark is thus actually regulated by its percentage of quinine; the shape and outward look of the produce has little to do with it, but it should not be purposely rejected. The eye also has its requirements, and it may be fully satisfied by carefully, uniformly treated produce, without any more trouble or expense.

This comes about by careful sorting; we cannot repeat it too often, that no produce of different percentages should be mingled, where with a little care, they can be kept separate.

Absolute high percentage of quinine alone, does not determine the value for the manufacturer. If a bark possesses with plenty of quinine, a preponderant quantity of secondary alkaloids, then reasonably enough, its manufacture is difficult. Succirubra bark with 3 % of quinine, approaching 7 or more per cent of secondary alkaloid, will not be chosen before Ledgeriana bark, which with a total alkaloid contents of 3 %, has more than 2.5 % quinine.

Irregular pieces and fragments, morsels, shavings, powder from inferior kinds, have a relatively small value; but if it is certain that it is suitable for quinine preparation, then the form occasions no real difficulty.

It is altogether different with the druggist's or shop-barks. For these a more distinctly taking appearance is required; they are bought more by this outside, than after their chemical contents, which can be pretty well guessed when the origin of the produce is known.

The trade prefers regular quills, the longer the better, (the longer quills of 5 to 6 decimetres in length, appear much in demand, and evidently do fetch higher prices) with strong healthy appearance, silver grey in colour from being covered with lichen growth. The flat shape is also highly appreciated, provided it is the result of the natural thickness of the bark and not a consequence of artificial drying and weighting the fresh bark during that operation. The thick barks from stout stems, do not curl up in drying, but remain almost flat, only somewhat bent into a gutter shape, where it was cut.

If now a parcel of Cinchona be bought, judging by the outside of the samples, and on unpacking it be seen that the sorting leaves much to be desired, and that the entire bulk is not uniform, then the buyer's disappointment will make him distrustful.

Thin, less robust quills of barks are also in request, provided they are seen to be similarly shaped, intact, and handsomely covered, and are offered for what they really are.

*
* *

The first crop of Javan Cinchona was sent in mats, bags and cases. This was done to learn the best, and at the same time most economical packing. Meanwhile the primeval forests, destined for the planting of Cinchona yielded such an abundance of timber, that we gave the preliminary preference to cases. These were prepared at the Cinchona establishment by ordinary carpenters, 0.7 metre in breadth and length, and 0.42 metre deep. Such cases, well packed, hold 60 to 75 kilos of bark, according to the weight of the latter. The barks cut to a length of 0.2 metre, were stood upright therein, and put close together in two rows, one above the other.

A few quills were then put in a horizontal direction to fill up the space at the top. Plaited mats of *Pandanus* leaves were so put into the case, that they bent over the edges of these in sufficient measure, that when brought back over the uppermost layer in the cases, they entirely covered the whole contents. Cases packed thus, with a stout cover nailed down, were so solid, they were able to withstand the roughest transport. An experiment was made with a loaded bullock cart, which was purposely overturned on the edge of a ravine, so that the five cases had a serious and long continued tumble. They seemed quite uninjured by this violence, and thus they might be supposed capable of withstanding the most troublesome travelling.

The packing thus described is still kept to, though in 1874 another plan was also tried, on the ground of the conviction, that private planters at least, in the long run might be unable continuously and economically to provide themselves with the necessary timber for the cases. The cases weighed moreover one with another about 20 kilos, and as all the wood was not absolutely dry at all times, they might show a considerable difference in the tare, found when sending from the establishment and on its arrival in Europe.

The cost of a case amounted to about one guilder [1], and for that price efficient, strong gunny-bags were obtainable. The kind however used in forwarding coffee, rice etc., would not answer our purpose; regular packing of Cinchona bark in these is hardly practicable. We therefore prepared bags with a circular bottom, and a corresponding loose cover. By folding the loose margin over and back, the quills can be put in there as evenly and closely as in the cases. Five of these rows found room in the usual bag one metre high; if desired, barks of greater length than 0.2 metre of course can be included in these bags, or rather, fewer rows placed on each other, so as to keep the

[1] One shilling and eight pence. B. D. J.

packages uniform. The packing finished, the loose cover was sewn on, and the bale thus formed was furnished with four solid enclosing hoops of *rotan,* and over these, a transverse band of the same material. The well-filled bale has a clean cylindrical shape, is easy to handle, and as appears from several years' experience, can withstand a violent blow. The tare is from $1\frac{1}{2}$ to 2 kilos; a difference in weight compared to the cases of considerable importance, both as to the cost of the entire freight, and transportation power of the carts, and therefore in the long run on the freight.

The principal thing in each way of packing, is that care be taken to prevent chafing and consequent damage to the upper layers. We therefore supply the following method of filling.

The prepared barks are tied together in bundles of the same thickness. For packing in cases they are made of such dimensions, that four bundles just cover the bottom of the cases, but leaving empty places, where they do not touch one another, because of their cylindrical form; these spaces are filled up with loose quills. Afterwards the ties are taken away, and the case is rocked lightly to and fro, to give the barks an upright direction. If it now appear that the closing up was not complete, a handy workman puts a quill here and there carefully between the others, so that the whole mass is wedged together and all movement prevented.

As the barks were all cut to the same length, not quite halfway up the case there is a new firm bottom, on which the second layer is piled in the same careful way. When it seems necessary, the ends are filled up with barks put horizontally, as we have already described.

In filling the bags, we go to work in the same fashion, only here the bundles are made about the same diameter as the bottom of the bag.

Since 1874 dispatching in bags (or bales) has much increased, and the cases in like ratio, have been less used. The bales do excellently; only once (crop of 1876) was there any complaint made in the Netherlands. This however was not due to the mode of packing as it has just been described; it so happened that at one of the establishments, for a moment the packing had not taken place with the usual care and supervision.

If it is wished meanwhile, to bring a selected parcel into the market of *cabinet* pieces, then cases, though heavy, must always have the preference.

Each case or bale has its marks denoted on a place easily seen. These consist of the initials of the species of Cinchona, and the plantation, the number of the package, and the gross or tare weight. For the bales, denoting the tare is superfluous as it is known once and for all time.

The three principal descriptions of Cinchona, *C. Calisaya Ledgeriana*, *C. succirubra* and *C. officinalis*, are denoted by the letters C. C. L., C. S. and C. O.

If a descriptive invoice be sent with the goods, showing the contents of the various parcels of bark, it is certain to gain the confidence of the market, so soon as the bidders (buyers) are convinced that the statement is accurate.

When the systematic harvest is begun in the commencement of the East monsoon in June, it is possible to send the produce by steamer to Europe in the same year, and thus there is no need to wait long for realisation.

The producer must calculate, that his success in the long run is dependent on the confidence that he can inspire in the merchants, by strict order and accuracy in sorting, packing and marking. He must never think of offering his produce under a name which does not belong to it, but on the contrary consider that honour should be observed in the sale and nothing against it.

From the first crop and onward, we had to accustom the merchants to judge of the barks, and to receive them under the names of the trees from which they were procured. The Netherland advisers were not at one with us at first, and thought we must persevere in the old trade names of "brown", "crown-bark", etc. Thus it fell out, but quite soon and properly there were in the German periodicals, remarks thrown out against the old nomenelature [1].

Since the first auctions, there has been a general adhesion to our wishes, and the Javan barks are still sent to market under the names of their botanical origin. In like manner the antique trade names, which still obtain even in scientific works and Pharmacopoeias, with time must undoubtedly give place to a nomenclature which denotes the exact origin, and thereby conduces to estimation of the value.

CHAPTER XX.

ADMINISTRATION OF CINCHONA.

Previous to 1820, Cinchona bark was used remedially exclusively in the form of powder or extract, infusion or decoction. The Cinchona alkaloids were not then sufficiently known, but although the discovery and separation of quinine soon obtained a wide application in medicine, still the old forms are not entirely discarded, and it has appeared many times that an effective use of the bark according to pharmaceutical prescriptions, has effected recovery or amelioration where quinine alone was inoperative.

[1] In Buechner's "Neues Repertorium für Pharmacie", vol. XX, p. 343, Jobst says, speaking of Javan brown bark, "without doubt the famous Pahudiana" and at p, 657 Henkel remarks, that of the Javan barks no accurate account of their origin was given, which is simple, for no single Cinchona expert would enough recognise the offered barks under the trade names which had been abandoned.

The conviction has more and more gained ground, that good Cinchona barks judiciously applied, frequently do not merely rival quinine, but even surpass it in useful effect. More attention is now being devoted to the secondary alkaloids, and at various places these have been tried separately on thousands of patients. The results are not universally in accord, but they have sufficiently demonstrated that the healing power must not be ascribed exclusively to the quinine, but in many cases it resides in the subsidiary alkaloids [1].

The enormous quantity of Cinchona bark exported from America and the East Indies, and not destined for the preparation of quinine, can really be called an assurance that the bark, as such, is much used and highly valued. Quinine indisputably remains the preëminent febrifuge, and its physiological action action is best and most completely known. This does not take away the fact, that there are other medicinal virtues in the bark besides, and in many cases of sickness, the combination of different chief-constituents of the bark, conduces to its favourable action.

A large amount of the produce serves for the preparation of quinine wine; great quantities also, in British India especially, are intended for the manufacture of *Quinetum*, which possesses all the Cinchona alkaloids in one, thus named and highly recommended by Dr. de Vrij. *Quinetum* is another name for the mixed crude alkaloid, *rough mixed alkaloid*,

[1] It is now some years since therapeutic experiments were made, and Pleischl, Appolzer, Seitz, Briquat, Bouchardat, etc. testify to the value of the secondary alkaloids of quinine. In British India on a greater scale, attention was fixed on the subject, but in the Dutch East Indies there was no energetic testing as to the use of the associated alkaloids of quinine. Really it seems folly to seek after a surrogate for quinine, as long as these known, valuable and cheap bye-alkaloids can be had in quantities. On pharmacodynamic grounds we are meantime going backward, instead of forward, by urging the use of a mixture such as *quinetum*, so long as it has not a fixed composition which can be guaranteed. With *quinetum*, as prepared from Succirubra barks, the doctors have no fixed guage to go by as to its results.

Cinchona febrifuge, *Indian quinine* or *Quinquinine* prepared in British India, and an improvement on the older preparation, *Quinium* of Delondre, in which much quinovic acid occurs.

It is not possible for us to give in a short space, a complete statement of the manifold and multifarious applications of Cinchona in its different forms and preparations.

In a medical work it would be appropriate to give the many experiments, which have already been made, and still are, on the various alkaloids. They have at all times led to disputes, sometimes very violent and unrefreshing, which the planter and dealer can very well neglect. For the two latter, after knowing the different Cinchona species and their chemical contents, the only really important thing is the certainty, that the use of Cinchona is very far from having yet reached its limit. A considerable part of the population of the globe, remains still ignorant of its use, and as for another part, Cinchona and its preparations are luxuries which by their costliness, only permit the most moderate use.

The alkaloids occur in almost every part of the Cinchona tree; it is true, not to any great extent in the wood, and only traces in the leaves. Moens separated pure quinine from the wood of Ledgeriana. Meantime, the quantity to be obtained elsewhere than from the bark of the stem, branches and roots, can never be of practical significance.

The leaves can if necessary serve for the preparation of Quinovic acid, which is recommended in medicine, for amongst other things, dysentery, and it can easily and in ample measure be separated.

Dr. Phoebus, sixteen years ago, advised the admixture of the sweet-smelling Cinchona flowers with tea.

We have often tried this, but we cannot say that the tea has thereby gained any special scent; on the other hand we do not believe in the medicinal effect of so paltry a quantity of Cinchona flowers as can be mixed with tea, unless the flowers themselves were used for a drink.

In the list of remedies, Cinchona holds undoubtedly the highest rank Its consumption as a specific in fevers, falls short of the demand. The produce is still scarce and consequently too expensive. Since Cinchona however has been brought into regular culture outside America, the chance exists, that this excellent, almost indispensable remedy, before long will be produced in sufficient quantity to satisfy the extensive demand for it, and at the same time the price reduced to bring it within reach of the sick poor. Though the high prices which are now obtained, will then fall considerably, still the culture will remain a profitable one; above all, humanity will be benefitted; but the producer will still be rewarded with satisfactory profits, although he may have based his calculations, and directed his undertaking, on the maintenance of high prices. For the time being therefore, the raiser of raw material of good quality is guaranteed high profits.

It is quite another question, whether science will ever succeed in preparing quinine by method of synthesis. Allured by the high prices obtained, led also in part by purely scientific interests and aims, the chemists have been busy for years on this highly important question. If it attain to a reasonable, practical, satisfactory solution, then a comparison of the expense must be made, with that occurring in the existing culture, as to whether the latter is only valuable for firewood. We shall in the next chapter adduce what is known about this matter.

CHAPTER XXI.

ARTIFICIAL PREPARATION OF QUININE.

Even at the present day, chemists are not entirely agreed as to the composition and constitution of the different Cinchona alkaloids, for whilst Hesse describes a new Quina-basis under the name of *Homocinchonidine*, Skraup on the contrary denies its existence, because he considers it identical with *Cinchonine;* thus it seems that chemistry in the domain of quinology, has not as yet spoken the last word.

By numerous experiments, (whose continuance will certainly not be suspended, until the aim is reached, or else the conviction is attained, that in the present standpoint of science, any further search must be pronounced hopeless) it has been endeavoured to ascertain the constituents of the Cinchona bases, so that afterwards possibly thoses base might be built up synthetically.

