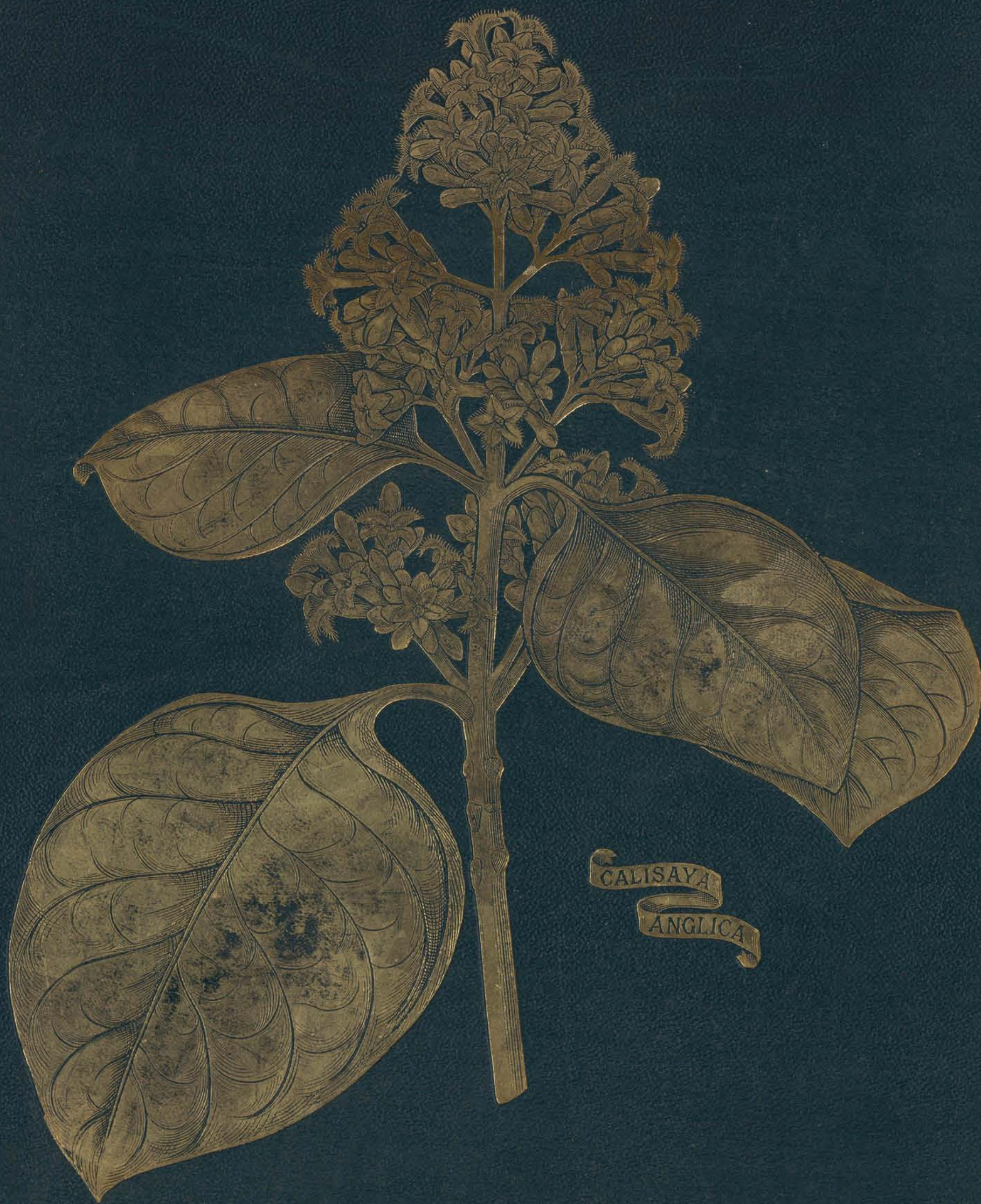


QUINOLOGY



OF THE
EAST INDIAN PLANTATIONS

851

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BY
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QUINOLONE

ANTHRAQUINONE

1884

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TO

JOSEPH DALTON HOOKER, M.D., C.B., P.R.S., &c.

IN ACKNOWLEDGMENT OF COURTEOUS ASSISTANCE

IN THE COURSE OF THE PREPARATION OF THE PRESENT WORK

This Volume is Dedicated

BY HIS SINCERE FRIEND

THE AUTHOR.

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REIGN OF

CHARLES THE FIRST

IN THE

REIGN OF

CHARLES THE FIRST

IN THE

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ADDENDA ET CORRIGENDA.

Page 60, transpose C and B; also on Page 62 for Form B read Form C.

MICROSCOPICAL OBSERVATIONS.

It is important to observe that the whole of the sections in the first two Plates, and partially those in the third, are of the same species, *C. succirubra*, Pavon. It is evident on inspection that, whilst a certain family likeness prevails amongst those barks which have not been subjected to unnatural circumstances, there is yet some variation in the size and manner of dispersion of the fibres of the liber and of the laticiferous vessels; so that attempts to classify barks according to a too-precise system, resting specifically on such distinctions, would certainly end in confusion. In the renewed barks the characteristics are in part less distinct, so that the renewed barks of *C. succirubra* and of *C. officinalis* are seen to be much more like each other than they are to the species to which they respectively belong.

The external appearance of the specimens varies according to their place of growth. In Plate I. Fig. 1, the circumstance of being grown under dense shade gives the bark a suberous aspect, that of the *China rubra suberosa* of the Germans, which Dr. Berg derived from a separate species, the *C. coccinea* of Pavon.* It is well known to those who are familiar with the *C. succirubra* in its native forests, that the bark of the same tree will assume these different aspects, as it grows in a more or less exposed situation. The bark of Fig. 2 had more the aspect of the *Cortex China ruber durus* of Berg. That of Fig. 3 is remarkable for its poor appearance, and for the ease with which the external coat exfoliates.

The crystals of alkaloid are distinguished from those of raphides, which are found in the abnormal concretions, by their aspect and by the circumstance of their easy solubility in glycerine, in spirit, in water or in any menstruum which I know how to employ. They also polarize feebly, and present the appearance of different salts of quinine and other alkaloids present in the bark, which apparently the feeble alkaline ley has not at once been able to reach. The Fig. 1 section, remarkable for its abundance in cinchonine, is also remarkable (as I found in some thick sections) for an abundance of a peculiar concretion of crystalline masses in the region of the liber. These are not seen in Mr. West's figure, having been removed by the caustic. I presume that the crystals found in Fig. 2 and Fig. 3 belong to the salts of cinchonidine, though the *facies* of the crystals most resembles those of the alkaloid itself.

In Fig. 8 we find the appearance of a salt of quinine, and that chiefly in the cellular envelope. In Fig. 8a the character of the crystals is more fully brought out, and contrasted with the earthy salts which fill some of the cells.

In Plate II. we are presented with the features of bark in varied stages of renewal. That in the early stage (Fig. 1) appears to be as yet very little organized, consisting almost entirely of ordinary cellular

* Berg's 'Anatomischer Atlas,' p. 64, note.

tissue, in which some few liber fibres are sparsely embedded, and also a number of abnormal concretions. A prolongation of a medullary ray seems to indicate the course of an active lateral circulation, and in the region of the liber may be seen a few small cells, of a shape that may indicate an approaching change to that structure which is seen in the region of the liber in the normal state, as in Plate I. Fig. 1, and also in the renewed bark in a state of greater advancement of organization in Fig. 2.

In this last bark (Fig. 2) we trace all the features of perfect organization, such as may be seen in bark in its natural state in Fig. 1. This may be compared with the remarks in the body of the volume (p. 19), but in Fig. 8, which is one stage further in the process of renewal, the bark having been *twice* stripped from the tree, this is much more evident, and I am really astonished at the perfectness and beauty of the organization. The bark was rich in quinine, and having probably been exposed to a warm temperature, although shielded by moss it also produced cinchonidine. The combined sulphates of these two alkaloids amounted to not less than 8.45 per cent.* against 5 per cent. from the first crop, represented in Fig. 2. The bark of Fig. 8 is consequently very rich in alkaloid, and "not only is the gross percentage of alkaloids larger than in the last decortication, but of this a more considerable percentage consists of quinine, and that less intimately combined with the yellow colouring-matter, so as to be more easily purified." The appearance of the Fig. 8 bark was decidedly more red in the bulk of the sample than that of Fig. 2; and this feature comes out so strongly in the microscopic sections, as drawn by Mr. West, that I have been induced to repeat sections of the bark recently, to satisfy myself whether this was an accidental feature or one which might be presumed common to the whole sample. It proved to be the latter; the sections, even the thinnest, exhibiting the rounded cells filled with coloured contents, which characterize Fig. 8, Fig. 3, Fig. 7, of Plate II. I mention Fig. 8 first as the one which appears to be most fairly contrasted with Fig. 2 of the previous crop of renewed bark.

The growth must be rapid, since we are told by Mr. M'Ivor† that renewed bark of one season's growth is "quite as thick as ordinary bark of two or even three years' growth." I should connect with this fact the existence of the broad band of coloured cellular tissue extending from the liber to the suberous envelope. It seems to indicate a vigorous lateral circulation, and perhaps the conversion of some of the colouring-matters into resin, for this is favoured by the same circumstances of warm temperature, etc., which induce cinchonidine, of which there is a large amount in this bark. The structure of the bark (which I thought from my early examinations resembled the granulated flesh over a wound) is in this specimen (Fig. 8) singularly perfect, especially when the circumstances of its formation are taken into account; and I think the bright colour must be owing to the early stage in which the nourishing sap, as derived from the wood, is found, in the full flow of sap and production of alkaloid; when more fully oxidized, it dissolves easily in the caustic ley.

I found in my renewed experiments with this bark, crystals of some soluble salt of alkaloid, rather abundant in the cellular envelope, specially near the corky layer.

In Fig. 3 (from the same sample of bark) we have a less perfect, or rather a less normal organization, the structure between the liber and the suberous envelope being apparently disturbed by the intervention of the spiral and reticulate vessels.

Fig. 7 presents in longitudinal section the structure of the same bark in very ample detail. The suberous layer is very thin in this specimen, and the commencing change of the cellular tissue into cork is well marked; also in the portion adjacent to the wood we may notice a rather unusual development of the liber-fibres, which occupy, nevertheless, but a small portion of the extent of the bark.

The whole of the sections of bark in Plate III., with the exception of Nos. 5 and 6, belong to the *C. succirubra*, and illustrate "the third crop of renewed bark" of which the analysis is given under E. in the

* 'Analysis of Fifth Remittance,' by J. E. Howard.

† 'Report' for 1864-5.

Appendix. The comparison with "the second crop of renewed bark" will there be found, and it will be seen that whilst there is a certain amount of increase in the total amount of the alkaloids obtained, yet in the production of crystallized sulphate of quinine there is a falling off in the third crop, and that it proved more difficult to work than the second.

The different season of the year at which the two crops of bark were gathered may have had something to do with this. The second crop was stripped from the trees in September and October, 1866, and, as it appears,* "at a season of full and luxuriant growth, when the sap is in full flow." It seems to me that the sections show the cellular structure to be gorged with recent supplies of nourishing sap, bringing with it abundance of the mother substance from the wood. This is probably just changing into Cinchona red and other products; among which the alkaloids are the most important, but the colouring matter the most manifest to the sight. At an early stage of oxidation this colouring matter is probably in a state comparable to that which I have described in another place.† A solution of pale liquor from red bark, after the fully oxidized Cinchona red had separated out by cooling, was mixed with isinglass, and when formed into a jelly, suffered to oxidize slowly; this it did very prettily, turning red from the outside; ammonia greatly expedited the process. The colour in these sections partakes both of the Cinchona red tint and that of another colouring substance of the bark, which is probably simultaneously formed.

The bark from which the specimens in this present Plate III. was taken, was (on the other hand) gathered in March, which must be a period of complete rest to the plant; for even in February, being the dry season, this is said to be the case,‡ and "the sap begins to rise in the early part of April." Everything in the appearance of the specimens seems to agree well with the period of rest. The abundance of liber fibres well filled up even to the region of the cambium—the segregation of the different products of vegetation into different regions of the bark, all coincide well with this view.

Resin is *deposited* in abundance near the outside, and some other indications in the same zone direct attention to the deteriorating change which goes forward in the outer bark, even to some extent when this is mossed.

In the liber are seen feathery crystals as of a kinovate, and, in the lax cellular tissue, globular concretions of imperfect crystalline structure (some also transparent and homogeneous) of more soluble salts of quinine; such I judge these to be from finding this state of things common in rich Calisaya bark. The lax fibre of the cellular envelope in the Calisaya is often filled with such masses, sometimes reminding of the appearance of candied honey.

I cannot help connecting with the above state of things the large proportion of uncrystallizable quinine in this third crop. My own view of the matter (differing from some able chemists, and which therefore, though sustained by experiments of my own, I express with reserve) is that this amorphous condition of quinine is not one connected with its *formation*, but with its *degradation*, and this latter in some way through the influence of resin which is associated with it at the same time. The same circumstances, viz. heat and light, which favour the production of cinchonidine, are noticed by both Mr. Broughton and myself to favour that of resin; and as these must tell most on the outside of the bark, we have a reason for that deposition of resin near the cork, which is evident in many of the sections. It is particularly difficult to purify cinchonidine from resin.

More extended researches will indicate the proper season for gathering the bark; but the conclusions to be drawn from the examination of the *second* and *third* crop of renewed bark seem, as far as they go, to indicate the period of the full flow of the sap as more favourable than that of the repose of the plant for obtaining the maximum of quinine in a crystallizable state.

* W. G. M'Ivor to Sec. Gov., 3rd Oct. 1863, No. 91 also.

† Illustr. Nueva Quinologia, Mic. Illustr. p. 8.

‡ W. G. M'Ivor to Sec. Gov., 17-March, 1864; also 3rd May, 1865.

Mr. West noted the section (Fig. 1) as most interesting to him. The small size and lax character of the cellular tissues, the different conditions of the alkaloid salts in different portions of the bark, and the numerous prolongations of medullary rays in very pale tissue particularly arrested his attention; but there is more even than appears at first sight, for by comparison with Fig. 6 of this same Plate it will be seen that, as to the size and shape of the cells, both these barks have put on the same appearance, which also corresponds in part to that of the richest Calisaya barks,* though not entirely confined to these. It is not so evident why this should so be, as it is that this lax cell-structure is favourable to the production of quinine.

Fig. 2 shows this structure still more clearly, together with the included alkaloids.

Fig. 3 brings out the characteristic features of these rounded aggregations of crystalline matter from the same, drawn with the camera *in situ*, but without the cells.

Fig. 4 shows the whole section of bark under small magnifying power, giving the whole detail of structure, both of the old and new bark and their junction, which must be understood to be about *x*, the part to the left of which is renewed, whilst the portion to the right retains its normal appearance.

Fig. 5 and Fig. 6 represent different ends of one and the same quill about 10 inches long sent to me by Mr. M'Ivor in the eighth remittance which I have previously described. About 2 inches of one end are labelled "*Chinchona crispa*, original bark under moss, 5 years old, 1868." About 6 inches more remaining of the renewed end are labelled "*Chinchona crispa*, renewed bark under moss 1 year old." This though as thick, or even thicker than the unrenewed part, is distinguishable at first sight from the latter, and the point of junction is quite evident. The unrenewed part has the appearance of the "*Colorada del Rey*" bark, but I have simply described it as *C. officinalis*, without defining the variety. The remarkable point in the microscopic section is the entire contrast in structure between the two ends of the *same* quill, a contrast which would surely cause these to rank as different species, if judged according to the rules laid down in the Anatomical Atlas of Dr. Berg; I am not able to say whether an equal contrast prevails in the richness of the alkaloidal contents. The zone of liber fibres in Fig. 6 is very remarkable, as also the numerous and prolonged medullary rays, extending to the corky layer, and probably telling of rapid growth.

Fig. 7 shows a section of the third crop of renewed bark under the curiously disturbing influence of the spiral tissue, which is seen in isolated portions as well as in bunches; the pale colour of the adjacent portions is well represented, having the appearance of being subjected to the exhaustion of contents by the proximity of this spiral tissue. One spiral will be seen running a little within the corky layer and parallel to it, for a considerable distance. Towards the upper part of the figure we have lines of cells, and incipient medullary rays placed directly at right angles to those on which they abut.

Fig. 8. With regard to the actual fact of different forms of spiral being present in the same section, this has been well noted by Henfrey in the 'Micrographic Dictionary,' under the heading "Spiral Structures," but it is not less interesting to add to the number of examples in which the fact has been recognized and carefully represented.

* Berg's 'Anatomischer Atlas,' Taf. xxx.; Weddell, Histoire, tab. 1, f. 27, et alia inedita.

SECTIONS OF BARK.

PLATE I.

Fig. 1. *C. succirubra*, from Ceylon, grown in the forest under dense shade.—*a*, the suberous coat; *b*, cells becoming changed into cork; *c*, prolongation of the medullary rays; *d*, laticiferous vessels; *f*, liber-fibre, cut transversely; *g*, fibre not yet filled up with layers of incrusting-matter; *h*, indications of the cambium layer. $\times 50$ diameters.

Fig. 2. *C. succirubra*, from Ceylon, grown in open garden.—*a*, the suberous coat; *b*, cells compressed and undergoing change; *c*, the prolonged medullary rays opening out into cellular tissue of ordinary structure; *d*, laticiferous vessels; *e*, cellular tissue of the liber in smaller polygonal, or globular cells; *f*, fibres of the liber; *h*, point of junction with the wood, forming a cinnamon-coloured inner surface of the dried bark; *i*, crystals of alkaloid. $\times 100$ diameters.

Fig. 2 *a*. Portions of cellular tissue of the above, showing more distinctly the crystals above mentioned; *i*, crystals, probably of cinchonidine; *j*, small globular aggregations, probably of alkaloid, united with cerotic acid. $\times 100$ diameters.

Fig. 2 *b*. The same crystals as above. $\times 200$ diameters.

Fig. 5. *C. succirubra*, from Ceylon, grown in the open garden, six feet apart.—*a*, the suberous, *d*, the laticiferous vessels; *e*, liber-fibres of larger dimension; *h*, dark brown inner surface; *i*, crystals of alkaloid. $\times 50$ diameters.

Fig. 5 *a*. Portion of cellular tissue of the above; *i*, crystals, probably of cinchonidine; *j*, globular concretions; *k*, isolated crystal; *l*, abnormal formation, a cell filled with granulations of some earthy compound (insoluble in any menstruum employed), also colouring-matter. $\times 100$ diameters.

Fig. 5 *b*. Groups of the above crystals, and also isolated crystals. $\times 200$ diameters.

Fig. 8. *C. succirubra*, original bark, six months under moss.—*a*, the suberous coat; *i*, crystals, probably of kinovate of quinine; *l*, abnormal concretions; *d*, laticiferous vessel; *f*, fibres of the liber; *e*, lax cellular tissue; *h*, internal surface, with indications of the cambium. $\times 50$ diameters.