At the present time, *Cinoline* and *Cinoleine* are considered to be two, isomerous bases, very much resembling each other, about analogous in nature and reaction to aniline, both having the formula $C_9 H_7 N$. The one occurs in coal-tar and can be thence separated by partial distillation, the other is with many other productions, formed by dry distillation of quinine, quinidine, cinchonine and cinchonidine, with potash or soda. That both these isomerous bodies are very much alike, is is generally admitted. Dr. Hoogewerff at Rotterdam obtained from both bases, the same products, by oxydation with Chamaeleon mineral. These constitute a series of homologous bodies, belonging to the same class, distinguishable by great stability when heated with nitric acid. *Lepidine* ($C_{10} H_9 N$), *Dispoline* ($C_{11} H_{11} N$) etc. belong here. Certain members of this series are met with in coal-tar.

For some time there have been active endeavours to build up quinine from this Cinoline, and chemists of good name and repute do not doubt the eventual success of these attempts. It has even happened in Germany, that an actual artificial fabrication of a Cinchona alkaloid has been effected, but it possessed no polarising power, therefore not identical with the natural production, and decidedly differing in other properties.

Granted now, that at no very distant period it may be possible to prepare the most valuable Cinchona alkaloid by the synthetic method, what dangers have the Cinchona planters to fear from this scientific triumph? In our opinion the natural product would not be thrust aside, though the competition might become serious. It is by no means certain, that with a similar chemical composition, similar physiological and therapeutical effects would follow, and even were it so, then people would for years cling to the old well ascertained state of things, before an unconditional trust would be placed in the new venture. In any case the artificially obtained quinine would require costly production, and experience must show, by which way this remedy can be most advantageously prepared.

What does the history of madder teach us? Its culture seemed doomed to entire extinction, when the way to prepare that colouring matter artificially was found out. Yet it is not only still existent, but it is even considered at the present day, that an extension of madder cultivation is desirable and profitable, where it can be prosecuted under favourable conditions. The product of art does not seem to satisfy the dyers in every point, as well as the material which nature offers.

Indigo also has now been prepared artificially; this fine discovery however will be first valuable to industry, only as soon as the indispensable raw material can be procured in sufficient quantity and in a profitable manner. Indigo culture goes on its way, and is not as yet dangerously menaced.

If quinine can be obtained synthetically more cheaply than from Cinchona bark, and further if it appear that the artificial product quite ousts the vegetable bases, the need of Cinchona bark as such, is in no sense abandoned. Pharmacy will not contract its considerable demand for it, but will still utilise it.

The possibility of an artificial preparation of quinine may rise up before the planters as a threatening spectre, but we continue convinced, that the cultivation of Cinchona thereby would in no way receive a death-blow, that at most it would have to be narrowed or modified, and yet remain profitable.

CHAPTER XXII.

PRODUCTION AND COMMERCE.

Among the Cinchona producing countries, besides the original fatherland of the Cinchona trees, there have come into notoriety during the last ten years, Madras, Bengal, Ceylon and Java. In other countries also, as we shall bye and bye show, the culture has been tried and introduced, with however as yet lesser production.

The produce of the plantations of the Dutch East Indian government exceed as yet that from all the private growers together in Java. In the meantime these last are continually extending and within a few years the relation may be reversed, and we believe the exports from Java, will exert a certain influence upon the Cinchona trade even of the globe. The private speculations are still quite young; a few only, Krawang, Buitenzorg and the Preanger, on the private estates of Pamanoekan, Tjasem and Tjiomas, and the leasehold estate Naspada, possess important exploitable plantations.

The following statements show the production, in so far as they can be compiled from the official reports and brokers' circulars. The figures may not be absolutely correct, but cannot be far from the truth.

PRODUCTION OF PRIVATE ESTATES.

	1875	1876	1877	1878	1879
In half-kilos,	3,125	914	6,387	20,606	48,777.

PRODUCTION OF GOVERNMENT PLANTATIONS.

1869	933	half-kilos.	1875	87,273	half-kilos.
1870	9,000	„	1876	94,548	„
1871	15,200	„	1877	100,178	„
1872	36,000	„	1878	121,343	„
1873	50,000	„	1879	106,000	„
1874	66,000	„	1880	109,080	„

In these figures, except those for 1880, not only are the exports and sales comprised, but also the quantities which were destined in the Dutch East Indies or the Netherlands for the medical service of the state, or the preparation of crude alkaloid.

The following tables A, B and C, give a summary of the Javan Cinchona sold by auction in the Netherlands. If these data are compared with the indications concerning the development and the strength of the plantations, an idea will be obtained of the productive power of these within a certain number of years. It must be borne in mind however, that in each single year was harvested whatever seemed fit for it, also what in the interest of the culture as a whole was thinned out or uprooted to prepare the place for better descriptions of Cinchona.

A. SENT TO THE NETHERLANDS FROM THE GOVERNMENT PLANTATIONS IN JAVA.

	1869	1870	1871	1872	1873	1874	1875	1876	1877	1878	1879	1880	Total
Succirubra	—	Calisaya, Hasskarliana, Pahudiana officinalis and caloptera.	Various kinds.	724	4,425	14,249	16,502	38,769	38,188	43,525	25,207	13,323½	194,912½
C. Javanica	282			12,662	26,811	25,026	37,054	26,991	27,757	23.494	8.517	16,060½	204,654½
C. Schuhkraft	—			—	1,289	—	687	8,663	11,727	18,658	40,987	61,256½	143,267½
C. Anglica	—			692	242	1,963	503	—	122	320	6,584	—	10,426
C. Ledgeriana	—			522	2,944	4,500	4,452	3,925	2,419	8,007	7,850	4,235	38,854
Hasskarliana	—			2,716	692	1,699	6,339	4,740	13,004	12,346	9.413	6,234	57,181
officinalis	—			814	—	665	2,021	3,751	3,347	2,702	3,365	5,417	22,082
Pahudiana	657			4,386	975	3,704	1,654	482	121	107	121	122	12,323
Caloptera	—			124	—	388	—	960	—	1,646	—	—	3,118
micrantha	—			—	—	—	434	—	—	—	—	—	434
lancifolia	—			—	—	—	—	—	—	1,516	—	2,433	3,949
various . . . . (dust, powder or broken bits).	—			7,600	4.721	10,759	15,107	3,282	—	—	—	—	41,469
N°. cases	—	28	61	208	332	377	339	188	197	112	49	26	1,917
» bales	14	41	—	—	—	63	248	499	578	803	753	825	3,824
Total packages . . .	14	69	61	208	332	440	587	687	775	915	803	851	5,741
Weight of bark, in half-kilos.	933	6,900	6,716	30,240	42,099	62,953	84,753	91,563	96,685	11,234	102,044	109,080	746,287

Of the 1873 crop, 80 cases containing 10152 half-kilos Calisaya javanica, were lost by the wreck of the steamship *Prins Hendrik* in the Red Sea.

With the crop of 1874 there was a beginning of the selection of the barks into first and second quality, according to its thickness. They were also for the first time cut at double their former length.

In 1878 as an experiment, 12 cases with 1620 half-kilos of shavings of Ledgeriana bark were sent to market. In the year following there were offered 5 cases with 544 ℔ similar material, and moreover 1 case of Officinalis shavings containing 93 ℔. This time the name *schraapsel* (scrapings) was replaced by that of *schilfers* (scales or shavings).

From the beginning we strove to obtain from the government Cinchona exploitation, an endeavour after pr oportionate yearly increase of produce. If we had only actually tried to deliver from what might be got from the same kinds at the same age, without doubt by this time, there might have been 3 or 4 times as much sold. In the last year or two no more was harvested than was moderate and reasonable, agreeably to the principle aimed at, because the continuous wet weather was not favourable, and also because the means of transport, consequent upon cattle-disease, or the workpeople, the result of fever epidemic etc. fell short. If less has been harvested in 1879 and 1880 than was expected, the plantations which have been that much spared, can meantime form so much the more produce, and the following years may, under favouring circumstances, yield so much the more than the average

In 1880 there was harvested and exported of renewed bark, Ledgeriana in shavings, one case, containing 111 half-kilos. Analysis shows that this contains 7.5 % quinine in a total a!kaloid contents of 8.7 %. Further, 18 cases of Ledgeriana shavings, containing 1890 half-kilos, of 7.9 and 8.8 % quinine, in a total alkaloid content of 9 and 8.8 %. Lastly, there were 6 bales Officinalis bark, 694 half-kilos in shavings, containing 4.2 % quinine in 6.5 % of total alkaloid.

B. STATEMENT OF THE AUCTION-SALES OF CINCHONA FROM THE GOVERNMENT PLANTATIONS IN JAVA WITH THE RESULTS OBTAINED.

Accounted for by the Trading Company in kilograms.				Auction of								
	20/10 1870	14/3 1872	27/5 1873	31/3 1874	30/6 1875	1/6 1876	1/74 1877	18/7 1877	30/4 1878	30/4 1879	2/7 1879	20/7 1880
A. Shipped at Batavia .	1001	6744	11,299	13,195	24,579	32,963	31,725	12,116	47,166	45,594	9892	50,422 sold.
B. Delivered at Amsterdam	876	6200	10,924	12,616	22,318	31,523	29,970	11,586	46,103	44,581	9373	46,685
Waste	12.6 %	8 %	3.3 %	4.38 %	9.2 %	4.3 %	5.5 %	4.3 %	8.83 %	2.2 %	3.2 %	?
Proceeds, gross	f 2225	f 17,616	f 31,097	f 32,163	f 64,329	f 102,332	f 153.270	f 30,105	f 95,565	f 158,992	f 38,425	f 201,599
do. net	f 1935	f 15,552	f 27,193	f 27,772	f 56,016	f 91,693	f 140,926	f 26,764	f 81,215	f 144,624	f 35,076	f 184,761
Charges	14.19 %	11.71 %	12.55 %	13 65 %	12.90 %	10.39 %	8.05 %	11 09 %	12.92 %	9 6 %	8.7 %	8 3 %
Average gross-price per $^1/_2$ kilo of bark	f 1.28^{69}	f 1.48^{30}	f 1.42^{22}	f 1.27^{46}	f 1.44^{11}	f 1 62^{21}	f 2.55^{7}	f 1.29^{9}	f 1.02^{15}	f 1.74^{74}	f 2.03	f :.15^{87}
Cinch. powder, as per A.	—	—	3898^{5}	2047^{1}	6043^{80}	8321	123	660^{98}	—	—	—	—
» » » » B.	—	—	3808	2009	5548^{60}	7748^{7}	128^{5}	644^{28}	—	—	—	—
Gross proceeds of ditto .	—	—	f 1181	f 2232	f 7955	f 8982	f 208	f 802	—	—	—	—
Net » » » .	—	—	f 606	f 1884	f 6864	f 7642	f 186	f 690	—	—	—	—
Furnished to War Depart.									—	—	—	8 bales.
Cinchona bark, as per A.	—	—	—	257^{91}	492^{59}	587	—	664^{52}				
» » » » B.	—	—	—	255	457	577^{5}	—	643^{5}	—	—	—	
Cinchona powder » » A.	—	—	—	237^{16}	—	—	—	—	—	—	—	
» » » » B	—	—	—	236	—	—	—	—	—	—	—	
Ditto brought into account	—	—	—	f 638	f 1223	f 1619	—	f 2857	—	—	—	
Gross proceeds, total . .	f 2255	f 17,616	f 32,278	f 35.033	f 73,507	f 112.933	f 187,242		f 95,565	f 197.417		f 201,559
Net » » . .	f 1935	f 15,552	f 27,799	f 30,294	f 64,103	f 100,955	f 171,423		f 83,215	f 179.700		f 114,761

There is much information to be drawn from this statement of the 12 government sales and therefore we must fix our attention on certain points of it.

The calculated average prices, in which also the purchased samples are brought into account [1], are naturally useless for estimating the prices of the different kinds and varieties of bark. On pages 111—115, we have given a summary of the sales of the three principal kinds, and only these are of significance for the future, because though not exclusively, yet they are raised by preference and in quantity. The prices of these three chief species; *C. Ledgeriana*, *C. officinalis* and *C. succirubra*, will probably always strongly fluctuate in relation to each other, yet in accordance with their typical percentage, they will come more and more to fixity. Each species or variety is moreover again sorted, as the bark is derived from stems, branches or roots; whether cut in short or long pieces, or else delivered as pieces or fragments (dust) They are further distinguished as we have already said, as bark in shavings (superficial barking) mossed, and renewed bark.

Within a short period the market prices may show considerable differencies, which are dependent upon the various actual needs, in connection with greater or smaller imports and expectations about these. At the auction of 11 March 1881 at Amsterdam, prices were obtained for ordinary Javan barks, which otherwise were usually grudged for good raw material for quinine making, and so also at the auction of 18 January previous, single parcels of Schuhkraft ran up to 205, and rootbark of this species, to 231 cents per kilogram.

Great differences were noticed in the invoiced freight, and delivery weight of the Cinchona packages. From our summary B, it appears that the waste, from the shipment at Batavia, to

[1] Samples were given out thus; for the sale of

30 April 1879 —	175	kilos	*fr.*	1132.00
2 July 1879 —	44^{20}	»	»	397.10
20 » 1880 —	251^{15}	»	»	1538.05

the delivery at Amsterdam, amounted from 1.83 to 12.6 per cent., and as we have heard on good authority, private consignments at the present time lose from 5 to 7 per cent. in waste.

The product of the first two government auctions was sent by sailing vessels, and thus was longer exposed to loss, than the later consignments which were sent by steamer. The weights as invoiced, might differ considerably from the bills of lading, because the weighing of the packages did not take place at the Cinchona establishments, but in the coffee warehouses closest at hand. When the Cinchona establishments were subsequently provided with weighing machines, it was not even than possible for various reasons, for the Director of the government undertaking to ensure accurate weighing. And were the just weight taken, the weighing machines at the establishments and those of the factory at Batavia, would probably always show certain discrepancies. In later times things have been managed better; in every instance the weighing machines at the establishments and at Batavia, were brought into complete accordance by testing against standards. Meantime it must be understood that the difference in weight when shipped at Batavia and delivered at Amsterdam, is in no case to be imputed to negligent weighing here or there, and now the loss which is constantly leading to the disappointment of produces or consignor, must receive a clearing up and explanation.

The Cinchona barks are delivered air-dried and packed in cases or bags. Trials carefully made at my request by the firm of Heeren d'Ailly have shown that Cinchona bales after remaining ten days under a shed exposed to the air outside, gain in weight, that is, take up water, and the bags also are hygroscopic; that on the other hand, loss of weight takes place in parcels of bark, remaining a similar period, in a closed room, exposed to a temperature of 16° to 17° centigrade. [60° to 63° Fahr.]

In transport by steamer, the packages are not only constantly exposed to the influence of a certain current of air, but at most times also to a more than ordinary temperature. It is thus admissible that they lose in weight, but *a priori* the influences and circumstances are hard to calculate which come later into play, when the same packages are turned into the warehouses in Amsterdam for some time, and there remain open for many days. The bags cannot exert any important influence upon the gross weight of the packages, for they do not weigh more than about one and a half kilogram; the cases on the contrary have usually a weight of about 20 kilograms and as they, especially in the first years, were not made up of thoroughly dry and seasoned wood, it may be understood that they must lose in drying, and notwithstanding that the tare denoted in India is allowed for, yet a loss of weight actually occurs, to the advantage of the buyer, but to the loss of the seller. Lastly it deserves to be noticed, that the invoices speak of half-kilos, and the deliveries, (although the Cinchona prices are noted by the half-kilos), on the other hand take place by kilograms without the turn of the scale, also the worthlessness of the lower portions, at least in a considerable number of packages, may have for the seller a very injurious difference. It is possible that the buyers reckon advantageously upon these turns of the scale, but the producer who brings his produce to market is advised to keep account of all these circumstances, for otherwise be may easily be exposed to great disappointment.

We shall presently give the conditions of auction, and then the charges which are noted in our tabular statement B, find therewith an explanation. We must first let a display follow of the results, obtained at the auctions held in Amsterdam in the years 1878—80 of private Cinchona growers from Java.

C.

Auction of	Ledgeriana.		Officinalis.		Succirubra.		Schuhkraft.		Javanica.		Hasskarl-iana.		unnamed.		Total.		Extreme prices per ½ kilo.
	Packages.	Kilos.	Packages.	Kilos.	Packages.	Kilos.	Packages.	Kilos.	Packages.	Kilos.	Packages.	Kilos.	Packages.	Kilos.	Packages.	Kilos.	
28/2 1879	2	135	—	—	—	—	58	3840	—	—	—	—	—	—	60	3975	75 to 170 cents.
18/4 »	—	—	—	—	—	—	39	2700	3	210	—	—	—	—	42	2910	90 » 162 »
30/4 »	2	129	—	—	8	499	30	1891	—	—	—	—	—	—	40	2519	70 » 185 »
26/9 »	—	—	—	—	—	—	12	355	—	—	—	—	1	19	13	374	25 » 115 »
26/9 »	—	—	—	—	—	—	38	2100	—	—	—	—	—	—	38	2100?	49 » 123 »
26/9 »	—	—	9	550	—	—	108	7300	19	1250	5	300	—	—	141	10400	54 » 295 »
14/. 1880	2	75	3	280	—	—	35	2200	5	320	—	—	—	—	45	2775	84 » 205 »
21/5 »	—	—	—	—	—	—	128	9050	20	750	—	—	—	—	148	9800	37 » 355 »
15/10 »	2	comprised among Javan.	3	360	3	220	395	29500	16	1375	9	675	1	comprised among Javan.	429	32030	92 » 260 »
15/10 »	23	1419	—	—	—	—	33	2152	—	—	—	—	—	—	56	3571	81 » 171 »
9/11 »	—	—	—	—	—	—	28	?	—	—	—	—	—	—	28	?	sold by tender.
25/11 »	—	—	17	100	8	335	296	21935	4	240	2	150	2 anglica	100	314	22880	37 to 233 cents.
Total.	31	1758	17	1090	19	1074	1200	83023	67	4145	16	1125	4	119	1356	93334	25 to 355 cents.

So far as we can trace, there were no other sales in 1879 and 1880; earlier sales are of no significance. A small parcel of inferior Cinchona from the Koripan estate (Buitenzorg) was sold on 17 April 1877 at 29 to 61 cents. The outward appearance, sorting and packing, left much to be wished; the same day government Cinchona sold for 81 cents for powder, 141 for dust (broken bits) and 168 to 879 cents throughout, for the different descriptions. A few parcels of Ledgeriana reached 1085½ cents per kilo, circumstances being very favourable for disposal.

De Vrij in a published letter of 12 March 1881 remarks, that the Succirubra barks brought from private growers in Java, fall below the quality of the government and English plantations, and he calls it a sad fact, on which attention should be carefully fixed.

It may be useful with regard to this, to give some explanation.

The Succirubra seed gathered in Java, when only a few trees flowered and bore fruit, gave plants, which in a great measure departed from the type of the parent trees. Evidently the flowering parent-trees had experienced the influence of foreign pollen. Since the time when seeds could be collected from extensive, enclosed, and developed plantations, greater assurance could be felt of having true, undegenerated seed, therefore is it to be expected that younger Succirubra plantings will show slighter aberations from the typical form. That in certain exceptions, true Succirubras were raised in Java from seed received from British India, is to be attributed to the fact that the plantations in British India are composed almost entirely of *C. succirubra*, and little danger is thus run of fertilization by pollen of inferior species of Cinchona. In the government plantations in Java there were many species of Cinchona to be met with, and the scattered Succirubra trees were exposed to fertilization by pollen of the common *C. Cali-*

saya, C. Hasskarliana and even *C. Pahudiana.* The old plantations of *C. Ledgeriana* were designedly isolated, but it was absolutely impossible to ensure a like isolation also with regard to the rest of the varieties. For raising *C. succirubra* and *C. officinalis,* we gave with good reason, always the preference to seeds from British India, and the *C. succirubra* barks brought to market from the government plantations, can, in by far the greatest proportion, be considered to be derived from trees raised from British Indian seed.

Another cause of the inferiority of private-grown Javan barks may be in this, that private planters are impatient and crop too early, whilst besides, there are well founded reasons to suspect, that it is not every grower who is in a position of certainty as to the identity of his plants and trees. At Amsterdam we have seen produce offered for Ledgeriana bark, that as soon as our eye fell upon it was distrusted, and by analysis it was seen to be of very poor quality, thus having nothing in common with Ledgeriana.

It has already been mentioned, and now may once more be seriously pressed, the great importance for the producer to particularly to attend to the identity of his plants, the careful selection, and true naming of the harvested barks.

*
* *

The Dutch East Indies will for several years yield the finest manufacturers' bark, *C. Ledgeriana* and *C. officinalis,* and further the druggists' bark most in demand, *C. succirubra.* As it has been shown by the history of the culture, there has always been the endeavour to propagate the most valuable kinds, and to relegate the inferior descriptions to the background.

This has not been the case in British India. In Bengal, *C. succirubra* was almost exclusively propagated; the culture of *C. officinalis* opened well, but resulted in disappointment Up to and including 1877—78 there were obtained from the government plantations in the Himalaya mountains, Darjeeling being the central point, 878,242 pounds avoirdupois of bark, most of it being utilised for crude alkaloid, "Cinchona febrifuge"; it is now estimated that from 300,000 to 400,000 pounds weight can be taken annually. The production of 1877—78 amounted to 344,225 ℔. which according to the official report, remained at the disposal of the government chemist Mr. Wood, at Mongpoo, for the preparation of the previously mentioned alkaloid. The delivery in that year amounted to 5162 pounds of alkaloid, which with that for former years made a total quantity of 10,901 ℔. [1]

This alkaloid was partly sold publicly, partly applied to and the medical service of the State, to economise the more expensive sulphate of quinine; instead of one part of quinine, three parts of Cinchona febrifuge were administered. Various medical men have for many years tried this remedy on thousands of fever patients, and it is officially stated that in the above named proportion, the Cinchona febrifuge may serve very well as a substitute. About this for several years, many voices have been raised against the administration of a remedy, whose therapeutic action cannot be accurately foretold, on account of its complex and varying composition.

In the Cinchona febrifuge, following the explanations, there occur besides quinine (this always in small quantity) Cinchonine, Cinchonidine, Quinamine and amorphous alkaloid; each of these alkaloids is febrifugal, but each shows its power in its own

[1] The preparation of the quinetum in Bengal, is done so simply, that it can be left almost entirely to the natives to perform. Meanwhile it appears a deplorable fact, that the extraction from the bark is very incomplete, for one half of the alkaloids go to waste. It appears from the report for 1879, that things are not more fortunate in Java. In the chemical laboratory at Weltevreden, from 3000 kilos of Succirubra bark, which positively averaged 6 % of alkaloids, there were not more than 56 kilos of quinetum made.

degree and way, that is to say, the action of each separately, is different. The great danger however lies in the circumstance that the named alkaloids, although they occur constantly and together in the same mixture, vary in mutual quantitative proportion at each time of preparation.

The Bengal government meanwhile, makes its Cinchona culture serviceable before all things to the wants of its population, and thus only asks itself, how the people and army may be provided with febrifuges on the most advantageous terms. Starting from this principle, the financial results of the undertaking have been extolled, but in fact these last may, on good grounds be doubted.

No account has been taken of the bark, the raw material. The question has not been raised what this would realise at public sales, and thus it comes about, that the price of this substitute for quinine is placed no higher than 21 francs [16 shillings and 9 pence] per pound avoirdupois.

It is a wellknown fact, that not one half of the alkaloids possessed by the raw material are obtained, the greater part being lost. The large quinine manufacturers on the other hand, for whom the secondary alkaloids properly are a disadvantageous bye product, obtain them in bulk, because they must be separated to attain the entire and complete purification of quinine; they might thus yield a Cinchona febrifuge of constant composition, relatively and perhaps absolutely cheaper, or at least no dearer, than the raw produce at the present time costs the Bengal government.

It does not lie within our scope, further to speak here of the therapeutic value of the different Cinchona alkaloids; still less to solve the question as to whether the Bengal government will attain its end, in the most economical and practical way, by the method at present followed. It is certain that private planters do better to sell their bark, leaving the manufacturer to utilise it; at least so long as the manufacturing separation does not become simpler, completer and less costly.

In 1879 the private undertakings in Bengal must have harvested 1050 packages of bark[1].

There were brought into the London market during the years 1877 to 1880 in succession, 6260, 6250, 13,460 and 20,690 packages of British East Indian bark. The weight of these packages varied greatly, sometimes being very small.

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* *

In 1879 there were harvested in Madras, from the government plantations (Dodabetta, 429, Neddivettum, 779, Pykara, 241) 1449, and from private plantations, 557 packages. In 1877—78 the former produced 138,808 ℔ of which 132,951 ℔ were shipped to England. The rest was at the disposal of the medical service or remained in reserve.

In the Madras presidency, where the culture is prosecuted in the high-lying Nilgiris (Neilgherries, central point Ootacamund) *C. officinalis* thrives better than in Bengal, but is less propagated than *C. succirubra*. Here also all the other kinds of Cinchona introduced have no significance as regards trade.

According to the "British Trade Journal", British India, excepting Bengal and Madras, furnished in the years

1875—76	26,992 ℔	valued at £	2,570
1876—77	72,952 „	„ „ „	6,413
1877—78	286,944 „	„ „ „	39,635
1878—79	227,179 „	„ „ „	28,196
1879—80	459,286 „	„ „ „	66,071.

Within the last few years, Cinchona culture has attained considerable dimensions in Ceylon. Here also it is chiefly con-

[1] Moens who visited British India in the second half of 1880, explains that the application of quinetum is more and more extended and believed in. The Dutch government has lately ordered the delivery of 300 kilos of quinetum, and therefore experiments will be importantly extended.

fined to *C. succirubra* and *C. officinalis*. In the years 1875 to 1880 there were successively exported, 18,731, 16,842, 56,598, 173,497, 373,511 and 1,208,578 pounds of bark [1]. Other sources give for 1879 a total of 6229 packages, 3098 of which consisted of bark from branches, and dust.

Jamaica yielded in 1879 a crop of 16 bags. We have not met with advices from other countries where Cinchona culture has been introduced; the crops therefrom can in no case be considered as of any importance in trade.

From the foregoing data of the English and Dutch possession it seems quite clear, that the American Cinchona trade has already to dread a strong competition. What the production of America really is, can hardly be shown. No one knows, even approximately, the extent of the forests in which the Cinchona trees are scattered.

The exports of South America differ much from year to year, and that cannot be greatly wondered at, having regard to the ever changing political condition of the South American republics.

In every case there is no ground for the opinion that in the long run the exports will be diminished, and the fear of a possible extirpation of the original Cinchona forests, seems indeed to have been overdrawn.

Exports are chiefly consigned to London, New-York and Paris. In the last year or two, some well selected kinds of bark have come from Porto Cabello and Maracaibo. The price of the last named description, we see noted at the auction at London of 30 January 1881 at from 6 d. to 1 s. 8 d.