Fig. 8 *a*.—*i*, groups of crystals, as above; *l*, abnormal concretion. $\times 100$ diameters.

PLATE II.

Fig. 1. *C. succirubra*, bark in an early stage of renewal, from Ootacamund.—*a*, the suberous coat; *c*, cellular tissue, which apparently marks the course of the

circulation from the medullary rays to the external coat; *f*, isolated liber-fibre (two seen in juxtaposition on the reverse side); *l*, abnormal concretions; *e*, lax cellular structure (favourable to the production of quinine); *h*, indication of cambium. $\times 50$ diameters.

Fig. 2. *C. succirubra*, first crop of renewed bark, from Ootacamund.—*a*, thick, suberous coat; *b*, layer of cells, filled with resinous deposit; *m*, cellular envelope of cell-structure, resembling specimen (Plate II. Fig. 2, 'Quinologia'); *d*, large laticiferous duct; *e*, cells of normal structure, forming continuation of the parenchyma of the medullary rays; *e*, liber-fibres, normal in character and position; *g*, young liber-fibres not filled up; *h*, hard inner surface. $\times 50$ diameters.

Fig. 3. *C. succirubra*, second crop of renewed bark.—*a*, the suberous coat; *b*, cellular structure, apparently gorged with resin, and changing into cork; *n*, spiral or reticulate vessels; *m*, normal structure of the cellular envelope; *e*, lax cellular structure, in places filled with cincho-tannic acid in an early stage of oxidation; *c*, course of the prolongation of a medullary ray; *f*, normal liber-fibres; *h*, hard and coloured inner bark. $\times 50$ diameters.

Fig. 4. Spiral and reticulate vessels from the above at *n*, simply spiral vessels. $\times 100$ diameters.

Fig. 5. Spiral and reticulate vessels (from a transverse section of the above Fig. 3); *m*, the cellular tissue coloured by resin; *n*, the ends of reticulate vessels; *o*, vessels of the cellular tissue, apparently emptied of their colouring-matters by contact with the spiral vessels. $\times 100$ diameters.

Fig. 6. Natural size of section, at *n* showing the position of the spiral vessels.

Fig. 7. *C. succirubra*, second crop of renewed bark (long. sect.)—*a*, the suberous layer; *m*, cellular tissue; *d*, the same, surrounding laticiferous duct; *e*, cells of parenchyma, gorged with colouring-matter; *f*, fibres of the liber. $\times 50$ diameters.

Fig. 8. *C. succirubra*, second crop of renewed bark (probably exposed to greater heat).—*a*, the suberous coat; *b*, current of colouring and probably resinous matter from the medullary rays to the bark; *c*, lax cellular tissue; *i*, crystals of alkaloid; *d*, laticiferous ducts; *e*, globular cells of parenchyma, filled with colouring-matter; *l*, abnormal concretions; *f*, fibres of the liber; *h*, internal surface, with trace of cambium. $\times 50$ diameters.

Fig. 8 *a*. Crystals of alkaloid, seen in the parenchyma of the above. $\times 100$ diameters.

Fig. 10. Fibres of the liber, probably from *C. Palton* (see p. 23). $\times 50$ diameters.

PLATE III.

Fig. 1. *Third crop of renewed bark of C. succirubra*.—*a*, the suberous layer; *b*, deposit of resin in the cellular tissue about to change into cork; *m*, abnormal concretions; *i* and *j*, abundant deposit of soluble salts of quinine; *c*, prolongation of medullary ray; *k*, crystals of a kinovate; *f*, liber-fibres; *n*, inner surface with trace of cambium. $\times 50$ diameters.

Fig. 2. Lax cellular tissue from the above, full of alkaloid. $\times 100$ diameters.

Fig. 3. Globular concretion of the above alkaloids without cellular tissue; *j*, crystalline masses; *i*, transparent globes. $\times 200$ diameters.

Fig. 4. *Third crop of renewed bark*, and its junction with the old bark, drawing of complete section; *a*, suberous coat; *m*, medullary rays contorted; *f*, sharp line of demarcation between liber and cellular tissue; *h*, liber-fibres; *x*, abnormal formation, probably marking the division between the old and the new bark. $\times 10$ diameters.

Fig. 5. *Unrenewed end of C. officinalis quill*, 5 years

old; *a*, the suberous layer; *b*, changing into cork; *m*, ordinary cellular tissue; *f*, liber-fibre; *j*, prolonged medullary ray; *h*, traces of the cambium. $\times 50$ diameters.

Fig. 6. *Renewed end of quill of C. officinalis*, nearly a year and a half old; *a*, the suberous layer; *b*, deposit of resin in cellular tissue changing into cork; *c*, lax cellular tissue; *i* and *j*, the same full of alkaloid; *f*, congeries of liber-fibres; *c*, prolonged medullary ray; *h*, remains of cambium layer. $\times 50$ diameters.

Fig. 7. *Renewed bark of third crop*, with spiral tissue; *a*, the suberous layer; *b*, pale cellular tissue; *n*, spiral tissue longitudinally placed; *o*, bunches of spiral tissue. $\times 20$ diameters.

Fig. 8. Portions of spirals from the above bark; *a*, partially unwound, showing the angularity of the fibre; *b*, annuli; *c*, scalariform-like tissue; *d*, joined as spirals usually do; *e*, portion somewhat netted, and with the abrupt junction characteristic of reticular tissue. $\times 350$ diameters.

Fig: 1.

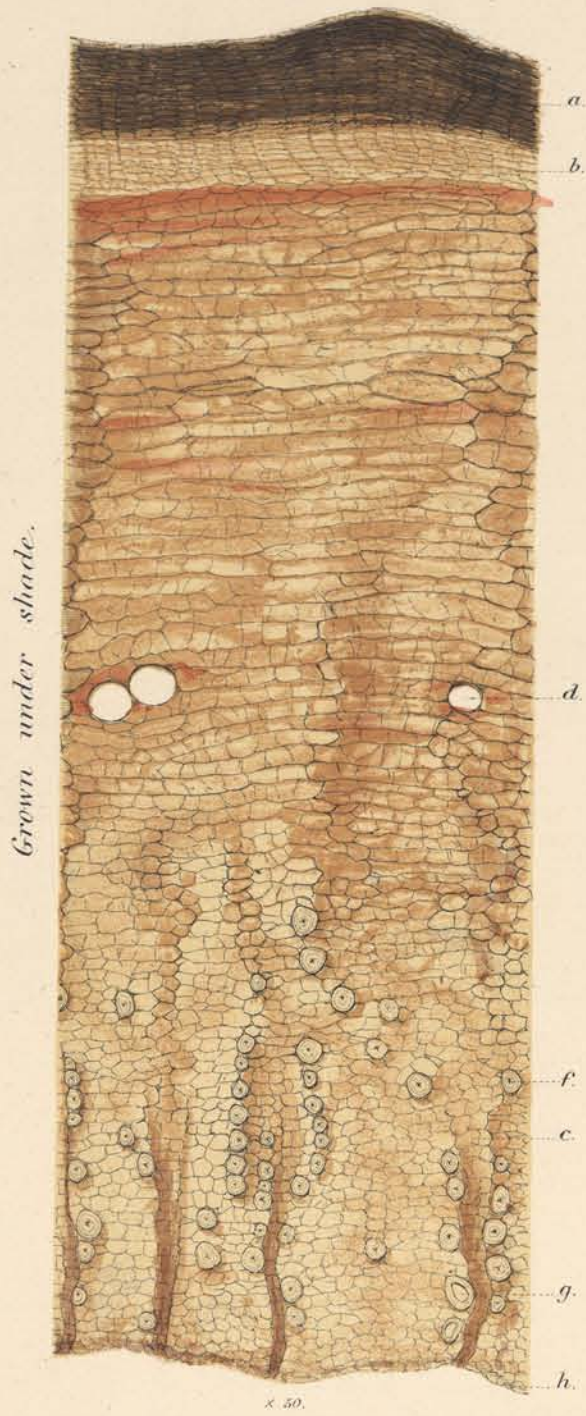


Fig: 2a

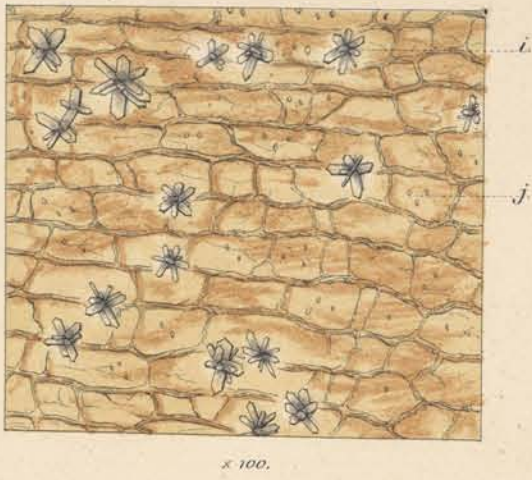


Fig: 2b

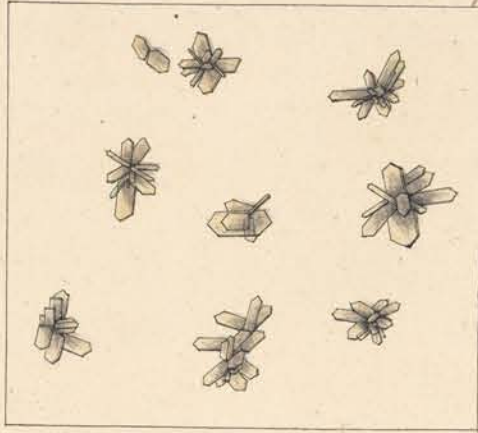


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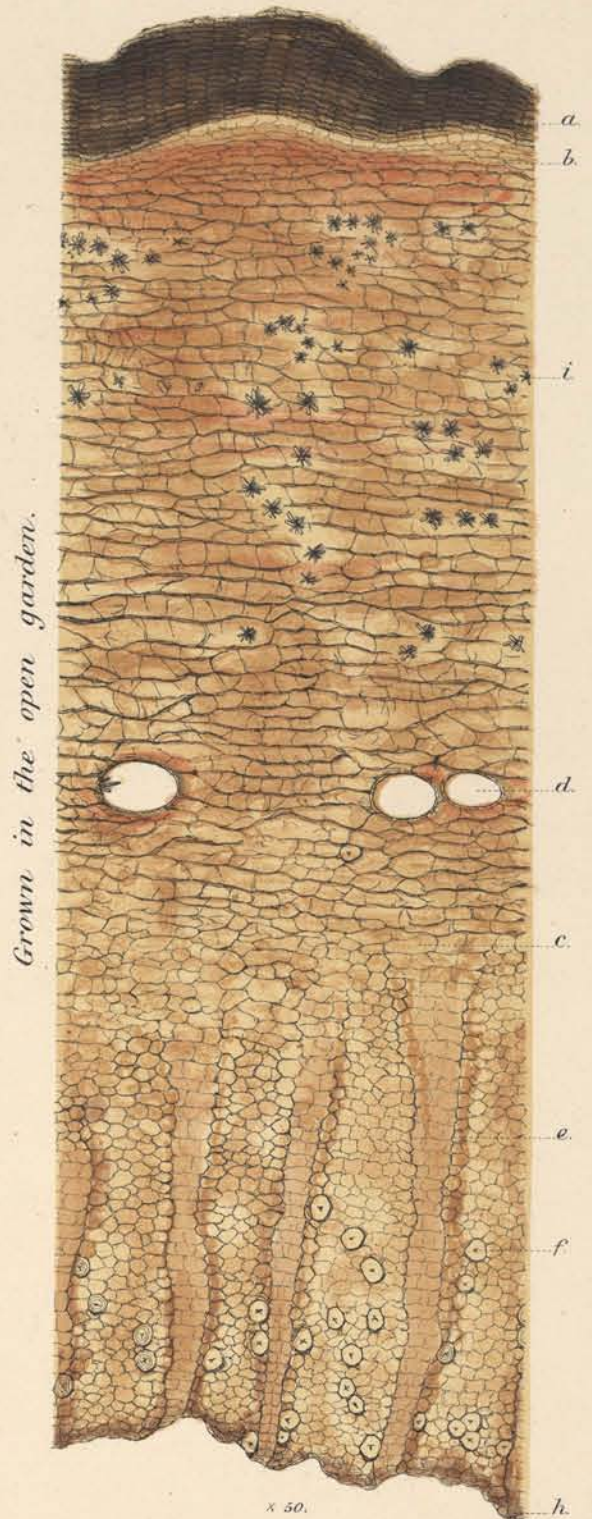


Fig: 5.

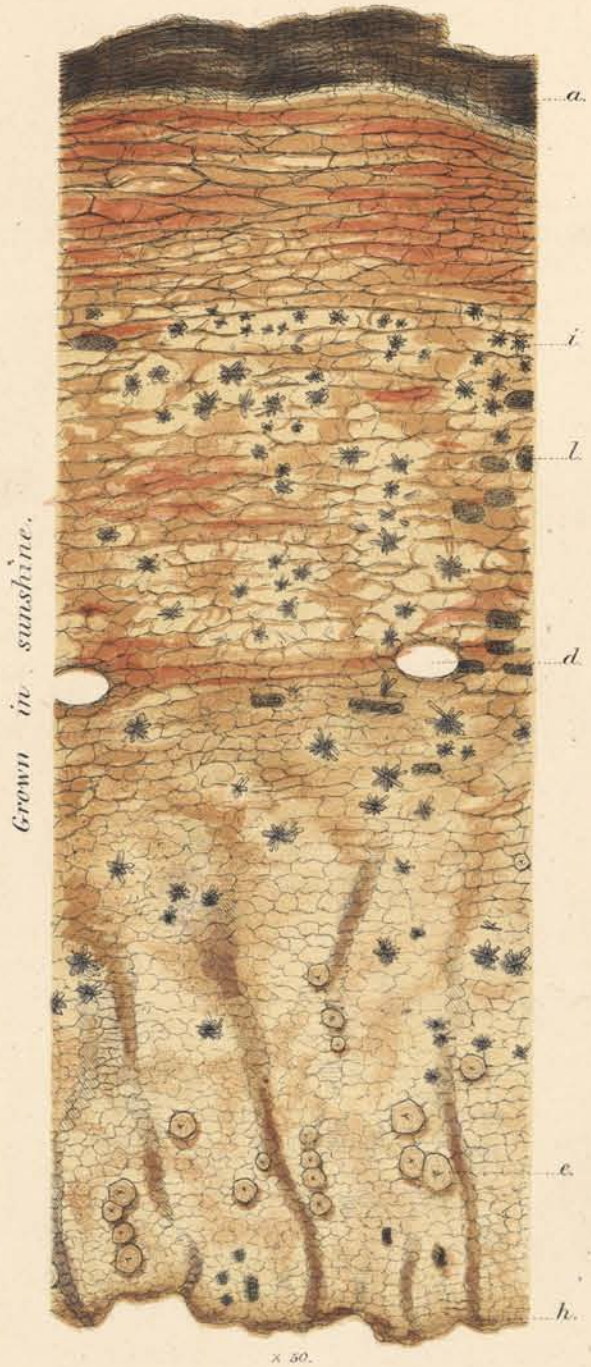


Fig: 5a

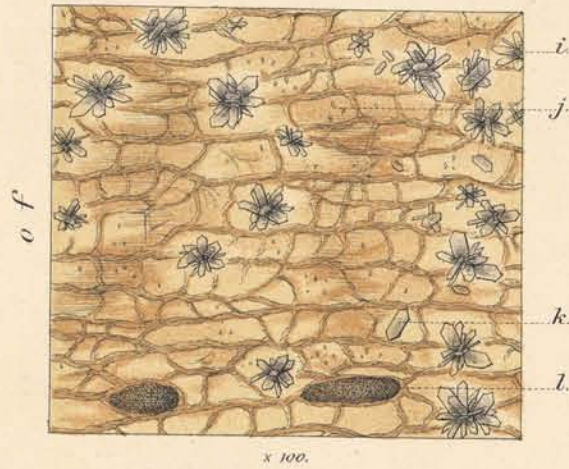


Fig: 5b

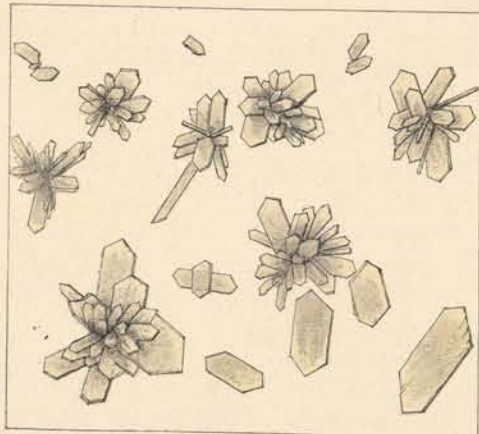


Fig: 8a

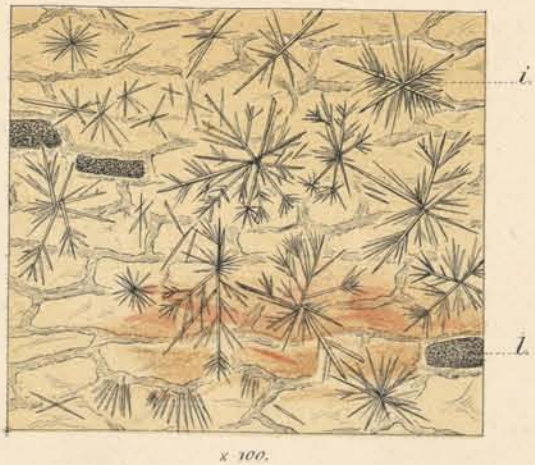


Fig: 8.