According to a communication of the Dutch Consul, the imports of Cinchona bark at Hamburg amounted to a value of 177,150, 34,830 and 177,150 marks, in the years 1877 to

[1] *Ceylon Observer* of November 9, 1880. Other reports do not agree with the figures here noted, which difference we can only explain by some confusion or combining the crops of succeeding years.

1879 successively. In 1878, 3995, and the following year 6794 kilograms of quinine, were imported, valued at the present time at 535,620 and 1,043,450 marks. Nine tenths of these quantities were derived from Germany, the remainder mostly from London. A considerable part of this quinine was again sent to North and South America. The following statement of the trade in Cinchona has been drawn up from the most important English, French and German reports.

D. LONDON MARKET.

	1879	1878	1877	1876	1875	1874	1873	1872	1871	1870	1869	1868
Imports of												
Calisaya	9190	7835	6800	3440	6060	7460	7083	6337	7300	6329	4021	3539
Columbia, Carthagena, N.-Grenada, Pitayo, East-Indian, etc.	49480	37415	24520	17295	28010	29490	37356	25679	24711	17947	11634	11156
Total serons and bales	58670	45250	31320	20735	34070	36950	44439	32106	29011	24276	15655	14645
Deliveries of												
Calisaya	8585	7865	6305	5065	6230	6415	6800	6591	8100	5441	3628	4487
other sorts	44965	35910	20860	32085	29250	31385	27673	22484	21763	12998	13701	12172
Total serons and bales	53550	43775	27165	37150	35480	37800	34473	29075	29863	18439	17329	16659
Stock at the end of												
Calisaya	1625	1025	1060	565	2190	2385	1341	1058	1312	2112	1224	831
other sorts	12580	8065	6560	2900	17690	18935	20835	11149	7954	8006	3057	5124
Total serons and bales	14205	9090	7620	3465	19880	21320	22175	12207	9266	10118	4281	5955
Prices at the end of												
Yellow Calisaya per pound . .	7 s.	8 s.	5 s. 6 d.	6 s.	3 s. 6 d.	3 s. 6 d.	4 s. 3 d.	3 s. 9 d.	3 s. 8 d.	3 s. 6 d.	3 s. 5 d.	2 s. 11 d.
Sulphate of quinine per ounce	11 s.	13 s.	10 s. 6 d.	11 s.	6 s. 6 d.	6 s. 9 d.	8 s 6 d.	7 s. 9 d.	7 s. 8 d.	7 s.	5 s. 5 d.	4 s. 6 d.

Thus the imports into London have considerably increased, but the consumption must have augmented in like proportion, since the prices both for bark and quinine have risen much instead of falling.

The imports during the years 1877 to 1880 are specified as follows.

	1877	1878	1879	1880	
Calisaya	6800	7835	9190	6580	serons and cases.
Columbia	10610	15350	16370	44500	» » bales.
New Grenada and Pitayo	5025	10045	14290		
Carthagena	2615	5777	5360	6480	» » »
East India and Ceylon	6260	6250	13460	20690	bales and cases, (some very small).
Total	31220	45250	58670	78250	

From these figures the influence of the culture in British India becomes very evident. Whilst the imports of bark into London have much increased, their percentage of quinine in the years 1877—79 in the contrary seems respectively, and in 1879 even absolutely to decline. Messrs. Gehe and C°. note in their annual report for 1879 that there were sold at London,

1879, 53303 packages with a calculated contents of 41695 kilos quinine.
1878, 43775 » » » » » » 47746 » »
1877, 27165 » » » » » » 30425 » »

Possibly these imports from British India bear the less favourable proportions, because they are mostly Succirubra barks, which are rich in alkaloids, but relatively poor in quinine.

According to the English official reports there were imported into England, in

1877, 34936 quintals of bark, value £ 402234
1878, 54746 » » » » » 658228
1879, 60878 » » » » » 973163

The imports into France amounted in the years 1877—79 to

	1877	1878	1879
Fine Calisaya, about 30 grammes and upwards of quinine contents	2934	3387	1658
Do. 20 grammes and upwards	754	1595	3617
Do inferior	360	1341	426
Do. not specified, and flat	770	800	718
Do. Schuhkraft			1540
Do. flat, specified			75
Total	4816	7123	8034

North America imported from Columbia and New-Grenada in the years 1872—80, packages as follows, 34,473, 35,344, 42,720, 35,150, 32,400, 23,400 41,000, 46,700 and 32,800. Messrs. Lewis and Peat state that the best barks find their way in increasing measure to England, and the ordinary qualities go to America. In July 1879 the import duties of 20 % on sulphate of quinine in North America were abolished, and thereby there was a greatly increased enquiry after this salt from Europe, in spite of the existing manufacturers in Philadelphia. It is certain that the latter, for whatever may be the reason, cannot deliver quinine at the same price as the large European establishments, thus the conclusion is patent, that the market in North America will gradually confine itself to the sale of so called druggist's or pharmaceutical barks, and the best manufacturer's material will be exclusively sent to Europe.

The imports of the three chief markets during the years, are

	London.	Paris.	N. America.	Total.
1876	20735	7900	32400	59335
1877	31320	7900	23400	62620
1878	45250	119400	41000	98190
1879	58670	15990	46700	121360
1880	78250	20166	32800	131216

As the weights of the packages (serons, bales or cases) vary greatly, it is difficult to give a just notion thereof. Meantime a comparison of these figures with those which are afforded by the Amsterdam market, show that the last named must gain in importance, and there is every reason for the belief, that within ten years' time, the Dutch market will outstrip the Parisian.

From our statements it appears most plainly, that the consumption increases with the exhanced imports, and that to the present time the ampler production has not as yet led to lowering prices.

It is difficult to foresay what the future in this aspect is likely to bring. It is beyond all doubt that even in civilised, and regularly governed countries, every year thousands suffer from fever, which is not combated in time by the administration of the necessary but expensive means of health, further that entire countries still remain insensible to the excellent remedy; so we may picture to ourselves, that the consumption at the present day of Cinchona and its alkaloids, merely represents a paltry fraction of the quantity which will be required, to satisfy the prescriptions of medicine and humanity in every country, and among all classes and races of men.

In fact, the want may be termed limitless. Meanwhile, the planting in the English and Dutch possessions and other colonies, not to speak of the culture in America itself, broadens out greatly, and within a few years the production will have increased to such colossal proportions, that at least the relations of supply and demand will become more reasonable.

The culture in Java as regards extent, is not to be compared with that of British India or Ceylon. Whilst in the former we reckon plants by the hundred thousand, in the latter, they already reckon them by millions. A hundred-weight of Cinchona seed is obtained every year from the English possessions. If now the number of plants obtainable from one pound of seed be taken at 80,000, then hardly any one, affrighted at such tremendous figures, would dare to commence new undertakings, but would even relinquish existing planting, for another staple. Augmented production furthers the general interest, but not the individual planter. The governments which have brought Cinchona into their colonies, started actually with purely humanitarian principles; it is however seen that selfishness herewith need not be indispensable in this matter.

For the rest, large figures cannot daunt us. For years together we were reproached, because we allowed ourselves to be outstripped by British India, although we began in Java earlier. Indeed, the English Cinchona reports soon spoke of higher numbers than ours. Though if we keep account of the mighty strides of the government plantations in Madras and Bengal, and our more modest progress in Java, we have at the present time, no cause to complain. The government plantations in British India are not so strong as might be expected, after the colossal propagation, which the official reports mentioned during so many years. The report for 1877—78 estimated the strength of the planting in Madras at 569,031 plants, of which 226,936 were *C. officinalis*, 260,837 *C. succirubra*, and 2762 other sorts [1]. In Bengal the government plantations consist of a surface of about 2240 acres, according to the same report, the number of trees thereon is not given, but it may fairly put down at 2000 per acre.

In 1866 the Madras official reports showed 1,123,759 plants, notwithstanding that the highly skilful and energetic director of the culture, Mr. W. P. McIvor, had parted with quite 100,000 to private parties.

At the same time Dr. Anderson at Darjeeling in Bengal

[1] It becomes more and more difficult to provide labour power. The mossing process which was carried on especially in Madras on a large scale, was seriously threatened by the scarcity of moss. This last danger occurred to us insignificantly, for, for the covering of Cinchona stems excellent use may be made of other, often occurring materials, and a short time since, successful use has been made of *alang-alang*. On old grounds in British India the Cinchona trees do not seem to be more than 8 years of age, and the deaths in young plantations are still considerable. When it once comes to this, that the want of new ground leads to a struggle, then the sudden over prosecution of the culture will produce its effects.

had carried his total to 192,765, and Dr. Thwaites happened in Ceylon, to be at Hakgalle in possession of 500,000 plants, besides the 180,000 which he had already imparted to private speculation. We have the greatest respect for the energy and activity by which our English brother-official in the time, gave evident tokens. His reports were held up to us in Java, as being more or less a reproach. But we remember that in one of those reports, about 800,000 plants of *C. officinalis* were mentioned as being written off, because they promised nothing, and we add thereto, that there they have much long confined themselves to propagating only *C. succirubra* in quantity, which is indeed is the easiest and quickest to propagate, but is not really the most valuable species, — then we cannot refrain from inferring, that too much has been built upon illusive prospects afar off, and calculations based thereon, and that the figures at the present day, would not have the present value, which we might expect. If we had once in Java set ourselves to create large extensive Cinchona forests, we had the amplest opportunity for it, by abundance of *C. succirubra* seeds and cuttings, and most certainly that would have spared us the difficulties and cares, which our endeavour to propagate the species richer in quinine such as the best Calisaya, brought in their train.

We do not by any means seek to depreciate the labours of our former brother-official by these retrospective views, on the contrary we do public homage to their value, and all thanks especially to the too early deceased McIvor, for whose important and valuable information as to improving the contents of the bark in the living tree, and for so much else; we have thought we must advert to the facts, in the interest of the growers; these must attain the important conviction, that their best interests must be sought for in the species, than in the quantity of Cinchona trees. If they adhere to this principle then not only will they be able to withstand the powerful competition of South America, but in the long run, to exercise considerable influence on the exploitation of the Cinchona forests in that country. The production of good Cinchona barks, harvested from the primeval Cinchona forests, seems indeed to stand in no specially favourable relation to that obtained by methodical cultlvation. The transport of the produce, from the Andes to the port of shipment, is at the present day at least, and probably for all time, far dearer than the entire culture and exploitation in Java, Ceylon, Madras and Bengal.

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In Java also a true Cinchona-fever has prevailed. Dazzled by the fabulous results of single government plantations, the creation of a Cinchona plantation, was thought nothing less, but even better, than laying open a rich gold mine. With strenuous eagerness clearing was entered upon, after doubting for years as to the future welfare of a Cinchona undertaking. Many have begun their task without the slightest knowledge, the smallest idea of the proper requirements of the plant they wish to rear. For them Cinchona was no other than Cinchona. The history of it has taught meanwhile, that this culture requires quite other attention, than that of coffee or tea for example, and that a man may be an excellent planter in general, without possessing any qualification or skill as Cinchona grower.

What then is the case? The planter who wishes to grow Cinchona, is dependent upon the seeds and plants which he can procure, and must exercise an unconditional trust, where he himself cannot judge. That trust may be well reposed, or it may disappoint. We have seen how hard it is to distinguish the plants when young; we know that degeneration when propagation is done by seed is not infrequent, and that the most various plant-forms may occur from seed of the same tree.

Definite certainty or even satisfactory guarantees that he is creating a valuable product, the inexperienced planter thus cannot have. If he is neither a chemist nor a botanist, he will not readily attain to certainty, and his produce not being selected with the required precision, the consequences do not promise an advantageous realisation.

During the last six years numerous parcels of waste land in Java have been given up to clearing for Cinchona nurseries. We do not accurately know the extent of the planting, but we do know that millions and millions of seeds have been distributed from the government plantations, and that very scanty results in proportion have been obtained therefrom. The seed of the best species is limited; he who does not do his utmost to ensure its germination, is opening for himself by that means alone, a source of disappointment.

Where a plantation of genuine trees exists, there should artificial multiplication be set on foot, as a security against degeneration, and as a means in the long run to have material at disposal for propagating by seeds, as well as cuttings or grafts.

It is possible that among the foregoing hints, here and there we may have seemed to say, what we have already repeatedly said. The common welfare has impelled us thereto. The lesson which we ourselves have drawn from the history of the creation and development of Cinchona culture in Java, was long and costly; may it teach and profit others!

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When speaking of sorting and packing it has been already remarked that the trade in Cinchona bark divides itself first of all into two chief divisions, according as they are suited and destined for manufacturer's use, or else intended for pharmaceutical ends.

In the long run undoubtedly those rich in quinine, the factory barks, obtain the best prices. We have endeavoured to show that many Cinchona trees may yield both factory material and for pharmacists, provided the bark from the different heights on the stem is kept separate; if mixed, they will possess an average contents, less serviceable and less in demand by manufacturers.

Strong, heavy barks, poor as to quinine like *C. succirubra*, have a higher value for the pharmacist or druggist, than light fine quinine-rich material, such as *C. officinalis* for example. The outward appearance of druggist's bark exercises so importance an influence upon the price, that this may run up 50 or 100 % higher, than its actual value in contents would warrant [1].

The London brokers take out very large samples from the packages of druggist's bark for inspection, whilst on the other hand, from each separate package of manufacturers bark, only a little portion is taken.

These little sample portions are afterwards mixed together, and from the similar mass, as finely powdered as possible, a necessary destined quantity is taken for analysis. The result of the chemical examination shows, as near as possible, the percentage of the entire parcel, and the quinine manufacturer estimates therefrom from the price he can afford to give.

Separate analyses of samples from each package, would cost too much time, trouble, and labour.

From table D it appears that the trade still names the barks from their place of origin of shipment.

Calisaya only is an exception, and although its bark may be recognised by its extraordinary percentage, as the history of culture in Java has sufficiently shown, the true identity of the botanical derivation can still less be defined by bald statements of the place of origin or dispatch, which may yield in

[1] It is evident, that in case the secondary alkaloids of quinine come into use in medicine, the pharmaceutical barks, *C. succirubra* excepted, will be regarded from another point of view.

the same region in the wild forest, many descriptions of Cinchona.

The division into Columbia, New-Grenada and Pitayo barks, which have so often occurred, has for trade not the slightest value. It is known that in the fight with Spain, Bolivia proclaimed the republic Columbia (1819) at that time consisting of 12 departments, with Bogota as chief town. One year after Bolivar's death, that is in 1831, the confederation resolved itself into three independent states, Venezuela, New Grenada and Ecuador. The last but one was in 1861 rechristened Columbia, and Pitayo is a town in its southwest district. The Pitayo bark is mostly derived from our *C. lancifolia*. In a certain sense then they know Columbia, Pitayo and New Grenada to be the same tract of country, and the same can be said of Carthagena, one of the principal ports of Columbia.

Peru and Bolivia yield chiefly, the Calisaya barks (yellow or crown barks) to which Ledgeriana and Schuhkraft belong; in the Paris market also the last is so called, after our consul-general at La Paz. In America the baptismal name Ledgeriana given in Java is quite unknown. The republic of Ecuador produces chiefly the *C. succirubra* (red bark) and *C. officinalis* (Loxa bark or crown bark) noted as the best varieties.

The old division of barks into yellow, brown, grey and red, was founded on the outward difference; it was further meant that quinine was prevalent in the yellow, cinchonidine in the brown bark and that both alkaloids occurred in the red in about equal quantities It is not so actually, and moreover the colours run into each other so much, showing so many shades, that the same bark might as well be assigned to one as the other.

Scientific value is not attached to division by colours.

Young Cinchona quills are naturally light or dark grey; older or flat pieces, are yellow, brown or reddish. Lichens which have developed on the outer surface, may change the appearance, the chalky-white or black spots must be ascribed exclusively to those cryptogams. Smooth when young, the barks attain a wrinkled surface, and in still older specimens a grooved appearance, as we have described when treating of *C. officinalis.* In thick Calisaya barks the cork layers often fall off or are intentionally removed, *Cortex sine epiderme*, and impressions may be seen on the exposed *bast*-layer termed, after their shape, *shell* or *finger*-grooves. Old stembarks are beset with a crust, and are thereby very uneven and pimply. On the inner surface Cinchona barks are smooth, finely or coarsely striped, and finely or coarsely fibrous, whilst their colour is a lighter or darker brown or else wine-red.

Dry Cinchona is brittle; Cinchona in quills especially, will not bear rough handling without breaking. The solidity of Cinchona is usually considerable, though latterly certain sorts have been readily divided, in the sense namely, that the innermost or bast-layer can be split up into its fibres with the nail. These softer barks are not considered to belong to the best descriptions [1].

On fracture, Cinchona quills are always smooth and even outside, but shortly fibrous within.

In pieces from old branches or heavy pieces from the stem, the smooth layer may be wholly wanting or in long fibres. The taste of Cinchona is partly bitter, partly astringent; the former resides more in the outer layers, the latter in the inner.

There exists very little connection between the bitter taste and the quantity of quinine. A bark may contain much quinine, *C. officinalis* for instance, and be comparatively only slightly bitter. Vice versâ, the intense bitterness does not ensure a high standard of quinine.

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[1] The dividing into *hard* and *soft* barks is nothing more than a trade test. Buyers will *feel* good Cinchona in the hand, and this really seems to be the case in practice. The false and inferior barks are termed very light. Pitayo and New Grenada barks are usually styled hard barks, Columbia and Carthagena barks as soft. In these distinctions and differences we recognise but little harmony.

It appears desirable to us, to bring the conditions of sale which are current at Amsterdam, before the notice of the East Indian grower and the trade. We here give a literal transcription of them. [Translation].

CONDITIONS OF SALE BY AUCTION OF THE DUTCH TRADING COMPANY.

(*De Nederlandsche Handelmaatschappij.*)

ARTTICLE I.

The sale will take place absolutely, without further claim or compensation, the lots seen or not seen; in cents per half kilogram in lots as set forth in sale-list.

ART. 2.

The weighing will be done without bias, by whole kilograms, per case or per bale. The tare will be deducted, according to the amount marked on the cases or bales in India or in the bills of lading.

ART. 3.

The registration duty and all other costs of sale, reckoned altogether at one per cent., must be borne by the buyer.

ART. 4.

For delivery, which must take place where the goods are lying, a term of fourteen days is allowed. After that time, and consequently after . . . . . . the expenses of transport and warehousing, (notwithstanding any injury or loss in consequence of fire, burglary, or other occurrence), must be borne by the buyer.

ART. 5.

Payment must be made at the Company's premises, or at their agents at Rotterdam, Middelburg, Dordrecht or Schiedam, on receipt of the goods, at the buyer's option, either under an abatement of one per cent., or without discount by approved acceptances at three months from the date of sale, payable at Amsterdam, Rotterdam, Middelburg, Dordrecht or Schiedam.

ART. 6.

The lots which are not cleared within the stipulated time and after notice thereof, shall thereafter be resold, at the cost of the defaulting buyer, who shall, in case of loss, make good the loss so occasioned, but without benefitting from any gain which may thence accrue.

ART. 7.

Brokerage amounting to one and a half per cent of the value is disbursed to the brokers dealing in Cinchona bark, at the place where the auction is held in respect of all that is brought by them, or in their name; they shall within three days after such sale, deliver in the name of their principals, living within the realm, to the agent of the Company, together with the acceptances of their principals; in the mean time the Company is at liberty, whenever the reported buyer or buyers is or are not sufficiently known to it, to demand the appointment of guarantees; in both cases, whether the names of the principals dwelling in this realm be not given up, or if no guarantors of sufficient standing be appointed, then the Company shall proceed to resell the said lots, and the broker shall make good any injury thence accruing; as set forth in Art. 6.

ART. 8.

The Company reserves to itself the right not to accept a bid from any one whe shall not be sufficiently known to it, unless he shall be prepared to give a satisfactory guarantee.

ART. 9.

Delivery will take place the day following the demand thereof; in so far as it shall be possible, against the warrant of the buyer.

Note. — The 1 % received as recompense for costs of sale, as defined by Art. 3, and the 1 % allowed for cash payment, Art 5, cancel each other, and therefore no notice will be taken of either, but the net amount.

CONDITIONS OF SALES BY AUCTION OF THE DUTCH EAST INDIAN BANK OF COMMERCE.

(*De Nederlandsch-Indische Handelsbank.*)

The auction will take place in the premises, without further claim or compensation, the lots seen or not seen, in cents per half kilogram in lots as specified in the sale list.

The weighing shall be done without bias, by half-kilograms, and tare per bale $1^1/_2$ kilogram.

Registration-duty and further costs of sale together reckoned at one per cent shall be borne by the purchaser.

For receiving, a period of fourteen days shall be allowed, after that time all costs and damage shall be at the purchaser's risk.

Payment shall be made by bills at $3^1/_2$ months, dating from the date of auction, or by cash at one per cent discount, at the option of the Dutch East Indian Bank of Commerce.

Brokerage at the rate of $1^1/_2$ per cent. will be allowed to drug brokers, for all purchases made through or by them of Javan Cinchona bark. The said brokers are on their part, obliged to give in the names of their clients to the agent of the Dutch East Indian Bank of Commerce, which reserves to itself the right of demanding guarantees whenever the purchaser is not sufficiently known to it.

Note. — The sale will take place in lots of 1 to 6 packages. The packages lie opened for some time, and on certain days in the warehouses for inspection. Samples will be given out at fixed prices. The Dutch East Indian Bank is accustomed to submit the samples from its lots for analysis to de Heeren d'Ailly en Zonen (Messrs. d'Ailly and Sons); analyses of the barks from the government plantations, are made in Java by the chemist of Cinchona culture. The Company abides by these, and the trade must place confidence therein.

The net production is shown in table B, as well as the gross. According to the official reports the charges are thus made up: — costs in the Dutch East Indies, principally shipping charges, marine insurance, freight from Java to the Netherlands (shipment usually by steamer, the crop of 1877, packed in 197 cases and 578 bales, together 775 packages, and weighing on arrival at the Netherlands 55,774 kilograms, amounting to 53 3/4 measurement tons), captain's premium, maximum of one per cent. per ton, lock dues, brokerage on on sale at 1 1/2 %, registration and additional percentage, recompense for scientific work at 1 %, costs of warehousing, fire insurance, sale charges, commission at 2 %, clerks salary etc.

The gains are thus manifold; the sale is considerable. The charges for scientific work were instituted at our request, when in 1869 we sent the first trial of Cinchona from Java. They have been kept up since then; they have exclusive reference to the outward appearance of packing and of contents, and we looked to these to give useful hints for service in the ensuing dispatch. Private grower's Cinchona is not subject to a similar scientific testing of its exterior. What concerns the percentage of the Cinchona barks, are the analyses of the chemist to the culture, transmitted with the parcels of government produce. Private planters do not furnish the like lists, but samples are taken at Amsterdam, for examination. (See Conditions of sale, page 246).

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The results of the auctions thus far have been very satisfactory; particularly when it is taken into account that the Cinchona market in Amsterdam is still very young, and has as yet attracted little or no attention from merchants outside the Netherlands. This is shown most plainly by this fact, amongst others, that after the last Exhibition at Paris, the Director of the government undertakings in Java, received letters, enquiring how the Javan Cinchona could be procured.

The principal Cinchona dealer at Hamburg declared in 1880 to our vice-consul at that place, that for several years he tried to bring Javan Cinchona into the Hamburg market, but had not been able to sell any. He was all the same time aware, that the Javan barks had a very good name on account of their high percentage.

The market in the Netherlands has really a great future. In proportion at the imports from India become greater, attention from foreign countries will be attracted, und when once it deals chiefly in Ledgeriana bark, which no other country can offer in like quantity and so soon, we even dare to predict that manufacturers will fix their attention by preference on the Dutch market.

Now as we have in tables B and C given a full statement of the auctions of Javan Cinchona at Amsterdam, it may be useful for comparison, to supply an impression of the results obtained by American and English produce on the London market. It seems to us desirable to give some of the English reports without alteration, by this means the nomenclature and the distinctions made by our neighbours will be learned.

REPORT OF LEWIS AND PEAT, DATED 14 FEBRUARY 1879.

The auctions, since our last, have embraced the following, viz: —

18	Packages	Calisaya Quill.
736	»	Soft Columbian
653	»	New Grenadian.
10	»	Hard Pitayo.
480	»	Carthagena.
26	»	Red Bark.
1923	Serons.	

At the auctions no Calisaya or Columbian, and only a little New Grenadian were sold. Carthagena all sold with good competition at only slightly easier rates on the average.

3	Packages Calisaya Quill, fine picked . .	at		10 s. 0 d. per ℔.
116	» » » fine	»		7 s. 9 d. » »
66	» » » good	»		5 s. 9 d. » »
7	» » Flat, good	»	3 s. 10 d. to	4 s. 0 d. » »
192				

527	Packages Soft Columbian, very good . .	»	4 s. 2 d. »	4 s. 3 d. » »
61	» » » good . . .	»		3 s. 9 d. » »
32	» » » middling . . .	»		2 s. 0 d. » »
620				

67	Packages N. Granadian, good	»		5 s. 5 d. » »
42	» » » fair	»	4 s. 3 d. »	4 s. 6 d. » »
101	» » » middling	»	3 s. 0 d. »	3 s. 9 d. » »
62	» » » common and ordinary	»	1 s. 2 d. »	2 s. 6 d. » »
5	» » » very low (Maracaibo)	»	0 s. 2 d. »	0 s. 6 d. » »
277				

10	Packages ard Pitayo, very good	»		3 s. 7 d. » »

106	Packages Carthagena, very good	»	3 s. 6 d. »	4 s. 0 d. » »
83	» » fair to good . . .	»	2 s. 7 d. »	3 s. 3 d. » »
242	» » ordinary	»	2 s. 2 d. »	2 s. 4 d. » »
77	» » common	»	1 s. 1 d. »	1 s. 5 d. » »
508				

1	Case Red bark, fine bold	»		8 s. 1 d. » »
20	Cases » » bold quills	»	3 s. 9 d. »	3 s. 3 d. » »
3	» » » fair »	»	3 s. 0 d. »	3 s. 3 d. » »
2	» common, part damaged	»	1 s. 1 d. »	1 s. 1 d. » »
26				

The auctions included 411 packages E. I. Cinchona (chiefly government importations), nearly the whole of which sold at good prices.

312 Bales Madras Cinchona, all sold.

5	Bales rich open Quill	at		10 s. 0 d. per ℔.
3	» small » part open, very curly	»		7 s. 2 d. » »
8				

14	Bales Neilgherry renewed Crown . . .	»		10 s. 0 d. per ℔.
19	» » mossed » . . .	»		7 s. 2 d. » »
20	» » unmossed » . . .	»		5 s. 11 d. » »
92	» Neddivitum renewed » . . .	»	9 s. 0 d. to	9 s. 4 d. » »
85	» » mossed » . . .	»		8 s. 1 d. » »
74	» » unmossed » . . .	»	5 s. 8 d. »	5 s. 9 d. » »
304	Government Importations			

45 Cases Calcutta Darjeeling. — Withdrawn

54 Packages Ceylon Cinchona. — All sold.

Good Quill	»	4 s. 1 d. »	4 s. 3 d. » »
Fair »	»	2 s. 9 d. »	3 s. 5 d. » »
Middling, part broken	»	1 s. 8 d. »	2 s. 9 d. » »
Twigs and Chips	»		1 s. 3 d. » »

Arrivals have consisted of 477 serons Calisaya, 591 packages New Grenadian, 266 packages Soft Columbian, 309 packages Carthagena, 768 packages East Indian, and 316 packages Crown and Grey (Druggist's).