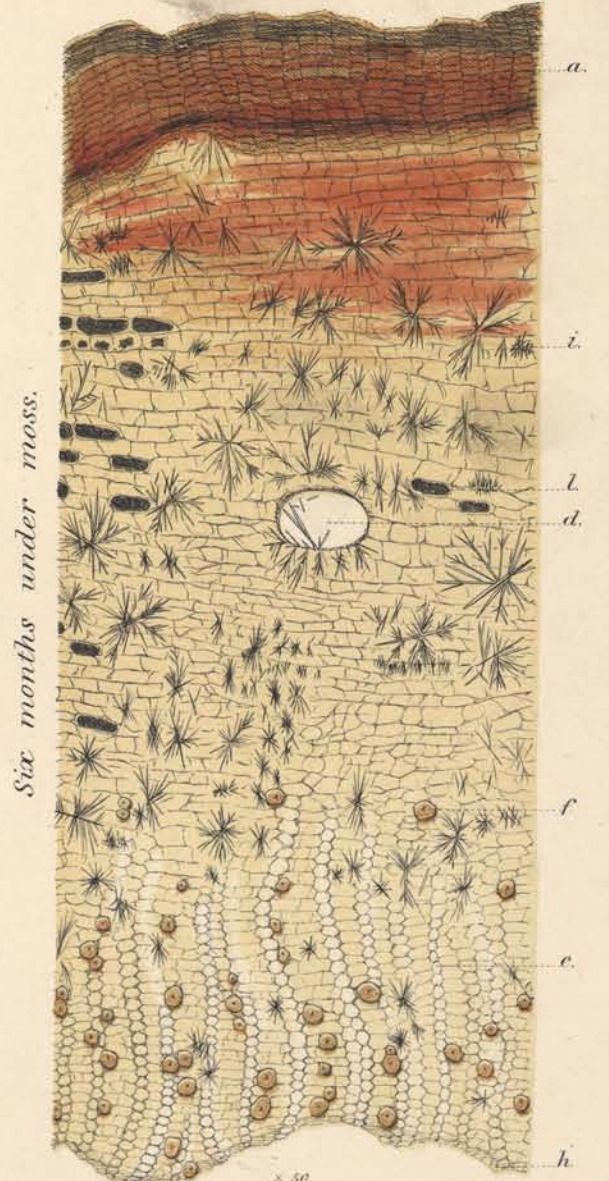
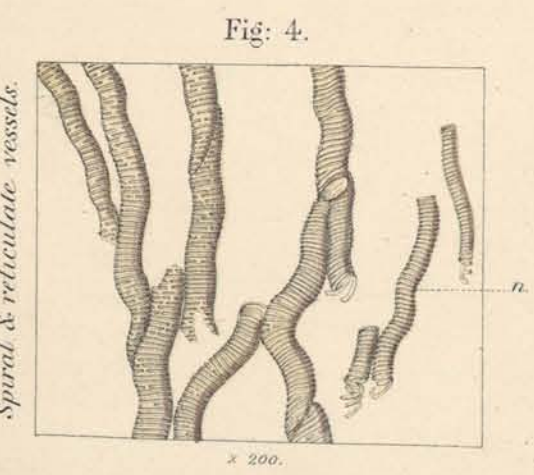
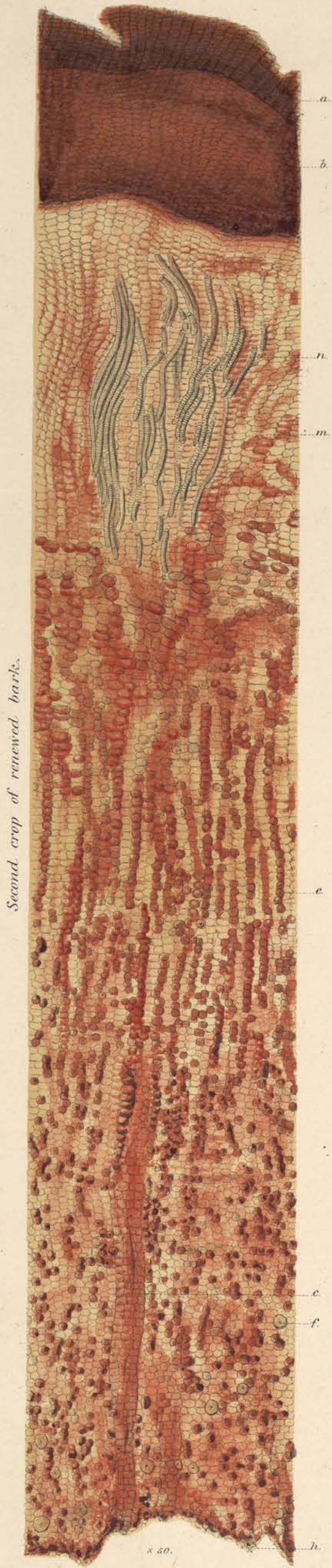


Fig: 3.



Tuffen West del et sculp

Fig: 1.

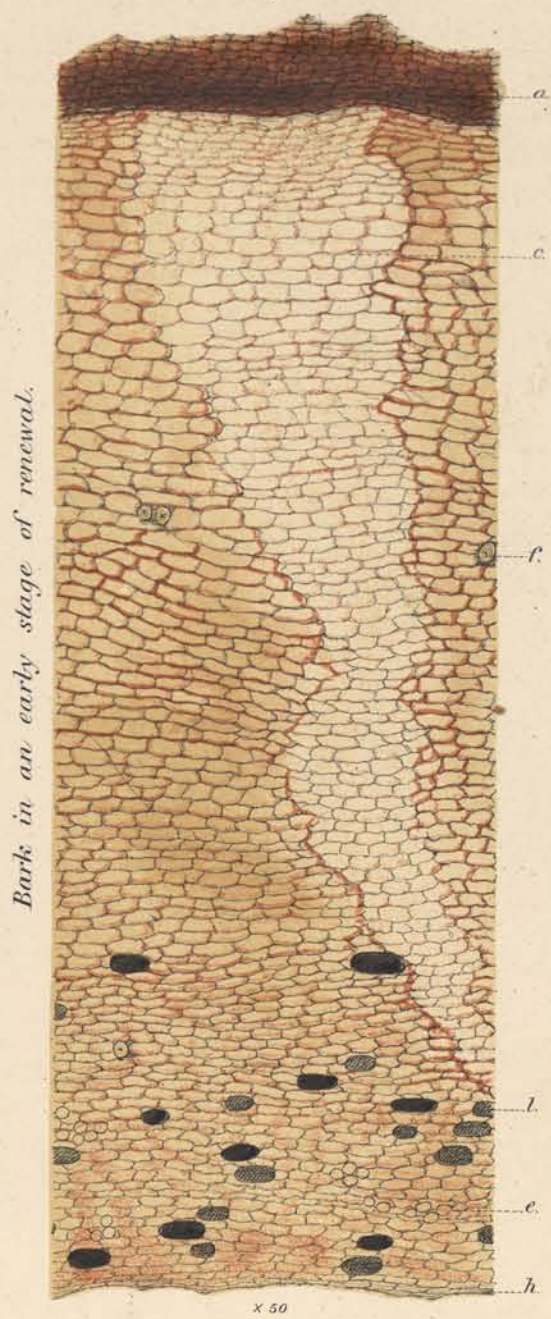


Fig: 10.



Fig: 6.

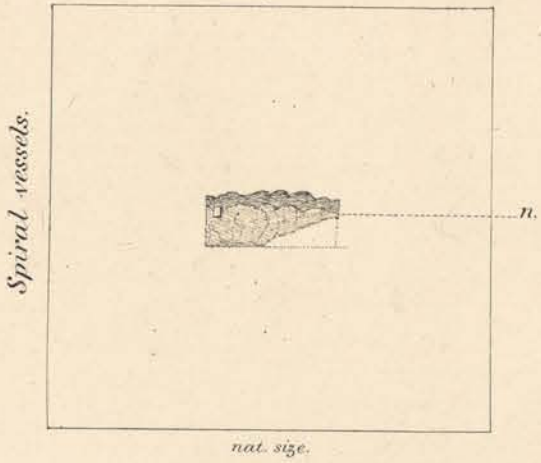


Fig: 5.

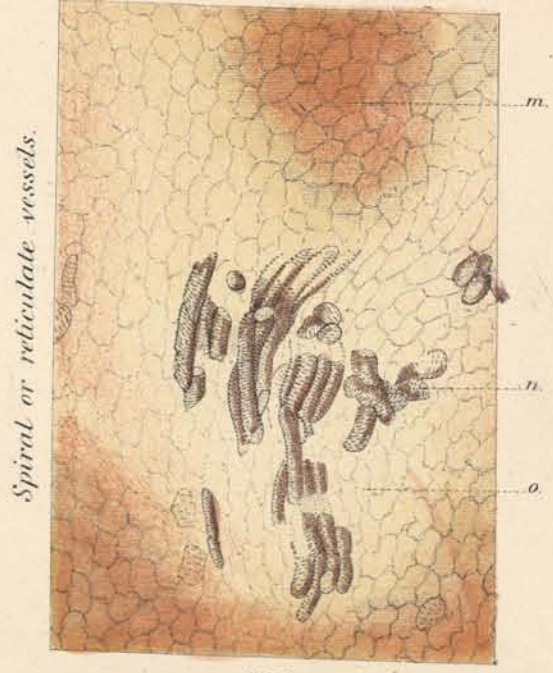


Fig: 2.

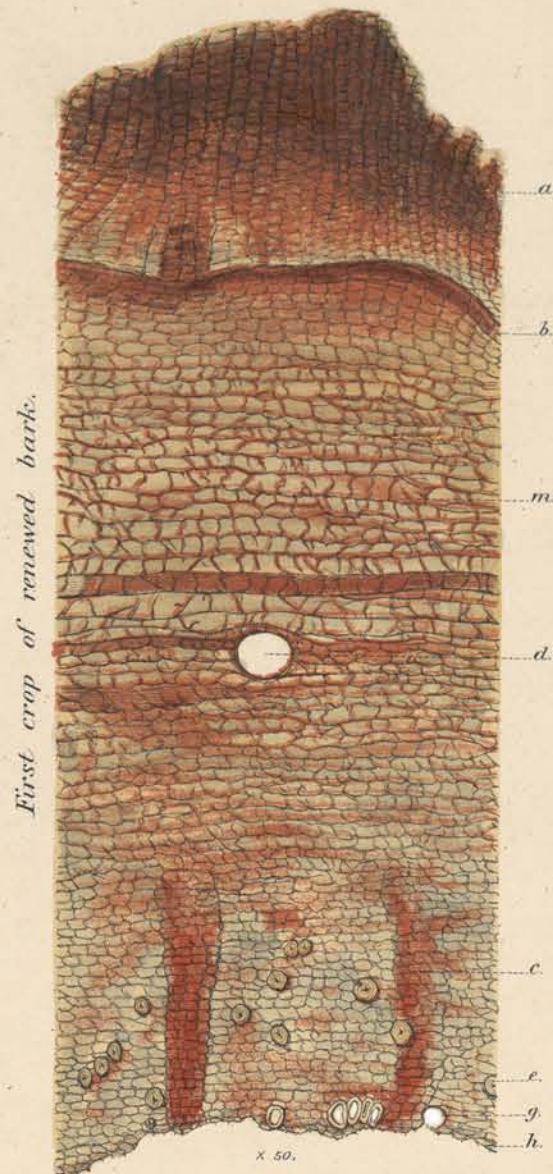


Fig: 8.

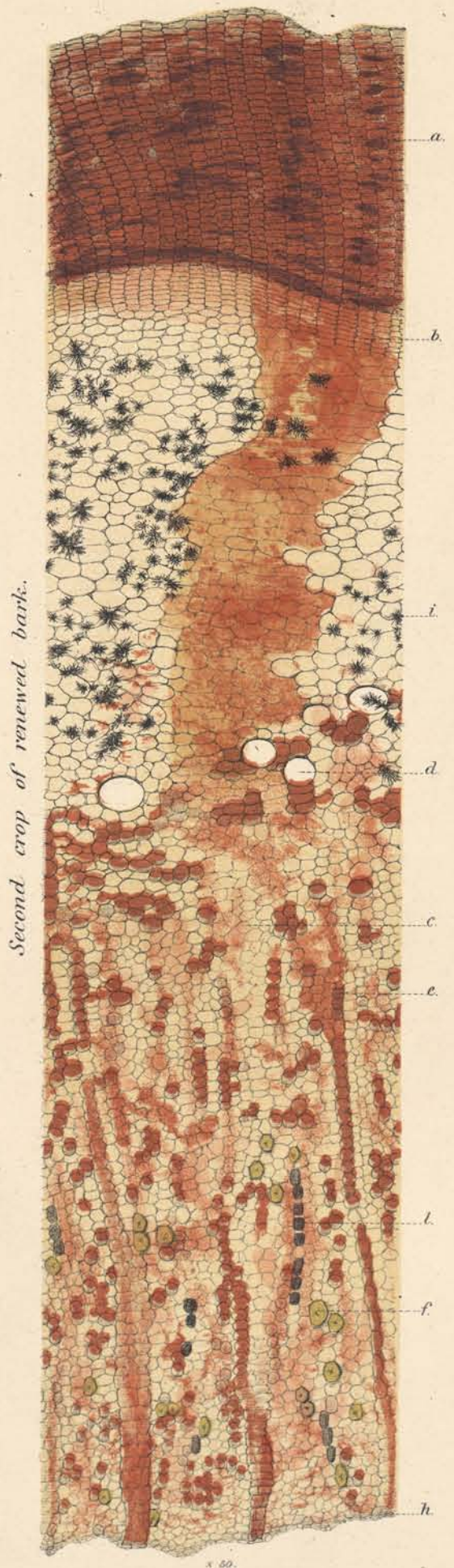


Fig: 7.

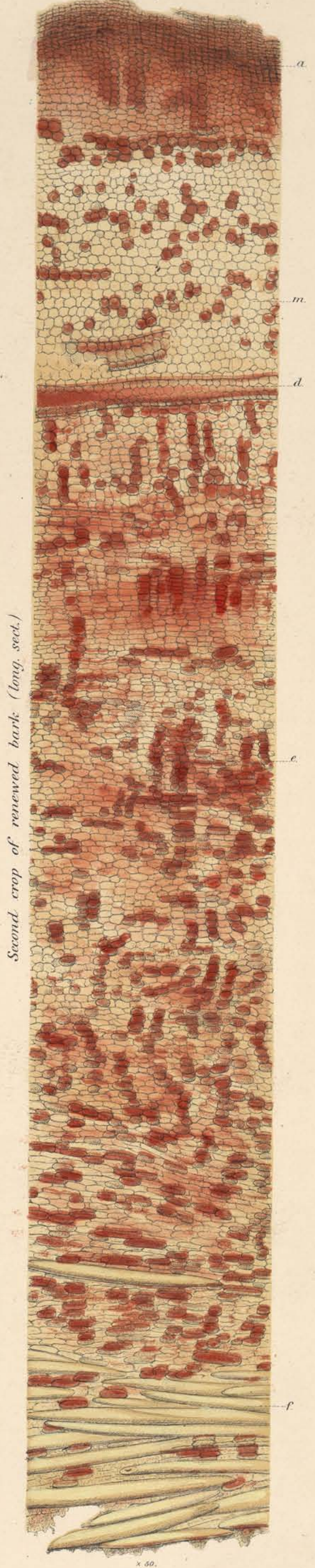
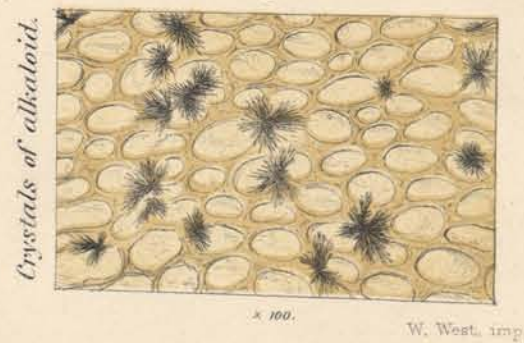
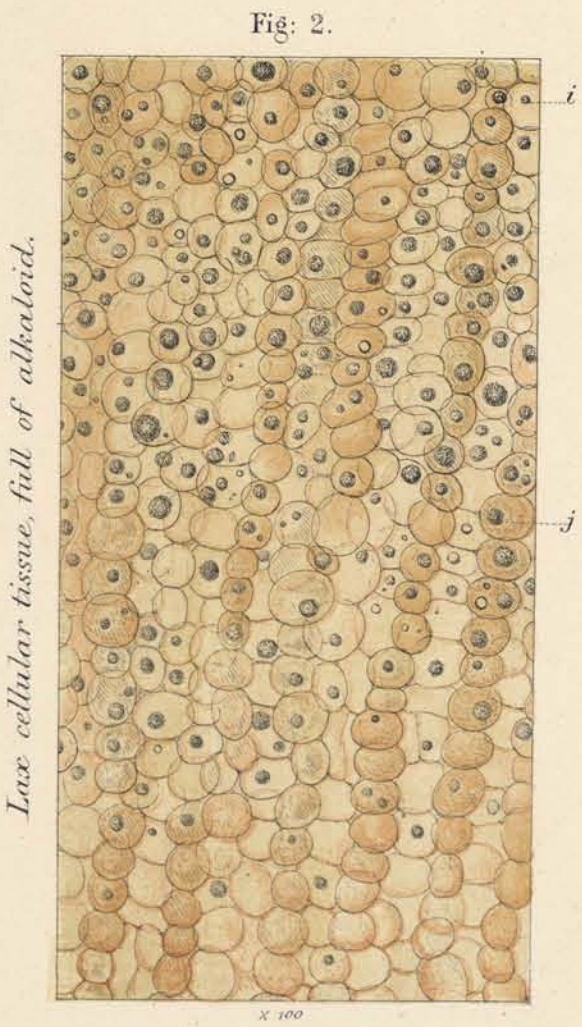
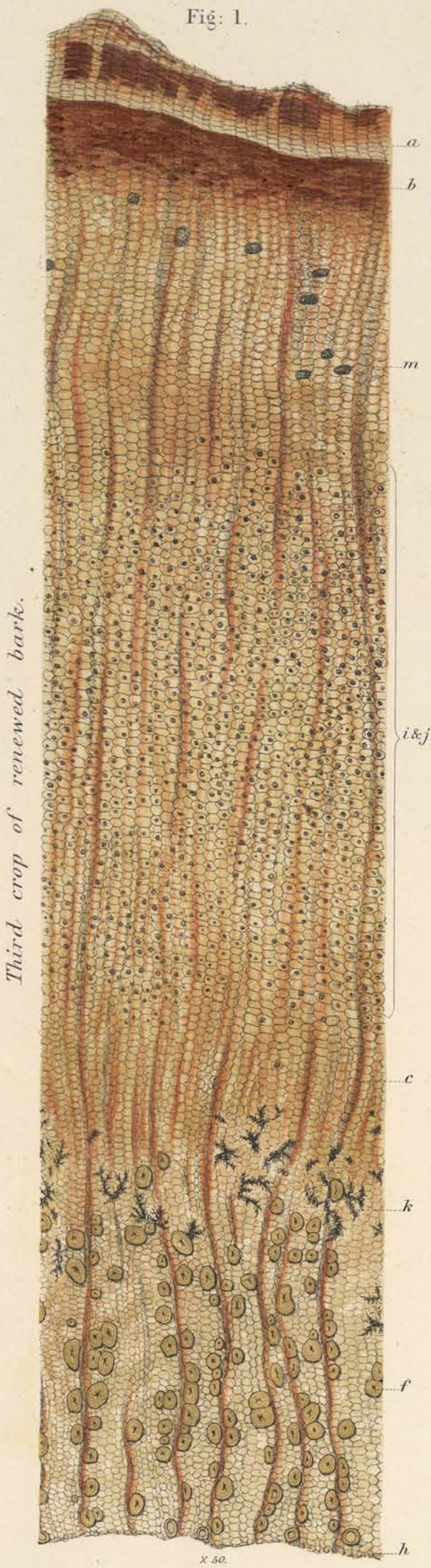