Sulphate of Quinine 11 s. 3 d. per oz. for English and French; 10 s. 9 d. for German.

REPORT OF LEWIS AND PEAT, DATED 14 FEBRUARY 1880.

The auctions since the 30th January have embraced the undernoted, viz: —

1087	Packages	Soft Columbian.
1050	»	New Granadian.
150	»	Hard Pitayo.
2287		

Only 60 serons of the New Granadians, 70 packages of the Soft Columbian, 10 packages of the Hard Pitayo, and 32 packages Maracaibo sold in the room, and are included in the following summary of all the transactions of the fortnight; superior qualities of both New Granadian and Soft Columbian have brought long prices; in none other is there any change, and our supplies increase.

90	Packages Calisaya, very fair	at	4 s. 3 d.	to	4 s. 9 d.	per lb.
15	» » common	»	2 s. 9 d.	»	3 s. 3 d.	» »
105						
389	Packages Soft Columbian, very fine	»			5 s. 0 d.	» »
66	» » » good to very good	»	3 s. 5 d.	»	3 s. 0 d.	» »
32	» » » middling to fair	»	2 s. 2 d.	»	3 s. 0 d.	» »
57	» » » ordinary	»	1 s. 4 d.	»	1 s. 7 d.	» »
544						
15	Packages New Granadian, very fine	»			8 s. 9 d.	» »
63	» » » ordinary	»	2 s. 0 d.	»	2 s. 6 d.	» »
57	» » » common and Maracaibo sort	»	0 s. 6 d.	»	1 s. 7 d.	» »
123						
10	Packages Hard Pitayo middling	»			2 s. 0 d.	» »

Arrivals have consisted of 800 packages Calisaya, 710 packages New Granada, 411 packages Carthagena, 92 packages Druggist's, and 1205 packages East Indian.

Sulphate of Quinine steady. We quote English 12 s., French 12 s., in bottles, German 11 s. 3 d. per oz. in tins.

E. I. BARK.

At the sales held on the 10th Inst., 340 packages Ceylon, 14 packages Madras, and 202 packages Calcutta were offered and sold.

Ceylon.

OFFICINALIS

Quill, fine bold	at	6 s. 1 d.	to	7 s. 2 d. per lb.
» small	»			4 s. 8 d. » »
Branch, small	»			2 s. 1 d. » »
» and chips	»	1 s. 10 d.	»	3 s. 6 d. » »
Chips and dust	»			2 s. 6 d. » »
Twigs	»			1 s. 9 d. » »
Dust	»	0 s. 7 d.	»	0 s. 10 d. » »

SUCCIRUBRA.

Quill, bold and mixed	at			2 s. 9 d. per lb.
» mixed	»	1 s. 8 d.	to	1 s. 6 d. » »
» »	»	1 s. 4 d.	»	1 s. 6 d. » »
» poor thin	»			0 s. 6 d. » »
Branches and twigs	»	0 s. 10 d.	»	1 s. 0 d. » »
Twigs	»	0 s. 6 d.	»	1 s. 1 d. » »
Roos	»	2 s. 3 d.	»	2 s. 4 d. » »
Root and Chips	»			2 s. 2 d. » »

Madras,

CINCHONA.

Quill pale open rich	at	9 s. 10 d.	to	9 s. 11 d. per lb.
» small open rich	»			7 s. 6 d. » »
» »	»			5 s. 6 d. » »
Branch and Twigs	»			3 s. 0 d. » »
Twigs and Chips	»			4 s. 10 d. » »
Twigs	»			0 s. 9 d. » »

Calcutta,

DARJEELING.

Quill very bold handsome	at			4 s. 1 d. per lb.
» medium	»			2 s. 11 d. » »
» good bold mossy	»	2 s. 3 d.	to	2 s. 6 d. » »
» bold and medium	»	2 s. 0 d.	»	2 s. 2 d. » »
» long, medium and mixed	»	1 s. 7 d.	»	1 s. 10 d. » »
» small and Branch	»			1 s. 1 d. » »
Dust	»			0 s. 2 d. » »

Arrivals: -- 1205 packages.

The English auctions of 1879 show in telling figures the remarkable difference in price between mossed, unmossed and renewed bark.

Here for the present we leave the consideration of production and trade. A positive declaration of the cost of harvesting, drying, sorting, packing and transporting to the port of shipment in India is not admissible, for it must differ for each undertaking, according to its situation. The stoutest bags of jute, such as we have described, are obtainable for one gulden [one shilling and eight pence] and as they hold when properly packed about 70 kilos, the charge upon each kilo of bark is at most $1^1/_2$ cents. Labour itself falls below the common business charges; women and children can do much of the work as well as strong men. The cost of carriage from the mountain to the parts is certainly not small, but in proportion to the value of the product is of less importance, and in no case so high, as in South America.

CHAPTER XXIII.

EXPENSE OF THE GOVERNMENT CINCHONA UNDERTAKING IN JAVA.

For years the government Cinchona culture in Java, has been spoken of as an undertaking which has swallowed up millions of dollars of capital. How exaggerated this representation is, we will show by the figures themselves, which will also be of use in reckoning the lump sum required to start a private plantation.

It is beyond our power, or at least beyond the present moment, to give the amount of the disbursements which were made for the introduction of Cinchona from America by Hasskarl's mission. So too, the cost of dwellings for the European staff, though known, are not included.

It must also be borne in mind, that the Dutch government did not undertake the Javan Cinchona culture as a speculation, also, that necessarily years were taken up in experiment, in various places at the same time, the question therefore was not how to proceed in the most economical way. What was wanted first and foremost, was to know how to propagate and rear, the choice of varieties, and the wants of the new denizens. All work and regulations had this aim in view, to ascertain the best methods and to pave the way for private planters.

We confine ourselves thus to actual performances, as on a somewhat moderate scale which the government culture has had to keep in account in its exceptional development-history. These are only of interest to the private grower, who himself must know how much he can afford for administration and dwellings, but with regard to the capital actually needed for work, the interest and charges thereon, that naturally is connected with, and dependent on circumstances.

The actual disbursements for Cinchona culture from its introduction, to July 1856 cannot be given with accuracy. They can however be fairly estimated, for besides Hasskarl's salary, they are of comparatively little significance.

From 1st July 1856 to 1st May 1858, the returns furnished to the Audit department, amounted to the sum of 3124 fr. 34 c.[1].

[1] Costs of clearing lands, salaries to permanent and temporary native staff, purchase of materials and implements, carriage and other daily requirements.

Form 1 May 1858 to the end of	1859	15,096	fr.	40	c.
During the year	1860	12,408	»	46	»
» » »	1861	16,158	»	36^{5}	»
» » »	1862	24,404	»	68	»
» » »	1863	21,039	»	32	»
» » »	1864	16,563	»	46	»
» » »	1865	11,871	»	74	»
» » »	1866	11,645	»	64	»
» » »	1867	17,379	»	25	»
» » »	1868	17,401	»	42	»
» » »	1869	24,948	»	77	»
» » »	1870	22,232	»	17^{5}	»
» » »	1871	25,041	»	29^{5}	»
» » »	1872	25,964	»	61^{5}	»
» » »	1873	25,920	»	77	»
» » »	1874	25,179	»	55	»
» » »	1875	24,881	»	51	»
» » »	1876	22,627	»	36^{5}	»
» » »	1877	32,575	»	20^{5}	»
» » »	1878	29,686	»	57	»
» » »	1879	32,735	»	86	»

Total to and including 1879 in francs $461.829.31^{5}$

To understand the true import of these figures it must be remarked that in the years 1864 to 1875 about 700 hectares were cleared in the primeval forests. Further, amongst the payments, there are also included considerable sums, which had not strictly to do with the undertaking itself, such as for distributing plants amongst the population of the entire Archipelago (1869—71), for sending to various Exhibitions, for experiments, etc. Also the expense of harvesting, treating, packing and convenance of produce to Tjicao, (the place from which further carriage to Batavia is done by water) are comprehended in these figures.

These can be no doubt, that for its kind, the government-undertaking is carried on, in the most economical way. The plantations lie mutually far apart, and so it costs more than would be the case, if they were all close together on one range of hills, or at least were situated in the neighbourhood of each other. There was every opportunity for that, but then the culture would not have been an experimental one. It was essential to try it under unfavourable conditions, and though, in spite of them, all payments whatsoever are at the present time already covered by the results of the crops. Yes, if it were wished to realise the actual crops which are at this moment in the plantations, the costs of shipment would once again appear far below the present value.

CHAPTER XXIV.

PRIVATE CINCHONA PLANTATIONS.

The initiative in these, was taken in 1866 by Heer K. F. Holle, on his rented grounds (later taken on lease) near Garolt in the Preanger. We granted with great pleasure the desired cooperation with Holle, and devoted heart and soul to the first beginning so as to assure extend Cinchona culture through the efforts of private landowners.

By repeated attempts we had aroused Heer Hofland the proprietor of the extensive estates, Pamanoekan and Tjiasem in Krawang, to make a trial. There was however no expectation of profitable results; our represention were often listened to with the utmost politeness, without being carried into execution.

The second pathmaker amongst the Javan planters was Heer Seelig, manager of the fine estate Tjiomas in Buitenzorg, who allowed himself to be persuaded by the friendly compulsion of Governor-General Sloet van de Beele.

In 1866 Heeren Holle and Seelig received a parcel of plants from the government plantations, and two years later, a trial was made on the previously mentioned estates in Krawang. The Cinchona barks which are brought to market in Java at the present time, are derived with relatively insignificant exceptions, from the estates Tjiomas, Pamanoekan and Waspada, aud for several years special attention has been given to the extension of Cinchona plantations, whose value has now to be estimated.

In 1869 thousands of plants were distributed throughout the entire Archipelago, the intention being to make the native acquainted with, and as far as possible, taken with the denizen. Everywhere nurseries were made, or single plants were accommodated, on the grounds of the aborigines dwelling in the higher mountains. The excellent opportunity here opened, to observe the power of growth in vàrious regions, might be at once a spur and guide to private workpeople, and here and there to start an undertaking.

The population to the present time, has shown no great liking for the culture. It requires too much care; the rearing of plants is not easy, and probably the great advantage or preëminent importance of the cultivation are not yet sufficiently visible.

On the other hand the results of the government undertaking are attracting more and more the attention of the land owners, and from various quarters there constantly come requests for plants and seeds. In 1874 for the first time, a plot of waste land was requisitioned, specially for Cinchona culture. From day to day this occurs in the Preanger, already there are perhaps twenty plots worked with that end in view, besides others still whereon coffee or tea is cultivated as well as Cinchona. For five years past, direct encouragement has not been required, rather it may be said, that a temporary exaggeration has prevailed, resulting in a feverish hunt for lands[1].

[1] According to the Colonial return of 1879—80, 26 leaseholders are busied with Cinchona culture in Java, 9 as the chief concern, 17 as subsidiary. We cannot consider these returns as complete At three places, in Preanger, Bagelen and Semarang, crops had already been taken. For several years certain Europeans have commenced work in Sumatra, with good success from the first The latest official reports do not mention this.

The Cinchona planter must reckon, that he must make pecuniary sacrifices for at least eight years, that he must be (at least at the outset), dependent upon the issue of seeds from the government nurseries, and that these may offer abundant disappointment, as the seed saving of the last two years has taught, (in consequence of wet weather) so that the chiefly desired Ledgeriana trees almost all miscarried.

The foregoing facts deserve to be well and seriously pondered; no one can with certainty define or foretell that within a certain number of years, he will possess a given extent of Cinchona plantations; the expenses of management, etc. in the meantime continue pressing.

The government has from the commencement always shown itself ready, to accord its co-operation disinterestedly. In British India, plants and seeds are sold to planters as asked for; there is much to be said for this system in Java, when once the value of Cinchona culture has become indisputable.

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Countries outside the limits of the East Indian Archipelago have profited in ample measure from the introduction and well-being of Cinchona culture in Java. The government attends really and loyally to all requests for help or co-operation. Plants and seeds are constantly being exchanged with the English authorities; where it is possible to help one another, it has on both sides been readily and promptly done.

By requisition of the governments concerned, or from private persons, from the government nurseries in Java, seeds and plants have been repeatedly dispatched to Algeria, Martinique and Guadaloupe, the Sandwich Islands, Australia, Cochinchina, Japan, Mauritius, Réunion, New Caledonia and the Portuguese possessions.

At the various International Exhibitions at Vienna, Paris, Philadelphia and Amsterdam, complete collections of Javan Cinchona barks made the best impression, and on each occasion were awarded the highest distinction. Scientific institutions abroad as well as in the Netherlands did not vainly ask for material to be placed at their disposal, for study and instruction, and the Cinchona culture in Java, whose introduction by the late Professor de Vriese was termed "a pearl in the crown of the Netherlands", is really known at the present day over the entire civilised world, and valued as an undertaking begun and carried on in the common interest of mankind.

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We here take leave of our subject, so far as it relates to our East Indian colonies [1].

The history of our Cinchona culture in all its extent, and transitions, is in no sense completely told, still less systematically followed up, for our chief intention was to lay it open and make it useful, more especially for the planter and trader. Although we have kept our attention more to the practical side than the purely scientific, historical truth has been rigidly adhered to, and the power of facts, in a culture, so full and easy to see as that of Cinchona, may be a rich source of information, for those who would extract such herefrom seriously and advantageously.

We have in conclusion still to speak of the acclimatization and its propagation outside the East Indian Archipelago.

This history is rich in important facts and costly lessons;

[1] From the latest official returns there seems to be no great liking for Cinchona culture among the native population. As to this we must be silent, but lament that the private growers do not send annual tabular statements to the Director of government cultures, of the state of their nurseries and plantations. In 1870 we offered them printed forms for that purpose, at the instigation of the Society of Agriculture and Industry at Batavia. These had only to be filled in, and returned with comments to the above named Director. (See Cinchona report for 1870). In this fashion hearty co-operation towards information and knowledge, collected from all, would now have been guaranteed, and satisfied all parties as to their achievements as well as their disappointments.

we must not, however, pass over it in its entire extent, because thereby our work would overstep its appointed limits, and would not be of paramount importance to the Javan planter.

Still, a short summary should not be wanting, were it only to estimate what England performed, France tried, and the 'Société d'acclimatation' at Paris, continued with unabated energy to essay.

CHAPTER XXV.

THE ACCLIMATIZATION OF CINCHONA, OUTSIDE THE LIMITS OF THE MALAY ARCHIPELAGO.

As early as 1813, Dr. Ainslie in his 'Materia medica' remarked upon the lamentable fact that no trial had ever been made, to acclimatize Cinchona in British India.

In 1839 Dr. Forbes Royle, in his work 'Illustrations of Himalayan Botany' strongly adverted to the introduction of the Cinchona plant in British India, and indicated the Nelgherries and Sylhet as the most suitable regions. Lord William Bentinck showed great interest in the question, but it never resulted in action. After the opportunity of a preliminary attempt of Blackwood at Lima, to introduce the cochineal culture into British India, Royle again took up the question of Cinchona. Three years later, 1850, John Grant of the (British) East India Company, in a communication, warmly recommended the undertaking, and in 1852, there were serious efforts made by the East Indian Government itself, which first of all published an elaborate opinion of Dr. Falconer, director of the botanic garden at Calcutta, and a partisan of the ideas brought forward by Royle. This opinion placed in the foreground, that a properly qualified and equipped person should be charged with a mission to South America. One report after another was sent to England and urged by Royle. It was to be expected that the latter would support his representations with emphasis and force. This occurred in a report of 27 June 1852, wherein he asserted, among other things, that after *tea*, there was no plant more desirable to introduce than Cinchona. Touching the mission to America, all advisers were at one, that this could only be committed to an experienced scientific man, since the Cinchona tree had never been an object of regular culture, and accurate investigations must be made about its local requirements, in the original forests.

Before passing however, to a recommendation so full of difficulty, and expensive a measure, the English government wished first to try how far it could procure this material, by the assistance and help of its consuls in South America.

The reply from Mr. Mark at Bogota was not encouraging. Mr. Sullivan in Peru reported that he had applied to Vice-Consul Crompton at Islay and Arica; the latter gave small hopes, and his attempts to procure Cinchona seeds broke down.

Mr. Cope at Quito was more successful; he was able to send several Cinchona plants from Loja, which however reached England in a hopeless condition.

In 1853, six Calisaya plants were sent to Calcutta, raised from seed collected by Weddell. They did not reach their destination alive. No better results were obtained from seeds sent by Weddell to Mr. Pentland, but these had been kept a long time; sent to Calcutta, they did not come to germination, notwithstanding Falconer's earnest care. Meanwhile Royle did not remain inactive. In 1853 he once more wrote a stringent communication concerning the acclimatization of Cinchona, and in March 1856, be made use of a powerful argument with the East India Company to set about earnest and vigorous measures. At this juncture, he pointed out Dr. Jamieson, Professor of Botany in the University of Quito, as the man best fitted to undertake the commission. One year later Royle made a fresh appeal. The question seemed now to be approaching its much desired solution, but alas! the true, courageous champion, one of England's most famous, and, for her colonies especially, most deserving botanists and naturalists, was not able to put the crown upon his labour. To his worthy successor, Dr. Forbes Watson, fell the task in part, to seek out and propose, to whom might be entrusted the expedition to Ameriea.

In April 1859, Mr. Clements Robert Markham was charged with this onerous commission. The choice was fortunate. Markham had already travelled in South America as archæologist and ethnologist; he was versed both in the native languages as well as Spanish, and knowing how much Hasskarl's mission had awakened the jealousy and suspicion of the population in the Cinchona districts, he considered it of pressing importance, to be prompt and ready in dealing with the matter. That was to be accomplished by the commission operating simultaneously in different regions, a measure which at the same time would be less costly.

On Markham's proposal, four expeditions were organised. He charged himself with collecting *C. Calisaya* and *C. micrantha* in Bolivia and Peru (Caravaya). For the exploration of Ecuador to obtain *C. officinalis* and *C. succirubra* plants and seeds, Spruce was designated, a skilled botanist who had known South America for years. By recommendation of Sir William Hooker, Markham and Spruce were respectively furnished with experienced gardeners, Weir and Cross. When Spruce was ill in America, Cross worthily carried on his work. To Pritchett the task was assigned, of searching the forests of Huanuco and Huamalies to obtain *C. nitida* and *C. glandulifera;* he also had been acquainted with the regions for years.

The fourth expedition was charged to explore the forests of New Granada, for the seeds of *C. Pitayo* and *C. lancifolia.*

Towards the close of 1859, Markham had completed his arrangements, so that he was able to start on 17th December of that year from England to Lima, where he arrived 26th January 1860.

We cannot follow the important commission on its difficult and dangerous paths. Suffice it to say, that it fulfilled its task with talent and perfect success. Before the end of 1860, the English possessions received the new nurslings from America, seeds as well as plants[1].

In a highly interesting book, 'Travels in India and Peru' (London, Murray, 1862) Markham has described the expedition entrusted to him, and under his guidance so splendidly successful, at the same time he has thrown clearer rays of light over the classic land of the Incas. The same author has recently brought out a new work, 'Peruvian bark. A popular account of the introduction of Chinchona [*sic*] into British India'; London, 1880.

In Bengal, Dr. Anderson, director of the botanic garden at Calcutta, was charged with the care of Cinchona culture, which speedily became an accomplished fact at Darjeeling in the Himalayas. In Madras it was committed to the energetic William McIvor, and in Ceylon Dr. Thwaites, of Peradeniya, laid out the grounds at Hakgalle for the now gigantic culture.

On 21st August 1862, there were counted in Madras already 72,568 plants, that is of *C. succirubra* 30,150, *C. Calisaya*

[1] In May 1860, Markham was able to dispatch 15 Wardian cases with 529 young plants (497 *C. Calisaya*, 25 *C. ovata* and 7 *C. micrantha*) from Islay; they arrived however in a deplorable state at Bombay. A parcel of plants collected by Pritchett, had no better fate; seeds however (of *C. nitida* and *C. micrantha*) sent at the same time, yielded 890 plants. Spruce was the most fortunate; he was able to send 10,000 seeds and 600 plants of *C. succirubra* to England. Cross who afterwards went a second time to America, in 1861 sent 100,000 seeds, via Southampton to British India. On the voyage through the Red Sea, however, the plants suffered so greatly, that they reached their place of destination in a hopeless condition. Besides these, there were 463 *C. succirubra* and 6 *C. Calisaya* plants, brought by Cross himself from England, and given over to McIvor in a fresh state, together with a large quantity of seeds.

1050, *C. Condaminea* var. *Uritusinga* 41, *C. Condaminea* var. *Chahuarquera* 20,030, *C. Condaminea* var. *Crespilla*, 236, *C. lancifolia* 1, *C. nitida* 8500, *C. micrantha* 7400, *C. peruviana* 2995, *C. Pahudiana* 425 and an unnamed species 2240.

As early as 1863, private persons began to devote themselves to the culture. They were readily furnished with plants from the government nurseries.

The plantations at Darjeeling received their original plants, partly from the botanic garden at Calcutta, where Anderson had reared them from American seeds, partly from McIvor at Ootacamund, partly also from Java, to which place Anderson betook himself in 1861, to personally inspect the culture already there advanced.

We have already in Chapter XXII, PRODUCTION AND TRADE, seen what an enormous extension the culture has received within a few years, in all parts of British India and Ceylon.

What Minister Pahud did for Java, with regard to Cinchona, Lord Stanley fulfilled for British India. Royle, Falconer, Forbes Watson, Sir William Hooker, and his son, J. E. Howard and others, were the skilful, courageous, and trusty counsellors who did not remain behind in their competition with the previously named Dutch scientific men.

Hasskarl was the great executant of the Dutch plans, Markham fulfilled that task for England, on a greater scale, but also better prepared and with ampler help. McIvor, Anderson and Thwaites were by Markham and his coadjutors, put into positions to lay the foundations of a culture which in 20 years' time may acquire an unimaginable significance and extent.

If rivalry has prevailed between the English and Dutch directors of Cinchona culture, it has in no sense harmed the development of the latter, the most cordial co-operation on both sides continues undisturbed. Impelled by international interest, it was held to be a principle of humanity.

In the year 1879 Dr. King the present superintendent of

Cinchona culture in Bengal and director of the botanic garden at Calcutta, visited the government undertaking in Java, shortly after the well-known Money, one of the foremost British Indian planters, had also visited our plantations. Both men declared their full appreciation of what they noticed in Java. In the second half of 1880, Bernelot Moens, the director of the culture in Java visited Ceylon, Madras and Bengal.

If we trust that this excellent opportunity for fruitful comparisons shall lead to unfettered judgment, still more do we look for, from the impressions received and the enlarged field of view, the scientific work carried on, which has so long been in hand, and most certainly with great completeness and undisputed knowledge of material, will indicate our present standpoint in the domain of quinology. We might already understand both one and the other from private reports and English periodicals (especially the "Ceylon Observer"), we do not, however, find ourselves at liberty at the present moment, to reveal anything. Only a complete report can conduce to the advantage of the planter and of science; and this the compilation of Moens purposes to do.

Only we must state the cheering fact, that the hearty co-operation and mutual estimation between the neighbouring Cinchona authorities, remain unbroken.

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Fulfilling instructions received, Markham sent seeds from America to Jamaica, where they were entrusted to the care of Mr. Wilson, superintendent of the botanic garden. By November 1861, Wilson was already able to plant out some in the open ground. He was greatly taken with the new culture, which he believed to have a great future. At the close of 1867, one specimen of *C. succirubra* had reached the height of 18 feet. Besides this species, *C. micrantha* and *C. nitida* were raised. Shortly after this Wilson retired on his pension, and since that time there seems to have been a temporary disturbance in the progress and development of Cinchona in Jamaica.

As far as may be seen, they might have been as forward there as in the Hindostan and Ceylon; the produce, however, is still of little significance, as appears from our statements. From later reports it seems, that Jamaica had already sent to the London market, in 1878 seven bales, in 1879 six, and in 1880, 303 of Cinchona bark; each bale weighing from 60 to 80 pounds avoirdupois.

Baron Ferdinand von Mueller, government botanist at Melbourne, in Victoria, and Dr. Walter Hill, his colleague at Brisbane, in Queensland, have introduced Cinchona. Both authorities extol the good development of the plant, and predict favourable results. Up to the present time, however, no Cinchona has been exported from Australia.

In Mauritius also, Trinidad and New Zealand acclimatization has been tried; as to produce, at least of any exportation, that is meantime unknown to us. Nor do we know any more, with certainty of the attempts in Brazil, where Senor Glaziou took the initiative, which, afterwards received the attention of the government; still less of Mexico, where the English government provided plants and seeds for the Imperial government for the time being.

The Portuguese have thought the Cinchona plant would thrive in their various over-sea possessions, Madeira, the Azores and the Canary Islands, in Goa and at Timor. As almost everywhere else, the first reports sound very favourable, and testify to thankful trust and great expectations. Meantime more precise information tarries, and the trade still knows nothing of any fruit of the culture.

Whether Spain has satisfied her declared wish to introduce Cinchona into the Philippine Islands we know not; still less if Russia has passed to an experiment in the Caucasus. Even

Turkey and Egypt had good intentions, and private persons at Alexandria, some years ago, desired a consignment of seeds, a request which we then, as always, gladly fulfilled.

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In 1849 M. Hardy, director of the botanic garden at Hammar, in Algeria, received some Cinchona plants, which had been raised under the care of Houllet, in France, from the seeds collected by Weddell. These were actually the first Cinchona plants which found a place in the open air, outside their parent country. La Condamine had already earlier, endeavoured to make the culture prosper in French Guyana but in vain.

Hardy's cares were not rewarded by good results.

Wardian cases were afterwards sent from Java with plants, but it seems quite clear that the good expectations, cherished of the climate in some parts of Algeria, could not be realised. In 1876 several plants were sent from Java to Japan, and in 1878 a second expedition followed thither for continuing, as the first experiment was satisfactory.

In Martinique and Guadaloupe again, there was no success. Better success was attained in Réunion where MM. Morin and Vinson, have devoted great pains and care for years. Here also from Java repeatedly, large parcels of seed were received.

New Caledonia, Cochinchina and Tahiti, have likewise received material for experiments, and the acclimatization Society at Paris for a long time took much pains to encourage and further the acclimatization and culture of Cinchona in the French colonies. In 1861 it offered a prize of 1500 francs for the actual introduction of the culture in one of the French colonies or else in the south of Europa.