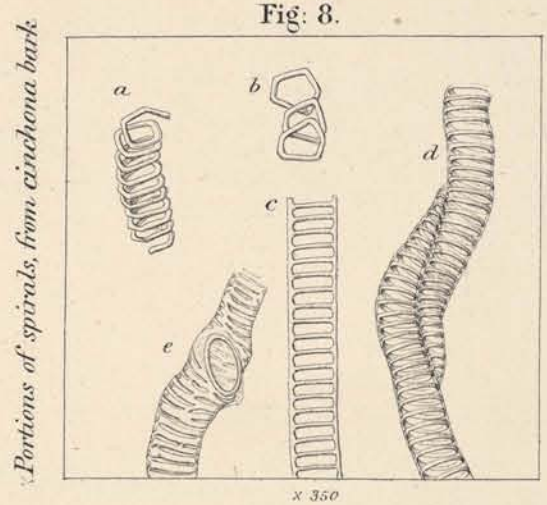
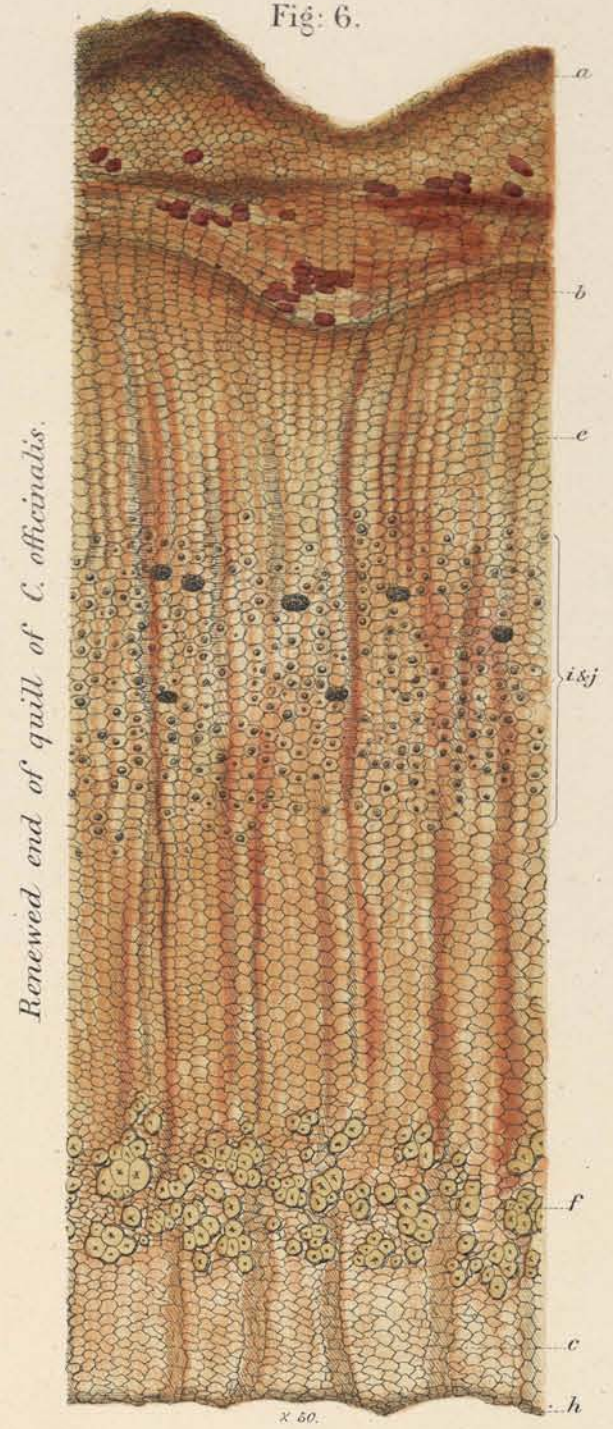
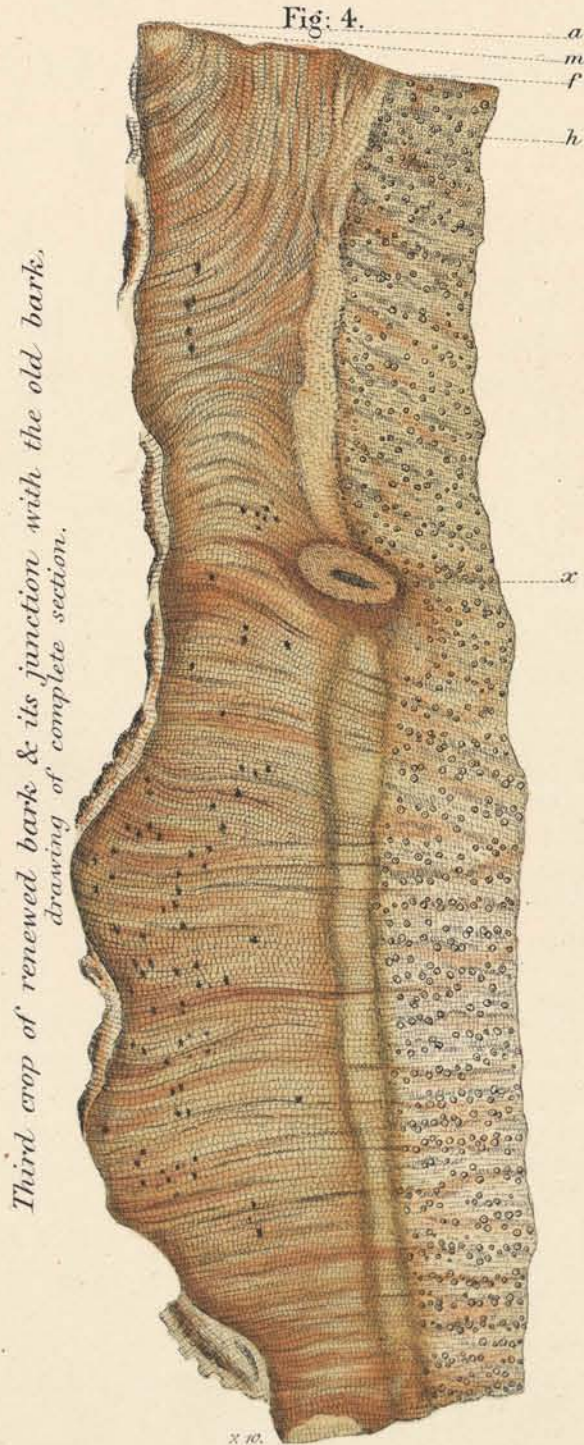
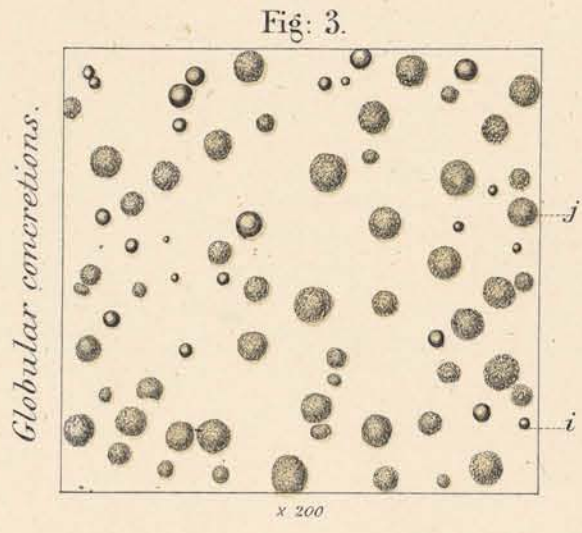
Fig: 8a.



W. West, imp.



Tuffen West, del. et sculp.



W. West, imp.

QUINOLOGY

OF THE

EAST INDIAN PLANTATIONS.

PART I.

CHEMICAL AND MICROSCOPICAL INVESTIGATIONS.

Introductory Remarks.

THE chemical and microscopical investigations contained in the present Part are strictly in continuation of the kindred researches in my previous works, and, although by no means complete or exhaustive, may afford some practical assistance in the great and beneficent undertaking of the naturalization of the Quinine-producing trees in India.

I defer for the present any detailed remarks on the botanical aspects of the varied species of *Cinchona** now under cultivation, the more especially as I am informed by J. Broughton, Esq., the Quinologist appointed by Government to the chemical oversight of the plantations at Ootacamund, that he has instituted and is carrying forward varied observations on the influence of soil and climate, and especially of elevation above the sea-level, on these plants, the results of which will doubtless present many novel and most important facts confirmatory or otherwise of views here advanced by me. The Indian Government has been fortunate in the choice of servants to whom the practical carrying out of the details of this great scheme has been confided, and I am glad to think that in this most recent instance they have been equally successful. It is not for me to award the meed of praise to those whose toils and dangers in the service entitle them to the gratitude of the world; but it may be permitted me, as having previously given what assistance I could render in the analysis of the specimens sent home from various parts of India, to bear my unbiassed testimony to Mr. Broughton's skill and diligence, as evidenced by what he has already accomplished in a peculiarly difficult line of chemical investigation.

Elevation above the Sea-Level.

Recent observations on this point may save the apparently useless attempt to cultivate these plants at a level below 4000 feet above the ocean; I refer for the full elucidation of the subject to the results of Mr. Broughton's observations, which I hope to see published.

* I adhere to the old Linnean term, but quote from my correspondents as I find the word spelt by them.

Mr. M'Ivor remarks that the Red Bark tree especially has found, in its new home in plantations on the Neilgherries, "conditions quite as favourable to its growth and full development as in the most favourable localities in the Andes."

"The *C. succirubra*, *Peruviana*, and *micrantha* thrive on the Nedivuttum and Pykara plantations at elevations varying from 4000 to 6000 feet; while *C. officinalis*, *Bonplandiana*, and *crespilla* continue to grow more sturdy and vigorous on the Dodabetta plantations at elevations varying from 7000 to 8500 feet. These latter species grow equally well upon grass as upon forest land, and bear almost every exposure, hence they can be successfully cultivated over the whole plateau of the Neilgherries, excepting such land-locked hollows as are subject to severe frosts."*

"A few plants of the *Calisaya* accidentally planted out at a high elevation, 7300 feet, seem to have adopted a much more luxuriant habit than those planted at lower elevations. Several plants of the *C. Calisaya* planted in the first Denison plantation in November, 1862, are now (1865) in full bloom, presenting a most beautiful appearance, while their fragrance fills the air for a considerable distance."

Mr. Broughton informs me that the *C. succirubra*, above 7500 feet, yields little more than two per cent. of alkaloid, and that destitute of Quinine and Quinidine, and that below 5000 feet the bark is thinner (which agrees with specimens sent me from the Wynaad and other places). Mr. Broughton adds, "that it appears to contain Quinidine in larger amount, and a large quantity of the vexatious resin," about which I had written to him. "In the Crown Barks the highest elevations yield bark of about even quantity down to 6500 feet. Below this the amount of alkaloid becomes somewhat less, and instead of Quinine, Chinchonidine and Quinidine are met with. At low elevations the trees do not thrive, and the resin of the bark becomes as troublesome as in the Red Bark."

It will be thus evident that the Crown Barks are adapted to the higher elevation, and the Red Bark to a lower. This might have been anticipated from what we know of their growth in their native habitat. The large leaves of the *C. succirubra* are liable to injury from strong winds, and the plant suffers in consequence; but I am informed, by one of the cultivators in Ceylon, that at the higher altitudes the plant shows considerable power of adaptation to the climate, and the leaves assume a somewhat different appearance.

Of all the varieties of Crown Barks, the *C. officinalis*, var. *crispa*,† has long been esteemed the most hardy; and I may here record the additional observation that this sort succeeded well with me in the open air last summer, and though I had to remove it to shelter under glass in November,‡ it did not then need more warmth than the half-hardy exotics. It seems to me that its requirements are so little in excess of those of the common *Arbutus* (which does not stand the winter with me), that where this flourishes in a mild and equable and moist climate, as at Killarney,§ I believe this *crespilla* sort might possibly be naturalized, although I am far from supposing it could there be grown to profit commercially, as the growth would be much too slow to admit of this. In other respects it appears, by Mr. Broughton's examination, to be a good variety. My own investigation gave me, from bark carefully mossed by Mr. M'Ivor when three years and a half old, the following product:—

Sulphate of Quinine	2.46
Un-crystallized ditto . . . . .	.44
	— 2.90
Cinchonicine . . . . .	.86
Total	<u>3.76</u>

* See Return, East India Cinchona Plant, ordered by the House of Commons to be printed, June 18, 1866, 353, p. 162.

† "The tree of the *crespilla* is the same with that of the *amarilla* and *colorada*, but grows in a cold, frosty climate."—*Arrot*, in a Paper communicated to the Royal Society in 1737.

"No. 2, *crespilla*, found growing, in general, in a deposit of peat on the summit of the highest mountains around Loja, where the temperature sometimes falls to 27° Fahr."—*R. Cross*, 1861.

‡ Again planted out in the open ground in April, 1868, but needing protection from severe spring frosts.

§ "Mean summer temperature, 59½° Fahr., mean winter temperature, 44½°. *Laurus nobilis* attains to a height of upwards of 30 feet."—*Dr. Moore*, *Rep. Bot. Congress*, 1866, p. 173.

The Quinine was associated with some Cinchonidine. My previous experiments were less satisfactory, perhaps owing to the great abundance of green colouring-matter found in this bark; and perhaps, also, as regards the specimens from Loja, owing to the very immature state in which they were gathered.

Change of Place of Growth as affecting Successive Generations of C. officinalis.

Any addition to the amount of our knowledge on the effects of change of climate on these plants must be valuable to the cultivator, and I have no doubt that those so engaged will read with interest the following examination of three generations of one species, the *C. officinalis* of Linnæus, growing respectively in South America, England (under glass), and in India.

The original bark of the first generation, from the mountains of Uritusinga, near Loja (Peru), was sent to me, with the flowering branches and ripened seeds, by Don T. Riofrio, and from these I raised plants in 1859. This was fine-looking, but very much weathered Crown Bark, with few adherent lichens, it gave me:—

No. 1.

FIRST GENERATION.

Oxalate of Quinine	1.87
Cinchonidine	1.20
Cinchonine . . . . .	.04
Total	<u>3.11</u>

No. 2.

SECOND GENERATION RAISED FROM THE ABOVE SEED.

No. 2 a.

Grown in England.

Sulphate of Quinine	1.36
Cinchonicine (with merely a trace of Cinchonine) . . . . .	.57
Total	<u>1.93</u>

No. 2 b.

Grown partly in England, partly in India.

Oxalate of Quinine	1.40
Quinine uncrystallized . . . . .	.17 = 1.57
Cinchonicine . . . . .	.79
Total	<u>2.36</u>

No. 3.

THIRD GENERATION, DESCENDED FROM No. 2 b.

Sulphate of Quinine	1.75
Sulphate of Cinchonidine	1.50
Cinchonine . . . . .	.08
Total	<u>3.33</u>

In the third generation* it is easy to remark a sort of *atavism*, the produce having returned almost exactly to the first; and having, in the Neilgherries, in India, rather surpassed the quantity of alkaloid yielded by the first generation grown on the mountains of Uritusinga, its native habitat.

This is so far very satisfactory, as showing that at least there is no deterioration in this species through the so great change of its acclimatization; and I am strongly of opinion that experience will manifest a still further decided improvement, especially consequent upon the effects of *mossing* the bark.†

* The analysis of this No. 3 I owe to Mr. Broughton.

† A specimen from Mr. Thwaites, apparently of this sort, grown in Ceylon, gave me:—

Sulphate of Quinine	3.93
Quinine uncrystallized	2.41
	<u>6.34</u>
Cinchonidine . . . . .	.51
Cinchonine . . . . .	.28
Total	<u>7.13</u>

I must direct particular attention to the fact that the variation of soil, temperature, and elevation united (all these being of the greatest extent) did not equal the effects of the altered character of *light* on the plant,—at least if I read the indications aright.

The first and third generations had probably an equal exposure to the sunlight and to the weather; but the second generation, raised under glass* (with enfeebled actinic power in the light, and in winter a greatly diminished, and in summer an excessive amount of this stimulus), shows a loss of product of alkaloid to the extent of more than one-third, and a still further deterioration in the substitution of Cinchonine for the far more useful product Cinchonidine. The loss of product in Quinine is smaller in proportion, for reasons that will presently be noticed.

The plant sent to India (2 *b*) recovered only partially its tone of production. It was about six feet in height when I presented it to the Government, and it was then quite a flourishing young tree, but in its passage from Madras to the mountains suffered by a sunstroke, and lost all its leaves. It was with difficulty recovered; but by the skill of Mr. M'Ivor was so entirely restored that it yielded many thousand young plants, and these are so constantly multiplying, that this gentleman intends to plant sixty acres with these alone.

The bark of this (2 *b*) plant was sent home to me last summer by the Indian authorities for analysis, and yielded as above.

Effect of Sunlight.

I have before remarked a particular sensitiveness to the action of sunlight in the Cinchonæ, especially in some of the more delicately-formed species; and I now present my examination† of the bark of *C. succirubra*, sent home by Mr. Thwaites from Ceylon, showing the different effect of growth in deep shade, in more partial, and in full sunlight. I thought this well-devised experiment worthy to be followed up by the most complete examination, microscopical as well as chemical, in my power. The chemical examination, as reported to the Government, is as under:

No. 1. Bark of *C. succirubra*, taken from trees grown in the forest *under dense shade*. Plants planted out 8th February 1862, yields (1866) :—

Sulphate of Quinine	1.48
Cinchonidine . . . . .	.61
Cinchonine	2.54
Total	<u>4.63</u>

The proportion of Cinchonine (including Cinchonine) in this sample is very remarkable.

No. 2. Bark of *C. succirubra* taken from trees growing in the open garden, planted twenty-five feet apart, on the same day as the last.

Sulphate of Quinine	2.35
Quinine uncrystallized . . . . .	.95
	<u>3.30</u>
Cinchonidine	1.11
Cinchonine . . . . .	.58
Total	<u>4.99</u>

* This plant (No. 2 *a*), which I was obliged to cut down (January, 1866) has again (May, 1868) grown up to above seven feet in height, and is more vigorous than before.

† Return, etc., p. 379.

In this specimen, grown in full sunlight, the Quinine and Cinchonidine may be looked upon as more than doubled, and the Cinchonine reduced by three-quarters.

No. 3. Bark of *C. succirubra*, taken from trees planted in the open garden six feet apart, on June 1, 1863.

Sulphate of Quinine	1.90
Quinine, uncrystallized	1.18 = 3.08
Cinchonidine . . . . .	.53
Cinchonine . . . . .	.32
Total	<u>3.93</u>

The Cinchonidine is diminished one-half, and the Cinchonine in almost the same proportion, the Quinine has suffered less. The time of planting-out I suspect to have been less favourable in this case.

Microscopical Observations on the above Specimens.

No. 1, grown in the forest under dense shade, presents a very regular and beautiful microscopical structure, which, however, did not indicate superiority in produce of Quinine. I observed no crystallized alkaloid in this section.

No. 2, grown in full sunshine, has also a regular and promising structure. The laticiferous vessels are rather large. The crystals of alkaloid, probably of some salt of Cinchonidine, become conspicuous in this section.