On May 1st 1875 this prize was awarded to the previously mentioned MM. Morin and Vinson. We have every reason to believe that the Cinchona of Réunion is derived from Javan seed. The late General Morin, formerly Director of the 'Conservatoire des arts et des metiers' at Paris, had entered into direct relations with us, and received seeds more than once from us, which he sent to his son. François Pollen the well-known naturalist, connected with the museum at Leyden, on his visit to Réunion delivered likewise three small packets of Javan seed, and by the intervention of the often named 'Société d'acclimatation', there were seeds procured from Java on several occasions.

In 1879 Réunion possessed more than 5000 plants from 1 to 6 metres in height, and 2500 cuttings and seedlings all of which by the end of that year, were ready to be transferred to the open ground. Indeed the care, cost and trouble which have been incurred by private persons in Réunion, give every promise of a paying success.

We close this important subject with the hearty wish, that Cinchona culture wherever it has been introduced, may conduce in increasing measure to the profit of the growers, as well as of mankind in general.

CHAPTER XXVI.

THE PREPARATION OF QUININE.

Not long after the discovery of the alkaloids in Cinchona bark, the firm of pharmacists, D'Ailly and Nieuwenhuis at Amsterdam, was among the first to devote itself to the separation of quinine. In this course it did not long persevere; it was confined to the years 1825—30. When the manufacturer's barks go beyond a certain price in the market, the manufacture can no longer be carried on at a profit. Abroad, factories were erected on a large scale, especially for this intention, the action, which here was considered as a subsidiary thing, became further impossible, whilst abroad they were content to submit patiently to costly erections.

When the first Javan barks arrived in the Dutch market, the then head of the old firm D'Ailly and Sons, Heer J. A. Rijk, prepared a sample of "Sulphas chinicus" from a parcel of Calisaya, which he offered to the government. The latter accepted it with great satisfaction, and gave the salt to the judgment of the skilful, unquestionable authority on the topic, Dr. J. E. de Vrij. The examination of this led to a most favourable and flattering report, giving rise to the notion, that the old industry in the Netherlands would rise again, and with the increasing imports from Java, a great future would be assured.

Such a course however could not be followed. To erect, put in order, and conduct a factory, which could compete with the older renowned sister-establishments abroad, would go beyond the powers of a private firm on account of the high requirements. No smaller capital than 300,000 to 500,000 guilders[1] was the amount of capital estimated to be necessary. Within a short time however, an active association has taken up the subject, made its calculations, and applied itself to erecting a factory at Amsterdam. If this city were once in reality to become the great Cinchona market, then a factory could be well supported, for the projector could secure the services and sustenance of an experienced maker.

After the London market, that at Paris is the most important at the present time. New York in its competition with London, has lost much of its importance since the abolition by the United States of the import duties on quinine, in July 1879. Two large factories are working at Philadelphia, of which it has been said, that they together turn out more produce than all the European factories. But these factories do not seem

[1] From £ 25,000 to £ 41,667 sterling. B. D. J.

able to continue competing with the great European firms, and America requisitions more and more of quinine salts from Europe and gradually the New York market will be compelled to confine itself to pharmaceutical barks.

Although London is more favourably situated than Paris, which must receive its raw material by a longer journey, from Havre, yet the Paris market has good development of business, thanks to the low costs of entrepots, etc. At Paris there are four quinine factories at work, of which two, Armet de Lisle et Cie, (maison Pelletier) and A. Calandier, are very extensive, that of F. Dubosc et Cie, moderately so, and that of Schiffmann frères the smallest. For distribution, Paris is particularly well situated, and is as it were a centre for all the continent.

The two large factories at Philadelphia stand under the name of Messrs. Rosengarten and of Messrs. Porvers and Weigtman. At London the principal factory is that of the well known quinologist, Mr. J. E. Howard, and the second of Whiffen. At Milan is the large Fabrica Lombarda; at Genoa the undertaking of Dufour. Large factories are also to be met with at Stuttgart and Frankfort a/M., respectively of Herren Jobst and Zimmer, whilst less extensive establishments are those of Koch at Oppenheim, at Brunswick under the name of 'Braunschweigsche Kininefabrik' and one at Stuttgart be-onging to Boehringer and Sons.

Thus altogether, so far as we know, there are 15 factories, and the annual production of the above named may probably be estimated at 15,000 to 25,000 kilos of sulphate of quinine. That the number should remain so limited, must be the special knowledge demanded for the extraction from the raw material, and separating into the one desired form, that of salts. Indisputably this knowledge is confined to a few people, and it remains more or less a secret, which each establishment keeps to itself. It is said that the British Indian Cinchona barks on account of their hardness, their amount of secondary alkaloids, and percentage of resin, are still difficult to work in France, though it seems that both the English and German manufactnrers do not experience any invincible difficulties therein.

We do not presume to give more than an outline of the manufacture; the full treatment of the subject would be out of the place here. Still for Cinchona planters if not for chemists, it will not be unwelcome to cast a rapid glance over certain special points concerning the alkaloids of Cinchona.

CHAPTER XXVII.

THE QUININE ALKALOIDS.

According to De Vrij, the alkaloids occur in Cinchona barks as chino-tannates, as well as hyper-salts.

If powdered Cinchona bark is treated with water, then the acid combinations divide into basic and still more acid-alkaloid salts. The latter are soluble, whilst the former cannot be extracted by water alone. By this it becomes clear that barks for pharmaceutical needs, in simple decoctions and infusions, may yet be excellent for the preparation of quinine, it being taken for granted, that this alkaloid, which forms combinations of difficult solubility, was present in certain quantity in the raw material.

The following gives a connected statement of the principal alkaloids, of which we cannot further sum up the manifold derivatives and salts.

a. Quinine
b. Quinidine } isomerous, $C_{20} H_{24} N_2 O_2$

c. Cinchonine
d. Cinchonidine } do. $C_{20} H_{24} N_2 O$

(according to Hesse, $C_{19} H_{24} N_2 O$.)

a and *d* are right-handed in polarisation, *b* and *c* left-handed.

e. Amorphous-alkaloid, as such indicated by Hesse in Cinchona bark and named, Diconchinine, $C_{40} H_{46} N_4 O_3$ and Dicinchonine $C_{40} H_{48} N_4 O_3$.

a, *b* and *c* are soluble in ether, *c* and *d* not, or hardly so; *a* and *d* are precipitated as almost insoluble tartrates from the dissolved salts, by potassic or sodic tartrates, whilst the tartrates of *b*, *c* and *e*, are easily soluble in water.

Besides these, there are separated from Succirubra barks oi Bengal and Java, Chinamine and Paricine; whilst Hesse has separated from Calisaya javanica, an alkaloid provisionally christened Javanine, which is accumulated in the amorphous basis, and is probably fugitive.

The methods for separation of the alkaloids most commonly used, are,

(*a*.) The lime and spirit method, in which fine Cinchona powder is mixed with milk of lime, and after complete desiccation, lixiviated with spirit of 90 %. For lixiviation, tar oil is used in France [1].

(*b*.) The acid method, in which the Cinchona powder is completely exhausted with water acidulated with hydrochloric acid, the resulting liquids percipitated by soda- or potash-lye, and the alkaloids collected and washed out with weak lye, and afterwards separated.

This separation of the diverse Cinchona alkaloids, generally takes place in the factory, by crystallisation of the sulphates and repeated crystallisation, by which the sulphate of quinine as the salt most difficult of solution, constantly falls down in the greatest quantity. The solubility of the different sulphates

[1] In the earliest times Pelletier and Caventou used dilute sulphuric acid when boiling down Cinchona. Afterwards by advice of Henry, hydrochloric acid was made use of. At the present day, other solvents are employed in extraction, and even De Vrij admits that all the agents applied in the factories are not known to him. (Nieuw Tijdschrift voor de Pharmacie, February 1880).

of quinine, quinidine, cinchonine and cinchonidine, are respectively exhibited by the fractions $\frac{1}{760}$, $\frac{1}{360}$, $\frac{1}{130}$, $\frac{1}{54}$.

For quantitative determination of the different alkaloids, these are taken as a whole, together, dried at boiling point of water, and weighed, afterwards dissolved in dilute hydrochloric acid, neutralised, filtered after cooling, and then mixed with $^2/_3$ of its weight of potassic-sodic-tartrate (salseignette). After twelve hours, the precipitated tartrates are separated by filtration from the quinine and cinchonidine, which are dried and weighed, after which it is again dissolved in hydrochloric acid, to which solution soda and ether are to be added. The cinchonidine remains tolerably insoluble, whilst the etherial quinine solution, evaporated by the atmosphere, is dried at boiling point of water, and the quantity of anhydrous quinine is indicated.

To separate the previously treated tartrates from the mother-liquor, they are precipitated by soda. The precipitated alkaloids are obtained by filtration, washed as may be requisite, the washing repeated with spirit of 40 % after drying, by which the amorphous alkaloid is dissolved and cinchonidine remains behind.

If quinidine prevails in the bulk, it is precipitated from the mother-liquor by potassic-iodide as hydro-iodates; the dried precipitate is dissolved in hydrochloric acid, the quinidine separated by soda, dried and weighed.

By these short instructions, we do not think we have put the means into the hands of the non-chemical planter of examining his barks himself On the contrary, it appears how far from simple the analytical methods are, and it may be calculated that much practice is necessary, even for a chemist, before he can exhibit the exact composition accurately, of so complex a structure as Cinchona bark. As we have previously said, analytical research has not uttered its last word on this score by a long way, and we can only act as a fingerpost, so as to give some notion of the extent and importance of quinology in its entirety [1].

What the future may bring, who will venture to predict? There is no doubt that the secondary alkaloids of quinine will be more and more esteemed, and thereby perhaps another direction given to Cinchona culture; in so far as the quinine-rich Cinchona species, their right to the chief place will seem to be disputed. We have, though, remarked that they are not always the easiest and most luxuriant growing, and it sometimes appears that the cultivation of the vigorous *C. succirubra* will really assure great advantages to the planter.

The prices of quinine are subject to violent fluctuations, which are as much connected with the greater or smaller importations of manufacturer's bark, as of the temporary want of this still above-all valued febrifuge. The following statement which merely extends over a short term, shows the results of the periodical, public contracts at the Hague, for the state service in the Netherlands and the East-Indies. The contracts embrace, as a rule, a quantity of 200 kilograms, to be delivered in parcels of 50 kilograms.

Tendered for		maximum	minimum.
26 August	1880	fr. 256.89	fr. 247.20 per kilo.
21 September	»	» 249.70	» 236.80 » »
18 October	»	» 234.95	» 224.50 » »
12 December	»	» 222.41	» 204.98 » »
29 »	»	» 214.30	» 203.01 » »
21 January	1881	» 223.—	» 215.46 » »
3 March	»	» 262.33	» 237.87 » »
14 April	»	» 224.40	» 211.— » »

Contracts were accepted by four parties in the month of March for 300 kilograms quinetum prepared from East Indian

[1] The Grahe Cinchona test rests upon the property of quinine, cinchonidine and isomerous bodies in the barks containing them, to develope carmine-red vapours by heating in a test-tube. Barks which do not possess the named alkaloids, yield only brown coloured fumes, and finally a brown tar. This test has some value as an indicator, but none as a means of registering. The carmine-red fumes are characteristic.

bark. The tenders ran from 40 francs to 72.89 francs per kilo. On the 27th and 31st May following 200 and 300 kilograms of sulphate of quinine were contracted for. For the first contract, the minimum tender was 194.95 francs; the maximum at the same, 206.70 francs. At the second, the minimum 191.50 francs, the maximum 204.88 francs. The quinetum prepared from East Indian *C. succirubra* bark possesses cinchonine, cinchonidine, amorphous alkaloids, quinine, besides water and impurities. and is left-handed in polarisation. Each manufacturer will turn out these alkaloids in various quantities, and in different mutual relation, as may be understood from the statement of the analyses of *C. succirubra* barks, which are given on pages 115—119 and also ascertained by numerous examinations of de Heeren De Vrij, Stoeder, Moens, Mr. Wood, etc. De Vrij reported in the 'Nieuw tijdschrift van pharmacie', 1878, p. 179, that the percentage of quinine plus cinchonidine in quinetum prepared by him, varied from 39 % to 70 %, whilst in the quinetum of commerce, it varied from 28 % to 68 %. Meanwhile the secondary alkaloids in the great factories are obtained in such large quantities, that there would be no trouble in producing a quinetum of definite constitution by mixing. The prices of the salts of the bye-alkaloids are far below those of quinine; quinidine is the most valuable which, however, occurs the most scantily, after it follow cinchonidine, cinchonine, chinoidine. The prices of these alkaloids also vary much, but that they remain far below those of quinine, is well shown by the result of the public contracts for this end [1].

[1] The minimum tender was 40 francs per kilo, the delivery appeared granted at the price of 60 francs. We add that once it happened, that 7.5 % alkaloid was separated from a large parcel of Succirubra bark, then for the contract delivery of 300 kilograms of quinetum, 4000 kilos of raw material is needed, and if this is bought at 3 francs per kilogram, the buying price of the raw material alone is as much as the minimum price, for which the quinetum was to be delivered. Instead of 7.5 % however, on an average at most not more than 6 % alkaloids may be calculated on, and the lowness of the tenders seen from this side, become patent.

With this we consider our task as regards the Cinchona planter complete.

We have kept strictly to fact in our history, and especially in this most important staple, may it be as a compass by which the producer may direct his course.

FINIS.

INDEX.

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97