No. 3, planted out sixteen months later, and in the month of June, has a comparatively shrivelled and unhealthy look, such as I have described in reference to the section of *C. Pahudiana* grown in Java;* the same abnormal formations also occur; so that I am not inclined to draw any absolute deductions from the chemical analysis of this peculiar specimen. I am satisfied that there have been some unfavourable conditions existing either in the season of planting or in the manner in which this was done.

The general result of these experiments† is, that sunlight favours the production of Cinchonidine and dense shade that of Cinchonine, whilst it appears from other observations that the most favourable circumstances for Quinine are, that the leaves should be well exposed to light whilst the stem-bark is shaded from the direct action of the sun.

Success of the Acclimatization of the Cinchona in India.

In reference to this question, I must refer the reader to some extracts from the very able and impartial address of Dr. Weddell to the Botanical Congress held in 1867, in Paris, which will be found in the Appendix.

My own belief is, that success, though not to the fullest possible extent, has been assured by the steps already taken; but it would not be well to overlook the fact that in Java‡ some disappointment has

* See Illustr. Nueva Quin. plate iii. fig. 34, Micr. Secs.

† I am glad to find that in one point these observations coincide with remarks made by Mr. Broughton, who says in a letter to me (under date July 28, 1867):—"Some Crown Barks grown under partial shade, which I examined, yielded but little Chinchonidine, whereas those in full sunshine yielded one and a half per cent. I believe you will find little in the plants in your conservatory, and should be greatly interested to know the results should you ever analyse their bark." (Vide No. 2, p. 3.)

‡ A Report by Van Gorkom, which has just reached me, speaks, however, very hopefully, especially of the prospects of the *Calisaya* plants, of which three or four varieties are growing in Java. It is specially remarked that about 3000 plants raised from seed from British India, present a quite peculiar character, which partly belongs to the *C. micrantha*. I assisted at the purchase of the bag of seeds (collected by Lechler) for British India, to which no doubt this refers, and having some growing freely, side by side with the *C. micrantha*, brought by Pritchard from Huanuco, can quite confirm this resemblance. The plants are, I think, those of the *C. micrantha* (Bolivian variety), of Weddell.

The plantations in Java have, by the last accounts (fourth quarter of 1867) suffered somewhat from heavy rains. The number of plants is as follows:—497.320 *C. Calisaya*; 5.559 *C. succirubra*; 18.569 *C. Condaminea*; 0.559 *C. lancifolia*; 0.385 *C. micrantha*. It is said that "a recent chemical examination of young roots of the *C. Pahudiana* appears to allow that this sort should attract new attention in order to be further cultivated." They appear to have been examined by Maier, with "not unfavourable" results, but the Report of Van Gorkom wishes to say little till more is known.—*Flora*, 1867, 1868, *Regensburg*.

been felt, and it is only by avoiding errors in the choice of species, and by carefully selecting the best situations and modes of culture, that individual planters in other parts of the world will see their efforts crowned with remunerative results.

It was at first a somewhat doubtful and anxious inquiry whether the product in alkaloids might not be deteriorated or altered by the change of climate to which these plants were to be subjected. It was with no small satisfaction, therefore, that in June, 1863, I first succeeded in obtaining from bark of the second year's growth in India the same alkaloids, and in equal quantity, as from bark grown in South America. Since then, it has been shown that the *Cinchonæ*, when cultivated, not only yield their normal proportion of alkaloid, but that, in some species at least, this is susceptible of a large increase.*

First Importations from India.

Another stage has now been reached, since the first importation of Quinine-producing bark from the East Indies, as a commercial article, took place in August of 1867. This first consignment was the product of six hundred small trees of *C. succirubra* (Red Bark), grown at Ootacamund, and on the Denison estate, and cut down and sent into the market by way of experiment. It was all contained in three large chests; thus showing that the plantation was far too young to afford, when thus treated, any adequate return to the cultivators. Moreover the chests, numbered respectively 1, 2, and 3, were by no means of equal value; although it so happened, that when exposed to public sale they brought nearly the same price per pound,—a circumstance tending to mislead the grower. The contents of No. 1 consisted in the bark of the stem; No. 2, of the large branches; and No. 3, of the small twigs; and these last were so poor in the yield of alkaloid that, when added to No. 2, the whole produce of the latter two chests would not have more than equalled that of the No. 1, containing the fine stem-bark. This was really fine, although the proper red colour of the bark itself was not yet developed. It consisted in pieces sometimes two feet in length, doubly curled inwards upon themselves, being not more than one-sixteenth of an inch in thickness. The diameter of the trees, for the time of growth, must have been large. The external appearance was long-wrinkled, with some slight cross cracks and protuberances, and in places traces of commencing lichens. Dr. De Vry informs me that No. 1 of *C. succirubra*, from Sir W. Denison's plantation, gave him 6·8 alkaloids, containing 2·85 Quinine. The rest was Cinchonidine, with a small quantity of Cinchonine. One of his former pupils obtained from this bark, by repeated decoctions with water, thirty-eight per cent. of extract, whilst American bark very seldom produces more than twenty-five per cent.

This first importation was attended with a curious result, which, having some possible bearing on the future, it may be well here to notice. It appeared that the bark, when submitted as usual to the examination and chemical analysis of those proposing to become purchasers, was differently estimated in England, France, and Germany. In England and France the variation of estimate does not demand notice,—depending in part on the mode in which the averages were taken; but in Germany a different result followed,—the agent for one manufacturer declaring that it contained no Quinine, but altogether another substance. I have shown that this species is particularly difficult to analyse; and it is quite probable that this chemist obtained all the product as Kinovate of Quinine, which would account for the statement. At all events it is important to let this incorrectness be known, since otherwise the notion may be propagated again so as to disquiet the minds of the cultivators. This effect, however, might not be injurious, if it operated as a check to over-production, which the map of the district published by Mr. Markham suggests (from the number of the plantations) as the chief danger to be now dreaded.†

Nothing can be more satisfactory than the luxuriance of the young trees in some situations. This is

* See in Appendix, First Report on the Bark and Leaves of *C. succirubra* grown in India, by J. E. H., to the Under-Secretary of State for India.

† Attempts at culture of the *Cinchonæ* have also been made, with more or less success, in Jamaica, in the Island of La

well shown in a photograph which Colonel Scott has recently had the goodness to send me of a portion of his plantation.* The characteristic features of the *C. succirubra* and the *C. nitida* are very manifest in this Plate.

The first instalment of the produce of the plantations in Ceylon, consisting of two small chests, has recently (April, 1868) been sold by public auction in London. The bark was that of *C. succirubra* and of *C. officinalis*, of only three years' growth, and consequently very immature. The bark of the *C. officinalis* was ascertained to contain already a good proportion of Quinine, having found a climate suited to its development.

The price per pound which was commanded in the open market for home consumption was higher than that of South American bark of the same age and species, since it proved to be superior in yield of alkaloid to that derived from the tree in its native habitat. Cultivation, in fact, had produced its usual effect, by removing as far as possible injurious agencies and surrounding the plant with circumstances qualified to secure its growth and vigour.

This is the favourable side of the question; but it must be admitted that the increase is slow, although fostered by the genial climate of the mountains of India, and that cultivators must make up their minds to wait longer than is convenient for returns from their outlay of capital, unless the production of bark can be in some manner accelerated.

Mossing the Bark.

Under these circumstances, it is well that Mr. M'Ivor should have discovered the plan of renewing the bark, after it has been removed from portions of the tree, by the simple application of moss, kept continually moist, thus allowing the plant time and favourable opportunity to repair the damage done to its structure. This damage would otherwise be fatal to the whole scheme, and hence the old writers exclaim against the injury thus inflicted upon the trees at Loja,† where the experiment of partial decortication was first tried. I received from Mr. M'Ivor, in 1864, a section of a tree which has been thus treated in India, and which most conclusively shows the great amount of injury it had received. Not only is the woody portion less developed than would normally have been the case, where the bark has been removed on the two opposite sides, but the wood itself is also partially deprived of its vitality and tending towards decay.

Mr. M'Ivor tells us that his "idea of artificially applying moss to the bark of our Cinchona plants originated from the fact that the best Cinchona bark of commerce is invariably overgrown with moss. Hence the supposition that moss preserved the alkaloids from the process of oxidation or deterioration, which they apparently undergo when the bark is long exposed to the full action of light."‡

This is an interesting account of the mental process through which the discovery was originated, and it is to be regretted that in describing it Mr. M'Ivor should have named *moss* instead of *lichen*, the closely-adhering thallus of the various sorts of which does no doubt produce effects similar to those described.§ "Moss" is scarcely ever seen on good barks, except on branches which have trailed along the ground.

Mr. M'Ivor's plan is thus described by himself|| :—"In removing the strip of bark, two parallel cuts should be made down the stem at the distance apart of the intended width of the strip of bark; this done, the bark is raised from the sides of the cut and drawn off, beginning from the bottom; care being taken not to press or injure the sappy matter (*cambium*) left upon the stem of the tree. This *cambium*, or sappy matter, immediately granulates on the removal of the bark, and being covered, forms a new bark, which maintains the circulation undisturbed." Mr. Broughton says in a letter to me (December 27, 1867):—

Réunion, in Guadeloupe and in Martinique, in Algeria, Rio de Janeiro, St. Helena, the Canaries, and the Azores, at Melbourne in Australia, in the Caucasus,—probably also in other places. Java, British India, and Ceylon, I need not again mention.

* Taymullay, near Soonda-betta Peak. See Markham's Map of the Neilgherries.

† See III. Nueva Quin. *sub voce* *Uritusinga*, p. 3.

‡ Return, etc. (as above), p. 167.

§ And yet lichens *tied upon* the barked trees are injurious, and to be carefully rejected, as generating a fungus which injures the wood of the plants (see the same page).

|| Return, etc., p. 167.

"If the cambium be not injured, fresh bark seems always rapidly to grow. I have found also the quality improved almost as if by mossing." Let us then in the first place seek to get a clear idea of this cambium, according to the most recent researches into its structure and functions.*

The Cambium.

If we examine the stem of a tree in winter, or during the period of complete rest, we find between the last-formed layer of wood and the bark a layer of cellular tissue. It was formed in the course of the preceding year by the influence of the nourishing sap descending between the bark and the wood. This matter appears at first as if in a liquid state, and constitutes that which is called the cambium, so named first by our countryman Grew, whose quaint, but for the time wonderfully accurate account, I subjoin.† By degrees this cambium becomes organized into a tissue, in which all the phenomena of the growth of the stem in width seem to originate. At the first return of spring the nourishing sap flows abundantly into this generative layer and swells up its component parts. This zone is composed of tolerably regular cellular tissue. Insensibly, by the progress of vegetation, a large number of these cells become longer, their cell-walls thicken, and soon present all the character of fibrous tissue. Coincidentally with this transformation, a certain number of cells dispersed in the midst of the others increase in diameter and in length, their walls present transparent punctuation, and they become converted into radiated or punctuated vessels. These vessels and these tubes form bundles separated by a cellular tissue, which keeps its primitive form, and, after some time, all the interior of the generative zone becomes organized into a new woody layer, which adheres to and forms part of the previously-formed wood. At the same time in the portion of the generative layer which is in contact with the bark, a certain number of cells undergo similar transformations, assimilating them to, and preparing them to form a new portion of bark.

The time when the sap thus begins to flow into this generative layer was chosen by M'Ivor as the most favourable for the removal of the bark; it is then easily separated from the wood, and I found the bark thus gathered to be in excellent condition, and rich in alkaloids.‡ This flow of sap takes place at different periods, according to the climate, but there seems to be always a period of rest and of renewed spring of vegetation.

Mode of Renewal of the Bark.

It will thus be seen how important it is to understand thoroughly not only the conditions under which the renewal can be effected, but also the mode in which it takes place. On this point I have not met with any clearer information than is afforded by the celebrated French botanist M. Trécul, in several memoirs presented to the Academy and afterwards published in the 'Annales des Sciences Naturelles.'§

M. Trécul|| not only furnished new proofs of the co-operation of the wood and the bark in the formation of new annual layers, but also demonstrated—which is very important—that each of these two fundamental parts of the branch, when artificially isolated, may give rise to the production either of wood or of bark.

Messrs. Duhamel, Meyen, and others, had previously asserted that when a portion of the wood of the trunk is laid bare, and that the portion thus decorticated is so ordered as to be preserved from desiccation

* Richard, 'Nouveaux Éléments de Botanique,' p. 167.

† "The sap, passing into the cortical body, through this (as through a *Manica Hippocratis*) is still more finely filtered. With which sap the cortical body being dilated as far as its tone, without a solution of continuity, will bear, and the supply of sap still renewed, the purest part, as most apt and ready, recedes with its due tinctures from the said cortical body to all parts of the lignous,—both those mixed with the bark and those lying within it. Which lignous body likewise, superinducing its own proper tinctures into the said sap, 'tis now to its highest preparation wrought up, and becomes (as they speak of that of an animal) the vegetative *ros* or *cambium*, the noblest part whereof is at last coagulated in and assimilated to the like substance with the same lignous body."—'The Anatomy of Plants, with an Idea of a Philosophical History of Plants,' and several other Lectures, read before the Royal Society, by Nehemiah Grew, M.D., F.R.S., 1682, book i. p. 15.

‡ Report, 353, pp. 181, 182. § Ann. des Sc. Nat. 1853, t. xix.; ibid. 1854. || Duchartre, 'Éléments de Botanique,' p. 282.

and from atmospheric influences, there are seen exuding from the surface of the wood, gelatinous protuberances,—*mamelons*, as they were named by Duhamel, or gelatinous drops, as they were called by Meyen.* These productions, after they have become multiplied in number, and extending nearer to each other, at length become hardened and organized as fresh bark. Duhamel looked upon this as an organizable liquid. Meyen noticed that this exudation, from the first moment when it shewed itself at the extremity of the medullary rays, was composed of a very delicate cellular tissue, the cells of which contained a gummy mucilage; but M. Trécul first clearly showed that these new productions are *from the beginning composed of cells*, and that these cells, which have a gelatinous appearance, are produced by those of the generative layer (*couche génératrice*), which remains on the surface after the bark has been removed. It would seem, indeed, that where these have been removed by the abrasion of the whole surface of the wood, renewal of the bark does not take place. It will be seen how strongly these views confirm the practical value of the plan of M. Ivor.†

We have seen that the one special condition of renewal is that the surface of the denuded wood should be constantly kept moist. In the year 1852 M. Trécul submitted to the Academy the trunk of a tree (*Nyssa angulisans*) brought from Louisiana, where it had been protected by the shade of a damp, marshy forest from the direct action of the sun. It had been deprived of its bark for the space of sixteen or seventeen inches all round the stem, and nevertheless not only continued to grow, but bore leaves and fruit. Fresh layers had begun to form, not only in connection with the bark both above and below the decorticated portion, but also on the surface of the wood deprived of its bark. Oblong or hemispherical projections covered with bark of a greyish colour, having as yet no contact with the remaining bark of the tree, grew as represented in the accompanying Plate. Well-executed representations of microscopical sections of these renewed portions are added. *This formation appears to be connected with prolongation of the medullary rays*, and, in addition to a fibro-vascular structure, there are seen, as in the Plate No. 18,‡ *some punctuated and radiated vessels*. The projections themselves partake of the nature of wood rather than bark, in this respect differing from the perfect bark obtained by mossing.

Origin of the Renewed Bark.

As it seems to be demonstrated that the most profitable mode of cultivation will be the renewal of the bark under moss, as described above, it becomes a very important practical question to consider whence the fresh and very rich materials are derived out of which the new bark is elaborated.

In order to arrive at the truth in this matter, it is necessary to pass in review some ascertained facts in reference to the course of those fluids in the plant, by means of which it is nourished and increased. It is through the roots, which are continually extending, and, as it were, going in search of nourishment, that the plant absorbs from the soil a large quantity of water and of common air,—both of which are needful to its existence. It also receives various earthy salts, of which it appears, from the most recent research, to have the power of admitting some and rejecting others.§ As is well expressed by Grew in his 'Anatomy of Plants' (Book i. p. 15), "The contiguous moisture, by the cortical body, being a body lax and spongy, is easily admitted; yet not all indiscriminately, but that which is more adapted to pass through the surrounding cuticle." The liquid thus absorbed by the roots rises through the fibro-vascular system. It is an essentially watery liquid, and contains only traces of certain principles,—gum,

* I have not met with any chemical analysis of this organizable matter, but suspect, from imperfect experiments of my own, that *hydrate of silica* (in some soluble form) plays an important part in it.

† Mr. Broughton writes (March 16, 1868):—"I have long remarked that the bark, when carefully removed without injury to the cambium, quickly renews itself from below, not from the edges. The analysis made of bark so renewed, of six months' growth, has at present corroborated your statement respecting the old practice of the *casarilleros*." ‡ *Sciences Nat. Botanique*, 1852.

§ See a very interesting paper, "De la Répartition de la Potasse et de la Soude dans les Végétaux," lu par M. Péligot, à l'Académie des Sciences, le 4 novembre 1867, 'Annales de Chimie et de Physique.'

sugar, albumen, gluten, and other material in solution. But during the progress of vegetation, the proportion of these matters becomes increased, and when the sap has arrived at the extremities of the plant it contains more organic principles than when collected in the vicinity of the roots. In the trees with soft wood the ascent of the sap takes place through the whole extent, in others apparently in the sap-wood only. This, which is generally called the ascending sap, is attracted to the leaves and to all the external parts of the plant, having in itself, it is said, no power to convey nourishment; but it is submitted in the leaves, in a very curious and complicated manner, to the action of the atmosphere and of the light, by means of which most important changes occur: carbonic acid is decomposed and the oxygen driven off; chlorophyll is elaborated, together with many other less marked products. The sap, which is fraught with these and now fitted for nutrition, and called the descending or nourishing sap (*sève nourricière*) makes its way downwards, and is attracted to every part of the plant where its presence is needed, the ordinary channel for its course being the portion belonging to the outside of the woody structure and internal part of the bark, in which increase very manifestly takes place at every fresh period of the growth of the plant. This course of the descending sap may be traced down even to the roots; and, as I have mentioned in previously published remarks, also laterally by the medullary rays, specially near the base of the stem, thus furnishing a channel for throwing into the ever-active circulation of the sap some of the substances which have been elaborated in the bark, and which may be carried by the ascending current to fulfil important purposes in other regions of the plant.*

If this circulation of the ascending and descending sap be entirely checked, of course the tree perishes; but there seems to exist considerable adaptability in seeking out fresh channels when the old ones are partially closed. Thus we familiarly observe old trees, of which the heart-wood has entirely perished, carrying on a vigorous ascension of the sap through what little may remain adhering to the bark; and, on the other hand, cases sometimes occur as in the trunk of a celebrated lime-tree at Fontainebleau, (described in the 'Annales des Sciences' for 1855). This tree was planted in 1780, and in the year 1810 was deprived of bark round the trunk for a considerable space; and, although this was so far from being renewed that decay affected the wood to such a depth that the diameter of the tree was at length reduced by three-quarters, it grew and apparently flourished till the year 1854. In this case the whole circulation must have been carried on in the centre of the tree, whilst the surface was being destroyed, showing the power of adaptation to circumstances which exists in the vegetable kingdom. An instance of the same adaptability, but in an endogenous plant, has just fallen under my notice in an account of the Great Dragon Tree (*Dracæna Draco*) of Orotava, in Teneriffe, described by Humboldt, which perished in a gale last autumn. "When I visited it in February," says Signor Fenzi, the writer of the description, "it was still in excellent health,—its immense crown covered with innumerable panicles of scarlet fruits, and the huge trunk, although completely decayed in the interior, sustained vigorously the spreading mass of fleshy branches and sword-like foliage. Its circumference was about seventy-eight English feet, while the total height did not exceed seventy-five feet; and it was remarkable that through some crevices in the trunk a small *Dracæna* was seen growing spontaneously in the decayed substance furnished by the parent-tree."

The sap must in this case have risen for many centuries in the outer portion of the trunk.

Having thus rapidly passed under review some preliminary observations in reference to the circulation of the sap in plants in general, I now proceed to consider a question which must be looked upon as practically important in reference to the cultivation of the Quinine-producing plantations in India. I have found by analysis a steady improvement in the bark renewed over spaces that had been previously decorticated, having received from Mr. M'Ivor specimens of the first, second, and third time of renewal. The structure, as exhibited microscopically,† also shows a manifest and gradually perfected building-up of

* Illustr. of Nueva Quin. Micr. Obs. p. 2.

† Mr. Broughton also says (March 16, 1868), "A microscopic examination shows no difference in structure between it and the mossed bark."

the tissues and component portions of the bark.* This is not more wonderful than many similar facts, both in the animal and vegetable world; but the truly remarkable circumstance is the very large amount of alkaloid found in the bark of the third time of renewal, in a state also easily purified and better fitted for the extraction of Quinine than the bark in its normal condition.

Is this state of things to last and become permanent, so that by continually stripping the trees of portions of their external covering, it should become in the same proportion more rich in the very product that we need? This seems very improbable; and yet it is the conclusion to be arrived at from the above experiments; and even theoretically considered, it may not be so unlikely as at first it appears. If the Quinine, like the chlorophyll, had to be elaborated almost entirely in the leaves, I confess that such a result would seem very unlikely, as it would render a more vigorous condition of the leaves necessary, or else a more abundant production of these respiratory organs of the plant; and it is quite certain that nothing of the sort could happen from the removal of the bark. Moreover, chemical analysis comes in aid of our conjectures, and shows conclusively that the leaves are so far from being a chief seat of the alkaloids that they possess only a trace of these.

Neither can the bark which remains round the decorticated portion be looked upon as the chief source of supply of alkaloids, more particularly since the following experiment of Mr. Broughton seems conclusively to show the contrary, and that, instead of finding an increase in the alkaloids in such a case, the reverse is the fact. In Mr. Broughton's Report for April, 1867, he says:—

"It appeared to me that an examination of the bark that had been renewed by natural processes, without the aid of moss, would possess considerable interest. It was suggested by a statement in Howard's 'Nueva Quinologia of Pavon,' and also given on the authority of Ruiz. I was able to obtain a small quantity of such renewed bark from two *succirubra* trees, which had been injured and partially stripped of their bark by the falling of a log in October, 1864. The renewed bark was thicker than that of the natural bark, measuring 0.19 to 0.22 inch, instead of 0.16, and had replaced itself *mainly from the edges of the wound, not from the surface, as is the case with mossed bark*; but its analysis gave but 5 per cent. of alkaloids, of which about 3.25 appeared to consist of Chinchonidine and Chinchonine."

This experiment seems to me important, as tending to the conclusion that the sap which is conveyed from the adjoining bark does not contain all the materials needful for the abundant production of Quinine and the other alkaloids. Nehemiah Grew was perhaps right in saying "that the concurrence by two specifically distinct fluids is as necessary to nutrition in plants as in animals."† Whence then can the cambium derive these supplies if not from the heart-wood?—a source which, as we have seen by the appearance of the sappy matter at the end of the medullary rays, is already rendered probable.

Mr. Broughton remarks, in a letter dated March 16, 1868, "I have long remarked that the bark, when carefully removed *without injury to the cambium*, quickly renews itself from below, *not from the edge*. The analysis made of bark so renewed, of six months' growth, has at present corroborated your statement respecting the old practice of the cascarilleros, as being richer in alkaloid than the original."

Mr. M'Ivor writes,‡ "the new bark rises direct from the sap-wood if the old bark is carefully removed; *in three days the new bark is formed entirely over the whole surface, i. e. rising directly from the sap [wood]*, and not formed by a current of cambium from under the remaining bark; as, in the general opinion, is the manner in which all wounds are repaired."

The Heart-wood.

The heart-wood comes next in review as a possible source of alkaloid. My attention was directed to the examination of it for Quinine by a letter from Mr. Broughton, in which he mentions, in the following

* "Les jeunes tissus végétaux, ceux de la couche génératrice en particulier, ont la propriété de se modifier, de se métamorphoser pour produire tel ou tel organe dans telle ou telle situation, suivant les besoins de la plante."—Trécul, *Ann. des Sciences Naturelles*, tome xvii. 1852, p. 276.

† 'The Anatomy of Plants,' book iii. p. 131.

‡ In Letter, 3rd June, 1868.

terms, his discovery of Quinine in the wood of *C. succirubra*:—"The most interesting point I have ascertained lately is the presence of alkaloid in the older heart-wood of the Red-bark tree. This amounts to 0.10 per cent of the weight of the wood. I have obtained it as a crystalline sulphate. The most remarkable instance is that of a tree which, though rich in alkaloids, contained no Quinine, but Quinidine. To my great surprise, *the whole of the wood-alkaloid was Quinine.*"

Now, since the weight of wood is to that of the bark as (perhaps on the average) 10 to 1, we should, in such case, be at once furnished with a kind of inexhaustible storehouse of alkaloids for the renewed bark, and should have discovered the very thing of which we were in search.

In order to obtain further information on this point, and to trace the results of the flow of sap as above described, I took some portions remaining of a Red-bark tree, part of which was sent me in the year 1860 from the Mountain Chahuarpata, in the Province of Alausi (South America), and which I have elsewhere described,* subjecting them to examination as below.

Root of Red-bark tree, 10 inches in diameter, solid, heavy, almost like box-wood:—

1.—1750 grains, acted upon by distilled water and a warm temperature for several days. The loss of weight, 25 per cent., consisting of water, gum, some impure Kinova-bitter, with oxidized colouring-matter, and combined with a trace of alkaloid.

I use the term Kinova-bitter as a name for this glycoside, which is not pure kinovic acid. (See my Illustr. Nuev. Quin. *sub voce* *C. magnifolia*.)

2.—The remainder, fully dried, was submitted to the action of ether, which formed a light yellow solution, which, evaporated, left 0.10 per cent. of the substance previously described as "Cinchotannic acid" or "mother-substance" (described further on).

3.—The residuary portion was acted on by spirit of wine, which dissolved out an additional 0.17 per cent. of the above substance (making, with that before mentioned, 0.270 per cent. of the wood examined), together with 0.330 of oxidizable resin, some part of which (when the above substance had been separated by ether) would not again dissolve in spirit, appearing to have been changed into humus. A similar change took place on the addition of solution of permanganate of potash to the mother-substance.

4.—Another portion, 3500 grains, was subjected to the action of lime-water, the filtered solution precipitated by hydrochloric acid, the Kinova-bitter dissolved in spirit of wine (and thus separated from about 1 per cent. of oxidized colouring-matter), and then evaporated, gave 1.60 per cent.

5.—A portion of the woody fibre was calcined and examined by my son, W. D. Howard, with the following result. The proportion of ash to weight of wood was 0.55 per cent., consisting of—

Carbonate of lime	0.121
Carbonate of potash	0.159
Carbonate of manganese	0.031
Silica	0.097
Phosphates of iron and alumina, and peroxide of iron	0.062
Loss and undetermined, which includes some carbonate of soda	0.080
	<hr/>
	0.550

6.—3500 grains, as above, were treated for the extraction of the alkaloids, and yielded 1.00 per cent. of rough and impure precipitated alkaloid, which partially dissolved in ether; the addition of oxalic acid to this solution did not cause a crystallization, and the Quinine present appeared to be in a peculiar state. I did not succeed in this experiment in getting a quantitative result; the next was more successful.

7.—Another portion, of 3500 grains, gave, of alkaloids soluble in ether, per cent.

Quinine and Cinchonidine	0.41
Cinchonicine	0.05
	<hr/>
	0.46

In both these experiments the presence of the peculiar resin, elsewhere described, to the extent of at least 1 per cent. of the wood, rendered crystallization of the sulphates difficult.

In order to follow the course of the ascending sap, I took a portion of the stem-wood of the same tree, measuring about 23 inches in circumference, and having split off the outside till the circumference

* See Illustr. Nuev. Quin. *sub voce* *C. succirubra*, p. 4.

was reduced to 18 inches, I examined the two portions separately, first the heart-wood, and then the more external ligneous portion, as under:—

1.—Heart-wood, 3500 grains in powder acted on by lime-water, and, as above (No. 4), gave of Kinova-bitter 1.13. This was not implicated with so much colouring-matter as in the root-wood.

2.—3500 grains, examined for alkaloids, gave—

Soluble in ether—Quinine, etc.	0.10
Soluble in spirits of wine—Cinchonine	0.03
„ „ „ Do., with resinous or colouring-matter*	...
	<u>0.13</u>

3.—Outside wood of stem. 3500 grains, treated as above for Kinova-bitter, gave (after separation by spirits of wine of a trace of colouring-matter), Kinova-bitter, 1.20 per cent.

4.—Examined for alkaloids, gave—

Soluble in ether—Quinine, etc.	0.09
Soluble in spirits of wine—Cinchonine	0.03
„ „ „ Do. with resinous matter*	...
	<u>0.12</u>

Showing apparently a trifling increase in the kinova-bitter, and *possibly* a corresponding slight diminution in the proportion of alkaloid towards the outside of the wood.

In order further to examine the stem-wood, I took another portion (of 7000 grains), without separating the outer and inner bark. This enabled me to check the results previously obtained, and also, as being a larger quantity examined, to carry out more fully the purification and separation of the alkaloids, which, in such small quantities, is proportionally difficult.

1.—7000 grains were treated with ether for extraction of the mother-substance, of which nearly 2 per cent. of the weight of the wood was obtained.

2.—The remaining woody fibre, digested with water, gave, of gum, kinate of lime, and some colouring-matter, not quite 2 per cent. of the weight of the wood.

3.—The remainder, digested with lime-water (and as above), gave, of Kinova bitter, implicated with 0.05 colouring-matter, 1.138.

4.—The remainder examined for alkaloids gave, as a rough precipitate, 0.37 per cent., or, as refined, 0.171, after separation of some adherent resin (chiefly) and wax, but also loss of alkaloid, as it had been very carefully purified; and, on solution in ether and addition of oxalic acid, gave a good crystallization of oxalate of Quinine.

Quinine	0.043
Cinchonidine†	0.030
Quinidine,‡ and soluble Cinchonine§	0.041
Cinchonine||	0.033
Cinchonicine	0.024
Total	<u>0.171</u>

* Very impure.

† Separated as hydriodate.

‡ Crystallizes as hydriodate; gives fine characteristic crystals from ether, and a green colour with chlorine and ammonia.

§ Under the head "Soluble Cinchonine" I include provisionally an alkaloid near to Cinchonine, but quite soluble in ether at 0.730, at ordinary temperatures. As I was desirous of having the opinion of Dr. Herapath, especially about its iodo-sulphate, I forwarded this gentleman a small quantity, from which he obtained the following results, in accordance with mine (as far as these latter went):—

1st. It crystallizes in long, rectangular prisms, having bihedral summits.
2nd. It furnishes a highly fluorescent sulphate in solution, having the same optical effects as Quinine and Quinidine, as far as the epipolic dispersion is concerned.

3rd. It gives, with chlorine and ammonia, a white precipitate, without any trace of the green of Quinine and Quinidine.

4th. It does not form an iodo-sulphate on a plate of glass, Quinine does (even if first made into a sulphate), but amorphous resin only.

5th. By spontaneous evaporation of a solution in a tube it furnishes black *aciculae*, having a purplish reflection, almost all opaque, but when thin enough to transmit colour, intensely blood-red; but very thin plates transmitted a deep brown-yellow.

6th. It is probably a new modification of Cinchonine, differing by a molecule of water from (*Huanokin*?) Compare the *two Cinchonidins*. (Ann. d. Ph. und der Ch. 1868, p. 325.)

|| Separated from the residuary liquor, insoluble in ether; soluble in and crystallizes from spirits of wine.

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It follows, from these experiments,* that the Mother-substance can be separated without any interference with or diminution of the weight of the kinova-bitter.

Also, that the alkaloids must be in a state of combination rendering them insoluble in water, as there was no evidence of their presence in any quantity in the gummy solution, which gave a brown, oily sublimate by Grähe's test. This agrees with the probability of their existing as combined with kinovic acid, and not with kinic acid, of which last the traces were very faint. Ammonia, in some combination, was very manifestly present.

I was surprised to find Quinidine well ascertained in the stem-wood, but, on referring to what I before published,† I see that I obtained Quinidine crystallizing as hydriodate from the inner and not from the outer bark, which shows a coincidence that can scarcely be accidental. In my present examination of the bark of *C. Almaguerensis* (which resembles red bark) I notice a similar result.

The heart-wood of young plants of *C. succirubra*, sent me by Mr. M'Ivor, in 1863, gave me an opportunity of examining the results of eighteen months' growth. Here there was not yet the true compact ligneous structure; and, on examination, I was unable to detect any of the mother-substance above mentioned, but kinova-bitter, gum, and some chlorophyll were present. The presence of the latter shows the immature condition of the wood in these specimens, which were gathered during a season of much rain, and in the full flow of the sap. I did not recognize in them any alkaloid.

The Leaves.

The leaves come next in the course of the ascending sap, and it is in these that we may expect to find its constituent principles more concentrated. We have to consider, in connection with these, the results of their exposure to the atmospheric influence, the fixation of carbon, the throwing off of oxygen under the influence of the light of the sun,—in a word, the well-known processes of vegetable assimilation and growth. I find in the leaves—ammonia, in some combination, abundant; chlorophyll in the second modification described by Berzelius, which, in combination with hydrochloric acid, gives a most lovely emerald colour,—a valuable dye, if it could be fixed in that state. It is indeed, as remarked by Berzelius, to be ranked amongst dyeing substances, though not amongst those giving fast colours. I also find the zanthophyll of Berzelius, and perhaps another modification of chlorophyll, which, under the influence of chlorine, gives rise to red and pink colours, such as are visible in the fading leaf.

I first showed the presence of alkaloids in the leaf in the following Report, given in June, 1863:—

"The absence of any carmine sublimate by heat‡ led me at first to an unfavourable conclusion. The decoctions and infusions made by M'Ivor, though in perfectly good condition, showed that the contents changed most rapidly under the influence of the oxygen of the atmosphere, as soon as ammonia was added to the, at first, decidedly acid liquor. Fortunately, a good supply of several ounces of dried leaves had been sent over, and from these I succeeded in obtaining Quinine, though in very small quantity, but presenting its usual characteristics . . . but nevertheless showing a characteristic implication with resinous or extractive matter, such as is usually met with in the very smallest quills or canutillos of South American bark, in analysing which it is frequently difficult to purify the Quinine from this adhesion. I obtained first from these leaves to the extent of 0·11 of alkaloid, of which part was soluble in ether, the remainder in spirits of wine, and afterwards, 0·19 of precipitate, still more combined with

* Another examination of stem-wood gave, by different process,—

(Quinine?) alkaloid soluble in ether, sp. gr. 0·714	0·129
Cinchonidine (soluble in ether, sp. gr. 0·730)	0·029
Cinchonine (and Quinidine?)	0·070
Cinchonicine	0·029
	<u>0·257</u>

The total amount is here more correct than in No. 4, as there was less loss of alkaloid soluble in ether. The qualitative estimate better in the above.

† 'Microscopical Observations,' p. 6.

‡ Grähe's test (Chemisches Centralblatt), March, 1860.

astringent matter. From these data, it seems to follow that the leaves will not supply a material for the extraction of Quinine, but that they will nevertheless be very useful when used fresh or in recently prepared decoction or infusion for the cure of the fevers of the country."

Towards the end of June, 1863, Dr. Anderson, of the Botanic Gardens, Calcutta, began, with Dr. Simpson, to examine chemically the nature of the leaves of *C. succirubra*, and reports, on the 25th July, having obtained "little needle-shaped crystals in a fluid obtained from the leaves of the Cinchona." In a subsequent letter, dated the 7th August of the same year, Dr. Anderson says, "I have the honour to inform you that I have to-day received intelligence from England of the discovery of Quinine in small quantities in the leaves of Cinchona sent from this country. Quinine obtained from the leaves was exhibited by Mr. Howard, at the meeting of the Linnean Society, London, on the 18th June, 1863."

In December of the same year, I gave a further report on the leaves, which I subjoin:—

"Several pounds' weight of leaves (well dried, and with a marked tea-like fragrance) have allowed me the opportunity of following various lines of experiment in order to ascertain their probable commercial value. I regret to be obliged to confirm the opinion I expressed in my last, that the leaves will not supply material for the extraction of Quinine, although the quantity of the first rough precipitate from an acid solution—having the appearance of a hydrated alkaloid—is considerably more than I succeeded in obtaining before, being equal to 1.31 per cent. of the weight of the leaves. Of this, a small portion was soluble in ether to the extent of 0.17 per cent.,* forming a clear yellow solution, which precipitates on the addition of a solution of oxalic acid in spirit of wine. Nevertheless, the further prosecution of the inquiry, and the attempt to purify the alkaloid, showed me clearly that I had to do with a state of things *very different from that which existed in the bark*, and that I should not succeed in obtaining an available salt of Quinine."

I remark further that "the alkaloid exists in the leaves in very intimate relationship with the green colouring-matter" (chlorophyll), and this is important in reference to the present investigation, for if the leaves were called upon for a fresh flow of sap, descending at once to where the denuded portion of the wood called for fresh clothing, it is but reasonable to suppose we should find something of the same very marked peculiarity,—as is, indeed, always characteristic of the bark of the young twigs, which stand next to the leaves in the nature of their product, as they do also in course of the sap circulation. So far from anything like this being the case, we have markedly the reverse characters; indeed, the presence of chlorophyll (though so important an element in the vigour of the plant) seems not correlative with that of the alkaloids, and it is entirely absent in the rich renewed bark of the *C. succirubra* as received from the East Indies.

Dr. Herapath has found optical results of very considerable interest arise from examination of the above constituents of the leaves; especially an alcoholic solution of the chlorophyll which I sent him gave in the spectroscope extraordinary results, agreeing with the properties of chlorophyll from the leaves of hyoscyamus, digitalis, tea, senna, and some other plants. Dr. Herapath remarks truly, "There must be some cause why solutions which have such equally green tints to the eye should present such different optical effects, and the most probable is the existence of different substances in these leaves."

Course of the Ascending Sap.

Next to the leaves come the very small twigs, which seem to partake more of the character impressed by the ascending than that of the descending sap. I quote as an illustration from my report (June, 1864) on "Bark from the spray or small portions of the same branches as No. 1:"—"From this I did not succeed in obtaining more than 0.90 per cent. of impure alkaloid, which lost one-half in the attempt to purify, since the alkaloids are much implicated with tannin (apparently) and not capable of easy crystallization."

* In April, 1867, Mr. Broughton reports that from four pounds of the leaves of *C. succirubra* he "succeeded in obtaining 3.10 grains of alkaloid, of which about one grain was soluble in ether, and gave a faint indication of Quinine when tested with chlorine-water and ammonia."

It will be seen that this amount ($= 0.45$) coincides almost exactly with the product obtained from the wood of the roots, which I have given above as Quinine and Cinchonidine, 0.41; and Cinchonine, 0.05; together, 0.46.

The increase in alkaloid in the bark of the larger branches of the same tree (sent as No. 1) was remarkable. These gave, of purified alkaloids, per cent.—

Quinine	3.14
Cinchonidine	2.06
Cinchonine	0.80
	<hr/>
	6.00
	<hr/>

I think I may fairly consider that in this latter case of the larger branches the descending sap must have come into play, together with the cell-formation of the cambium, as elsewhere described.

The Alkaloids formed in the Bark.

We have thus far traced the deposits of the ascending sap in its course from the roots, through the wood, to the leaves; and we do not find any reason to look upon either the wood of the roots, or of the stem, or of the more succulent and recently-formed portions of the ligneous structure as the seat of the formation of the alkaloids. In all these parts the proportion of alkaloid is insignificant when compared with that of the bark. In the root-wood, moreover, it is found in such a state as would naturally follow from its being deposited there (as combined with resin, which is a secondary and not a primary product of vegetation) after its downward course, such as I have described,* is completed, and then carried laterally from the root-bark by the medullary rays into the root-wood. In the outside portion of the stem-wood we find rather less alkaloid and rather more kinovic acid than in the centre-wood, and there is a smaller amount of resin, but a perhaps larger proportion of wax† associated with the alkaloids: they exist, in both, in a somewhat greater degree of purity than in the root.

When we come to the leaves, we find almost the same proportion of alkaloid as in the wood, but this amount not increased, as would surely be the case if the leaves were the seat of its formation. Nothing seems changed, except that here we find (as also in the very young wood) the presence of chlorophyll, which in the descent of the sap, appears gradually to degenerate in the bark of the small twigs into, or else to become mixed with, a tannin substance, and this again into resin. In tracing the course of the nourishing or descending sap, we find the alkaloids increasing *greatly*—not less than ten- or twentyfold, often much more—in their relative amount in the liber, as compared with the parts we have passed under review; and what is also very important, they are in a state of much greater purity, as if freshly formed. In the cellular envelope there is again a considerable increase, to the extent of 100 or 150 per cent. on the contents of the liber, and the alkaloids, or at least Quinine and Cinchonidine appear to be especially stored up in this cellular envelope, but this in connection ordinarily with various substances difficult to separate from them. In the mossed barks, and also, according to Dr. De Vrij, in the root-bark of the young plants of *C. Pahudiana*, from some cause—possibly from the absence of sunlight—the alkaloids seem to exist in the cellular envelope in a state of greater purity.

The review of the whole seems to point to the *bark* as the seat of the formation of the alkaloid.

In my 'Illustrations of the Nueva Quinologia'‡ I gave it as my opinion that the alkaloids were gradually formed, chiefly in the bark itself, and to this view (founded on practical observation of the increase of the proportion of alkaloid in the increasingly developed bark) I now return as the result of the more extended researches in the present volume.

* Illustr. Nuev. Quin. Microscop. Obs. p. 2.

† 'Microscopical Observations,' p. 2.

‡ Cerotic acid (saponifying with alkalies).

Ascending and Descending Sap.

TABLE TO SHOW THE INCREASE OF ALKALOIDS IN THE BARK.

The following Table presents in a concise form the result of the flow of the ascending and of the descending sap on the production of alkaloids:—

	Quinine.	Cinchoni- dine.	Quinidine.	Cinchonine.	Cincho- nicine and Sol. Cinc.	Total per cent.
<i>Ascending Sap.</i>						
Root-wood (Chahuarpata-tree)	0.410		. . .	0.050	. . .	0.460
Stem-wood (do.)	0.043	0.030	0.041	0.033	0.024	0.171
Leaves	*	*	*	. . .	*	0.170
Twigs	*	*	*	. . .	*	0.450
<i>Descending Sap.</i>						
"Canuto" of large branches	3.140	2.060	. . .	0.800	. . .	6.000
Bark of (4-inch diam.) branch of Chahuar- pata-tree	2.940	1.350	. . .	0.860	0.0250	5.175
Trunk (bark):—(a) liber or inner bark*	2.380	1.200	. . .	0.560	0.130	4.270
(b) cellular envelope	6.400	1.900	. . .	0.760	0.200	9.260
(c) first harvest of renewed bark	{ 3.750 } { 0.900 ? }	*	. . .	*	1.80	6.450
(d) second harvest of renewed bark	6.340	1.140	. . .	*	0.20	10.60 ?
(e) third harvest of renewed bark	{ 4.610 } { 2.000 ? }	1.140	. . .	. . .	0.053	11.20 ?
Root-bark, from Mr. Broughton's Report	2.150	3.850		. . .	. . .	6.000
Root-bark, Author's analysis	{ 1.031 } { 4.050 ? }	trace	trace	3.000	3.940 ?	12.750 ?
Do. De Vrij's analysis	4.031 ?	trace	. . .	7.440 ?		11.750

It will be seen that the twigs and the root-wood agree in their alkaloidal contents, and also the stem-wood and the leaves. The Quinine has diminished, and the Cinchonine increased as the sap draws towards the root. The Chahuarpata Red-bark-tree is the one previously described from Alausi.

Influence of Respiration.

The *respiration* of plants did not escape the acute observation and profound research of Nehemiah Grew, who says, in his epistle dedicatory to Charles II., that "even a plant lives partly upon aer, for the reception whereof it hath those parts which are answerable to lungs." The idea thus felicitously conceived has since been brought, by the researches of many observers, within the domain of actual science. In fact, the access of air to the internal portions of the plant, or in other words, its respiration, is so important to its welfare that it is found to be provided for in three distinct methods:—First, by the roots absorbing air, together with water, from the soil.† This has been compared by Bouchardat‡ to the functions of the *branchiæ* or gills in fishes, and is so needful that plants often perish from this supply being interfered with, as when, for example, a depth of earth is heaped over the roots of a tree. Secondly, by the curiously contrived *stomata* which constitute true respiratory organs of the leaves, analogous to the lungs in plants. Thirdly, by the vessels, reticulated or otherwise, which, having served the purpose of the conveyance of sap in the first spring of circulation, become gradually filled with air, and form channels of respiration, subjecting the fluids

* See p. 23, and also the Appendix. The (?) indicates a deduction of uncertain amount to be made for water, etc. The weight of acid, etc., is elsewhere in this table deducted.

† The experiments of Th. de Saussure prove that plants perish in a few days, if their roots are surrounded with hydrogen, with azote, or especially with carbonic acid, whilst they continue to live a long time if surrounded by common air. This botanist has also shown that oxygen, absorbed by the roots, forms carbonic acid in the interior of the vegetable, and at the expense of the latter; also, that if a root isolated from the stem is placed under experiment, the quantity of oxygen absorbed by it from the air does not exceed the volume of this organ; whilst, if a root attached to the plant is under examination, the absorption of gas becomes *much more considerable*.—Duchartre, '*Éléments de Botanique*,' p. 234.

‡ '*Recherches sur la Végétation*,' Paris, 1846, p. 153.

of all parts in which they are found to the vivifying action of the air they convey.* This is compared to the manner in which insects are supplied with air through the *tracheæ* which pervade their bodies. It has hence been called the *trachean respiration*.†

The general result is that the sap experiences modifications which change its nature. By *transpiration* it loses a portion of the water of which it was composed; by varied *secretions* it throws off certain products useless or foreign to its nutrition; and by its contact with atmospheric air—that is, its respiration—it acquires new properties, being converted into a fluid which descends from the leaves towards the roots, constituting what has been called the *descending* or, more properly still, the *nourishing sap*,‡ which seems to be attracted towards any part of the plant where special need exists for its services, as in the case we are here considering of the renewal of the bark after decortication.

As I have chiefly to treat of this kind of respiration which appears to be constantly going forward, though it has sometimes been named *nocturnal respiration*, and which supplies oxygen to the plant, I shall adopt for it the more correct term of *general respiration*; § in opposition to that peculiar respiration of the leaves and other green portions of the plant, by virtue of which, under the influence of sunlight, the carbonic acid of the air is decomposed, carbon is fixed, oxygen is disengaged, and the growth of the plant ensured. This latter has been named the *chlorophyllian respiration*, and on it all vegetable organization seems *primarily* to depend. Leaves, when once thoroughly exsiccated, lose the power of decomposing carbonic acid, and no restoration of water will renew this action.¶ The leaf, thus dried, dies, *because it ceases to breathe*; it is possible to kill it by suspending its respiration (by means of an artificial atmosphere of azote or some other gases) for a sufficient time, and that without the cells being injured, without elimination of the water essential to its organization, without any perceptible modification of the green colouring-matter. This is the *asphyxia* of leaves.¶¶

Researches of M. Decaisne.

In connection with these researches I heard of a work of M. J. Decaisne** on Madder which at once engaged my attention, as having myself studied the red colouring-matter of this plant, whilst occupied more particularly with that of the *C. succirubra*. I found, as I expected, considerable analogy, though not identity, between the two, as was to be looked for in plants so nearly allied botanically. I did not then pursue the subject: but when I read M. Decaisne's elaborate and very complete treatise, I was charmed not only with the clear and lucid style which, in common with his compatriots, he knows how to apply to scientific subjects, but also with the details of the investigation; throwing, as it seems to me, much light on the question, and, though published many years ago, not equalled, to my knowledge, by anything that has since been given to the public. He says, in the commencement of his preface, that he considered many of the principal facts and phenomena which he had to study might be explained by the knowledge acquired respecting the respiration of vegetables, and consequently the facts thus established became the point of departure of his experiments. The theory of the coloration of plants is dependent on the knowledge of the functions of the leaves, which are themselves pretty generally the seat of this coloration; and as the action of light exercises great influence on the respiration, which again is ultimately connected with the phenomena of the immediate principles of vegetables, he thought it was needful to study the action on the

* A. Richard, 'Nouveaux Éléments de Botanique,' Paris, 1864, p. 152.

† M. Dutrochet ascertained by experiment that the air contained in the different parts of the plant underwent a change in proportion to its distance from the orifices in the leaves, through which it must enter; as it circulates in the pneumatic vessels it loses a portion of its oxygen, which is absorbed by the sap in proportion as it traverses the vegetable tissue. (A. Richard, *ut supra*, p. 157.) Thus the air contained in the stem of the water-lily showed only sixteen parts of oxygen in a hundred, and that in the roots, only eight in a hundred.

‡ Duchartre, 'Éléments,' p. 716.

§ Duchartre, *ut supra*, p. 751.

¶ Boussingault, "Étude sur les fonctions des feuilles" (Ann. de Chimie et de Physique, mars 1868, p. 333).

¶¶ Id. p. 339.

** 'Recherches anatomiques et physiologiques sur la Garance.'

colouring-matter of the most powerful and universally extended principles, viz. light, air, and water, when supplied to the plant in different degrees of intensity. M. Decaisne thought that he ought not to limit this examination to the root of the madder, although it is this specially which is the depository of the colouring-matter so important in the arts. "All the parts of the same vegetable," he rightly says, "are tributary ('solidaires') the one to the other in their action, whether growing in the air or in the earth; and we only completely know the action of the one when the others have been carefully studied in their various aspects."*

The Plant an Organized Whole.

This is the conclusion to which I have also been brought—indeed, I might almost say—compelled to come; so that I place no faith in any of the theories of vegetation which isolate the different parts of the plant; but I agree with Kant, in what seems to me a clear definition, that "the cause of the particular mode of existence of a living body resides *in the whole*," and with Müller, from whose Physiology† I quote, that "there is in living or organic matter a principle constantly in action the operations of which are in accordance with a rational plan, so that the individual parts which it creates in the body are adapted to the design of the whole, and this it is which distinguishes organism."

I do not hold myself called upon to attempt to define the entity of that living principle or typical idea in the plant, of which nevertheless it seems to me to be needful to assume the existence, in order to understand the complete contrast which prevails between the totality of the phenomena of organization and those of crystallization.

There are in nature mysteries beyond the domain of science. Investigation fails, and all our study ends in this, that the invisible things of the great Artificer, even his eternal power and Godhead, are clearly seen by the things that are made. Therefore I consider with an author previously quoted‡, that "Nature and the causes and reasons of things, duly contemplated, naturally lead us unto God, and is one way of securing our veneration of Him." I also judge that "We may as well deny what God hath made *to be*, as what he hath spoken *to be true*, because we understand not *how*." I have no knowledge, for instance, how the *causa causans* gives rise to the *causa causata*, but I am assured that the acknowledgment of the great First Cause is essential to our forming any correct notion of secondary causes, or of the "laws of nature," as we *figuratively* speak.

It is, then, to the operation of this principle, which I may call the life of the plant, that I am obliged to trace the perfect re-establishment of the bark, with all its complicated parts and functions, over the places from which it has been removed by Mr. M'Ivor's process. I compared this at first—as, indeed, the first specimens sent seemed to justify—to the granulation of flesh over the surface of a wound, but the accompanying drawings under the microscope show the bark in the third time of renewal to be *perfectly* renewed, as is the case in the parts replaced by animals of low organization, as the claw, for instance, is formed again after being lost by the lobster.

The distinguished botanist M. Trécul remarks, "Not only do the elements of tissues thus denuded give rise by successive divisions to new formations, but they also undergo the most remarkable transformations to the same end; so that the woody fibre, the parenchyma of the medullary rays, and even vessels of small diameter, become metamorphosed into cellular tissue, the cells of which then become multiplied in their turn, and not only so, but this ordinary cellular tissue reproduces in its turn *new medullary rays, new*

* The vitality or growing power of plants seems to be pretty equally distributed throughout their entire structure. If destitute of any great visible centre of life, almost every portion of them, from the largest stem to the smallest bud, seems endowed with the power of establishing independent centres for itself. This potency and general diffusion of life-power enable each part of a plant to assist, to act and react upon every other portion; hence, if the top suffers loss, the roots make haste to make it good. In a similar way, if the roots are injured or removed, the top at once ministers to their healing and renewed production.—*The Gardeners' Chronicle*, July 4th, 1868.

† Vol. i. p. 19.

‡ See Grew's 'Anatomy of Plants,' ii. 79.

ligneous fibre, new punctuated vessels (reticulated or spheroidal), new laticiferous ducts." I have noticed in my Microscopical Observations on the Barks of the Cinchonæ that a similar metamorphosis takes place of all the constituents of the bark into cork as the vessels become pressed towards the surface.

I have now to refer to the accompanying drawings by Tuffen West, F.L.S., of sections of Bark from the East Indies, to show the complete reproduction of the substance of the bark, with all its parts in normal order and relationship to each other, and that nothing is wanting, only that the liber fibres are less numerous as being less necessary to strengthen the bark (thus shielded by the moss) against external influences, and consequently "the renewed bark is not so heavy as original bark," as I am informed by M'Ivor.

Looking upon the plant as an organized whole, it is not surprising that from its earliest development it should manifest some of its peculiar characteristics. This M. Decaisne found was the case with the madder, for in the first days of germination, and when the plant was not provided with any other leaves than its two cotyledons, it already contained the same sap, capable of acquiring a reddish tint from the air, which distinguishes the plant, and it followed, as the result of the experiments of this botanist, "that all the immediate principles obtained from the roots of the madder are but the chemical combinations of *one only product*, spread unequally through the whole vegetable."

This statement may possibly require some modification, but on the whole it contains the germ of much truth. I have in a previous work expressed a similar opinion as regards the most characteristic products of the Red-bark-tree in the early stages of growth. I cannot distinguish any remarkable peculiarity in the sap of the plant. It soon oxidizes and turns brown, it is true, but the full development of its peculiarities is reserved for a later stage of growth.* Nevertheless, I believe that the characteristic features of the plant are owing fundamentally to *one* substance. Indeed, when we consider the evident fact that all the complex products of the vegetable world (to say nothing of the animal, although so dependent on the vegetable) are built up out of a few simple substances, it must necessarily appear probable that the complexity is in a certain sense more apparent than real, as depending more upon the different arrangement than the actual diversity of the elementary materials. The aliments of plants must always be either liquid or soluble or gaseous; such only are capable of being taken up by the plant, either by its spongioles or through the stomata. All the solid parts, including even the wonder-working cell-structure, must then have originated in fluid,—*water* being both the means of conveyance of nutriment, and itself forming by far the larger proportion of most plants. Out of six simple non-metallic bodies—oxygen, carbon, hydrogen, nitrogen, sulphur, and phosphorus,—with the addition of the metallic—potassium, calcium, magnesium, and iron,—the whole *Cosmos* of vegetable growth around us takes its rise. It is doubtful whether any other elements† are absolutely indispensable to vegetation. To follow out, therefore, M. Decaisne's idea that the peculiar principle of the madder is *one*, we must reflect that the red colour which is so useful in the arts‡ is a chemical phenomenon totally independent of life. On the contrary, the yellow colour appears to be the result of a vital action which hinders the other, and "*depends on the membranes of the cells.*" To distinguish, then, between the yellow and the red products, is simply to follow the changes of *one substance* from its original formation through its different degrees of oxidation, or, in other words, of its degeneracy.

I have shown that the case is quite similar in reference to the Red-bark, that no red colour exists, in fact, in the living tree, except as it is modified in the flowers, and in the fading leaves or bracts, or in

* Pavon says respecting these, "In arborum corticumque amputatione, succum lacteum primum profluit: postea in colorem intense rubicundum transmutatur."

Spruce says, in a paper read before the Linnean Society, December 14, 1859, that his first care was to verify a report that had been made to him by the collectors, to the effect that the tree (*C. succirubra*) had milky juice. This appeared strange and incredible in the Natural Order Rubiaceæ. When a slit was made in the bark by a cutlass, it soon appeared that the sap is actually colourless, but the instant it is exposed to the air it turns white, and in a few minutes afterwards red. The more rapidly this change is effected, and the deeper the ultimate tinge assumed, the more precious is the bark presumed to be.

† My belief is that molecules of *water* enter *as such* into composition of organic structure, as well as oxygen and hydrogen, in atomic combination. I hesitate, therefore, whether I should not add this to the elements.

‡ 'Recherches,' p. 19.

the bark, especially when old and weathered; that it is the original yellowish mother-substance found in the heart-wood which turns pink or brick-red in the bark, under the influence of the oxygen of the air, especially when assisted by the presence of earth and alkalies, and that the various products, including perhaps the alkaloid, are derived or rather built up from this under the influence of the respiration of the plant. By the respiration of the plant, in this instance, I mean specially the *general* respiration, in opposition to the *chlorophyllian* respiration. The object of this latter is to fix carbon for the development of the plant, and is, of course, quite essential to its vigour and even to its existence; but I have long suspected that the development of the alkaloids and of Quinine, more particularly, did not stand in any special relation to the vigour of the plant; that in fact, where this was impeded, as in very great elevations, where more especially the plant had to clothe itself with much cellular tissue, there was Quinine the most abundant; the explanation being that the cellular tissue is the place of deposit for the peculiar products of the plant, as I have shown in my examination of the internal and external bark. I now proceed to notice one more fact connected with M. Decaisne's researches on madder, which seems to have analogy with the point I am considering. It appears that the cultivators of madder were in the habit of covering up with earth those portions of the stalk of the plant in which they wished to develop the peculiar colouring-matter in place of the chlorophyll, in order to add these etiolated stalks to the roots, in which alone the colouring-matter is found to perfection. M. Decaisne observed,* in examining microscopically the cellular tissue, that the cells of the root secrete a yellow liquid, whilst those of the stalk, which are to all appearance identical, become filled with green colouring-matter; and he proposed to himself this question, "Is this so great difference in the secretions, the invariable result of the tissue of the roots, as is the case in certain plants, or does the influence of external agents contribute to reproduce this phenomenon on other parts of the vegetable?" Well-devised experiments showed that it is possible to change at discretion the production of chlorophyll into the elaboration of colouring-matter similar to that of the roots. It happens in this case that the green portions which, when exposed to light, absorb the carbonic acid of the air whilst disengaging oxygen, thus augmenting the quantity of carbon which the plant contains, absorb, on the contrary, in darkness, a part of the oxygen of the atmosphere which surrounds them and replace it with carbonic acid.

This singularly interesting investigation may perhaps throw some light on the manner in which Mr. M'Ivor is able—apparently by causing the *general* to take the place of the *chlorophyllian* respiration—to cause the plants to produce alkaloids of a better quality, and more easily purified from green and other colouring-matters. It suggests the question, Whether the plant may not really produce alkaloid instead of chlorophyll? It is by shrouding the bark of the plant in darkness and moisture that the madder is compelled to produce red colouring-matter instead of chlorophyll. It is by a like process that the Red-bark-tree is made to produce a richer and better bark in the process of M'Ivor.

These facts suggest the idea that in connection with the above change in the respiration, under the influence of the presence or the withdrawal of light, there may be a change in the electrical state, and hence in the chemical activities of the cells themselves, so that the same cells, which under one set of conditions produce one result, under the stimulus of the ray of light, may produce other combinations.

M. Cailletet remarks in a recent paper† that, "the calorific rays, as well as the chemical rays, are without action on the strange decomposition of carbonic acid by vegetables, which takes place under conditions altogether different from those which we know how to produce in our laboratories; but the forces which determine this decomposition act upon the elements of this compound body dissolved in the liquids of the leaf, and we *must confess our entire ignorance of the state these elements are in when in*

* 'Recherches,' p. 22.

† "De l'influence des divers rayons colorés sur la décomposition de l'acide carbonique par les plantes," par M. L. Cailletet ('Journal de Pharmacie et de Chimie,' Oct. 1867).

solution. It seems . . . that the coloured rays of light which are the most active, in a chemical point of view, are those which least favour the decomposition of carbonic acid."

Since writing the above, I have met with a paper by M. Boussingault* which seems strongly to confirm the views I have expressed. He shows that a plant is exposed during the whole course of its existence to two opposing forces in connection with the general and the chlorophyllian respiration, the one tending to add and the other to abstract the material; and that according to the relation between these two forces, governed, as they are, by the intensity of light and of temperature, a plant will emit either oxygen or carbonic acid in variable proportions. In a feebly illuminated locality a plant remains in some sort stationary during whole months; and in absolute darkness, the eliminatory force being the only one in existence, the plant can only live upon its own resources, emit carbonic acid by combustion of these, and finally perish without increase of weight.

Further, and which is more expressly to my purpose, M. Boussingault says that "at certain epochs, in certain organs, the plant becomes, like an animal, an apparatus of combustion,—it burns carbon and hydrogen, it produces heat," and "a plant grown in darkness really behaves like (*se comporte comme*) an animal during the whole duration of its existence." An animal of the most simple organization not only produces heat through respiration, and emits carbonic acid, but a certain portion of the albumen which it contains is modified by the respiratory combustion into a crystalline, nitrogenized compound (*urea*). In the respiratory combustion of a plant growing in darkness, a like modification of the albumen could scarcely be as palpable, from the want of excretory organs; but we find in the juice filling the cells a crystalline immediate principle (*asparagine*), which, like the other, is an *amide*, becoming as easily transformed into aspartate of ammonia, as the former into carbonate of ammonia.

Thus the asparagus plants,† whilst flourishing in the light of the sun, produce no *asparagine*, but this is formed as a result of the *general respiration* when the light is excluded. It is easy to see how strongly these experiments confirm the results of the exclusion of light in the process of mossing adopted by Mr. M'Ivor. It is remarkable that green light is nearly the same in its effect as darkness, so that the shade of trees producing this coloured light is unfavourable to the development of vegetation. On the other hand, the products of the etiolated vegetation must be better adapted to sustain the life of those insects which always attack, in preference, plants of enfeebled organization.

The Woody Fibre of the Bark.

In order to complete my review of the question whereabouts in the bark the alkaloids are situated, and to put the reader in some measure in possession of the views of others on the subject, I will subjoin‡ a translation of a paper on this special subject by Dr. Flückiger, of Berne, presenting, as I think, the most recent, as well as the most correct views of the subject. It will be seen that the opinions of this talented observer are fully in accordance with those which I have expressed; and, as it seems to me, that he has, by well-devised experiments, shown that the views of Schacht and Wigand are not capable of being sustained.

I here present to the reader the results of some experiments of my own, tending to show more fully, and in different barks, the actual contents in alkaloid of the liber and of the cellular envelope.

Experiments.

The following experiments were instituted with a view of further comparison of the contents of the liber and of the cellular envelope. The plan adopted was the same that I have previously described. A

* "De la végétation dans l'obscurité" (Ann. de Chimie et de Physique, Fév. 1868).

† And others capable of producing asparagine; the same holds good as to solanine from the potato.

‡ In the Appendix.

large, thick piece of each sort was chosen, and carefully divided into two portions of equal weight, one of the inner, the other of the outer bark. Of each of these, 1000 grains were then taken and subjected to analysis :—

No. 1.—*C. SUCCIRUBRA* (Pavon).Thickness of bark, average $\frac{1}{2}$ inch.

<i>Inside.</i>		<i>Outside.</i>	
*Quinine, cryst. as oxalate .	0.50	*Quinine, cryst. as sulphate .	3.36
Do. uncryst.	1.90	Do. cryst. as oxalate . . .	2.24
	<u>2.40</u>	Do. uncryst.	2.20
Cinchonidine, hydriodate . .	1.20		<u>7.80</u>
Cinchonine	0.56	Cinchonidine, hydriodate . .	0.70
Cinchonicine	0.13	cryst. from ether	1.20
	<u>4.29</u>		<u>1.90</u>
		Cinchonine	0.76
		Cinchonicine	0.20
			<u>10.66</u>

No. 2.—SPURIOUS RED BARK.

Thickness, $\frac{5}{8}$ inch ; inside especially woody.

<i>Inside.</i>		<i>Outside.</i>	
Cinchonidine	0.50	*Sulph. Cinchonidine	0.60
Cinchonine	0.27	Cinchonine	0.30
	<u>0.77</u>		<u>0.90</u>

No. 3.—*C. ALMAGUERENSIS*.Approaches in appearance to Red bark, with leaves like *C. Pitayensis*. Thickness, $\frac{1}{2}$ to $\frac{5}{8}$ inch.

<i>Inside.</i>		<i>Outside.</i>	
Oxalate of Quinine	0.40	Oxalate of Quinine	1.00
Quinidine, with trace of Cincho-		Cinchonidine, and trace of Quini-	
nidine	0.68	dine	0.60
Cinchonine	0.35	Cinchonine	0.25
Cinchonicine	0.05	Cinchonicine	0.75
	<u>1.48</u>		<u>2.60</u>

No. 4.—*C. PALTON*.Saffron-coloured bark, very fibrous internally. Thickness, $\frac{3}{8}$ inch.

<i>Inside.</i>		<i>Outside.</i>	
Sulph. Quinine	0.85	Quinine, sulph.	1.83
Do. uncryst.	0.47	Do. uncryst.	0.80
	<u>1.32</u>		<u>2.63</u>
Cinchonicine	0.04	Cinchonicine	0.04
	<u>1.36</u>		<u>2.67</u>

No. 5.—*C. LANCIFOLIA*. Var. 7.Great contrast between the fibrous inner bark and the cellular envelope. Thickness, $\frac{7}{16}$ inch.

<i>Inside.</i>		<i>Outside.</i>	
Quinine, sulphate	0.60	Quinine, sulphate	1.80
Cinchonidine	0.40	Cinchonidine	0.50
Cinchonicine	0.15	Cinchonicine	0.15
	<u>1.15</u>		<u>2.45</u>

* In order to secure *minute* accuracy, the weight of the sulphuric or of the oxalic acid should be deducted from the salts in combination (as the reader will find in my Table, p. 17). *Practically*, I find more instruction from the statement of results *as obtained*.

No. 6.—*C. LUCUMÆFOLIA*, Pav.Very thick, woody bark, coarse fibre internally. Thickness, $\frac{5}{8}$ to $\frac{6}{8}$ inch.

<i>Inside.</i>		<i>Outside.</i>	
Quinine, sulphate . . .	0.85	Quinine, sulphate . . .	1.37
Do. uncryst.	0.05	Do. uncryst.	0.20
	— 0.90		— 1.57
Cinchonidine	0.80	Cinchonidine	0.85
	— 1.70		— 2.42

Mr. Broughton writes me (under date March 16th, 1868), "I have just repeated a capital experiment of yours, that of separating the liber from the external cortical portion deprived of periderm of the bark. The yield in Quinine in the former and latter was nearly as 3 to 5. As the 'Bastzellen' increase with age, the already marked difference will doubtless be augmented. The above has been made with great care, and checked by crystallization and a stoichiometrical trial."

To prove in another method the chemical composition, especially of the liber-fibres, I subjected the inner and outer bark (as above) of the *C. succirubra* to the following comparative examination:—

	Inner, per cent.	Outer, per cent.
Soluble in caustic liquor	13	23
Soluble in dilute hydrochloric acid	43	37
Soluble in chlorine water* . . . . .	..	..
Soluble in nitric acid; soluble in sulphuric acid with subsequent black coloration, and separation of carbon by addition of water .	44	40†

I have in former publications fully expressed my own opinion on the subject, and I may here be permitted to add that continued observation and investigation have confirmed in my mind the views I have all along expressed, and that it is gratifying to find these confirmed by Dr. Flückiger and Mr. Broughton. Mr. Broughton (letter, December 9, 1867) says, "I have quite come to your conclusion, that the woody part of the liber is *adverse* to the existence of much alkaloid. Indeed, I believe I even extend your opinion."

My difference with the great German authorities, Schacht and Wigand, as to the woody fibre being, in their views of the subject, the seat of the alkaloids, was not of my seeking; and since I became acquainted, not without some surprise, with the views entertained by them, I have gone over the ground again with some care, and with much additional confirmation of the views I continue to hold. It is to me more than ever evident that it would be as wise for a butcher to select cattle having the largest amount of bone in proportion to their flesh as the most fitted for the tables of his customers, as to reckon upon the woody fibre as available for the extraction of Quinine, when the woody fibres themselves, as dissolved by chemical means, do not afford the hope of any different constitution from woody fibre of ordinary composition; and would not even serve for as much in the manufacture of Quinine as the dried bones of cattle would for the purposes of general nutrition.

There remains, of course, the question whether the spiral concavity in the centre of the fibres might not have been filled with combinations of the alkaloid, or whether the cell-walls might not have been impregnated with the same, as they doubtless are, at times, with colouring-matter.‡ It seems to me that a simple rule of proportion would soon settle this question. If the reader will observe the proportion which the liber fibres bear to the rich, renewed bark in Plate II., Figs. 1, 2, and 3, he will find it impossible to imagine that one-tenth part of the whole contents of the bark in the shape of alkaloids can have been lodged in so small a space.

Finally, and, as it appears to me, conclusively, the liber fibres, after having been subjected to the

* Gives a yellow colour for the *inner*, an orange colour for the *outer*, by addition of ammonia: no appreciable loss of weight.

† Less slight residuum.

‡ Vide Illustr. Nueva Quin.

action of weak caustic liquor, then of dilute acid, present when acted on with chlorine water, the characteristics of *ligneous cuticle* of MM. Fremy and Terreil,* leaving a residuum which dissolves and blackens in sulphuric acid, and which is, I suppose, the *incrusting substance* of M. Payen, not showing a trace of alkaloid. How, then, can these fibres be the seat of the alkaloids?

Crystals from the Sap.

I have said that the sap is peculiar, but I do not find in cutting across the stem of young plants of the species any visible appearance in the abundant sap to distinguish it at first from the juice of other plants. It so happens, however, that in the *dried* barks rich in alkaloids which I examine, I find salts generally, if not always, in a state of granulation, or I might even say, of such crystallization as is to be expected from the *kinates* of these alkaloids, which, as is well known, are of a very soluble nature. This appearance, as seen under the microscope, is shown in the third Plate of the present volume. In the Red bark we find the *kinovates* much more abundant; also the occurrence of those very marked and peculiar crystals which are represented in my first Plates, and which I have before abundantly described. I have no thought that any deduction can be drawn from them other than that which I have given, and certainly not that any practical conclusion can thence be deduced as to the goodness of the bark.

My German friends naturally enough inquire how it is that they cannot find crystals which I see, and which our most skilful English draughtsmen find no difficulty in delineating. I have had the pleasure of showing those who have visited me the whole of my process, and convincing them by ocular demonstration that these crystals exist. The mode I employ in preparing the section of the bark, is to boil it for a few seconds in a very weak caustic solution, then to wash in abundance of water, and place the slice at once under the microscope,—the whole not occupying five minutes,—so that it is chemically impossible that any crystals (especially of quite soluble salts) could be formed under the circumstances. I call these crystals *quite soluble* (though far less soluble than the *kinates* I have mentioned), since they gradually dissolve, and in the course of a few weeks disappear in any menstruum that I know how to employ,—in this respect showing the difference of their nature from that of raphides or the granulations of inorganic salts in the crystal cells of the same bark, as also from the starch granules which are sometimes met with.

I do not profess that my plan is so elaborate as theirs,—it simply presents the natural appearances with less alteration; and it was not till after long disappointment with preparations made in the manner ordinarily practised in England that I adopted the present more simple arrangement.

Isolated Vessels.

Whilst subjecting the very rich renewed bark of *C. succirubra* to microscopical examination, I met with a curious exemplification of the production of isolated reticulate vessels in a part of the plant where they have been rarely (if at all) observed in the same position, viz. in the bark itself. I had the opportunity of hearing a very interesting paper by Herbert Spencer, Esq., read before the Linnean Society, since published in the Transactions of this body in 1866, which enters into the question of the function of these spiral cells, and is accompanied by well-executed drawings resembling entirely those which I now present to the reader. The author reconsiders the question whether such vessels ought not to be looked upon as carriers of the plant juices, and adduces satisfactory evidence, as I think, to prove the affirmative of this proposition. Such vessels are found in leaves, and in the young and succulent parts of plants, also, as shown by Trécul, in some renewed tissues, but not ordinarily in the bark of trees. Their occurrence, as

* 'Journal de Pharmacie et de Chimie,' Avril 1868.

presented in my Plates, seems to imply, in this instance, an abnormal state in the newly renewed bark, the source and tendency of which is not at first apparent. Though I made perhaps twenty sections of the one bundle observed, I failed to find these in other portions, but have again met with similar vessels in a recent remittance of the third harvest of renewed bark. In the plates accompanying M. Trécul's observations are seen the adventitious roots produced by a *Gleditschia* and by an *Ulmus*, in consequence of decortication,—showing what might perhaps be called an effort of the plant to regain its normal state and the needful channel for its descending sap; and the vessels I have figured may be a tendency to the production of adventitious roots or buds, such as are figured in connection with the paper of the above botanist, where the important part assigned to these vessels is clearly seen, and their occasional isolation mentioned as having been observed by the author.*

The Laticiferous Ducts.

I have hitherto taken little notice of the laticiferous ducts, and yet these must play a not unimportant, however obscure, part in the economy of the plant. The latex is one of the products which approach the most nearly to those of the animal creation, and it has been compared with the blood; but in my opinion it has more analogy with the biliary secretion, inasmuch as it is a secretion, and not the very life of the plant, which latter the blood seems to be in a certain sense to animals, and the chlorophyll to plants, and also to some animalcules.

It may not improbably differ from the surrounding cell-formation in its electro-chemical state, and may perform important services to the young developing structures, since it appears to be connected with quickening and stimulating them; and in the researches of M. Decaisne it was noticed by him that those portions of the cellular structure of the madder through which these ducts permeated were the first to change colour from yellow to red, as though by the addition of oxygen gas. I have also noticed that these ducts are the first portions of the structure to manifest the alteration when a deterioration takes place in the health of the plant. The latex, under these circumstances, changes colour, and gradually turns black. But in what relation are we to conceive of these ducts as standing towards the formation of the alkaloids?

In the first place, it is certain that, in proportion as the alkaloids become more abundantly developed, the laticiferous ducts disappear, as in the fully matured flat *Calisaya* bark, or else become much restricted in their size and relative extent and importance, as in the Red bark; in which last again the persistence to a certain extent of these ducts may be connected with a more abundant development of kinovic acid in the *C. succirubra* than is present in most other barks.

In the next place, where they do not disappear, as in some inferior barks, such as the *C. ovata*, an inferior production of alkaloid occurs, and of this poverty there is no more certain sign than the occurrence of wide, open, laticiferous vessels; further, that in the allied genus of *Ladenbergia* (or *Cascarilla*), in which these assume large proportions and are permanent, it is kinova-bitter alone that is predominant. Large development of these ducts, therefore, indicates large production of kinova-bitter, and diminishing and disappearing laticiferous vessels indicate abundant formation of alkaloid.

The conclusion, therefore, to which I arrive is, that laticiferous ducts exist for the secretion of kinova-bitter,—at least in the present families of plants under review. On the other hand, their disappearance is connected with the change of the kinova-bitter or its elements into alkaloid; and that not in these ducts, but rather in the parenchymatous cell formation.

* "Sur l'origine des bourgeons adventifs" (Ann. des Sc. Nat., tome viii. 1847). "Dans les bourgeons adventifs, ce sont des vaisseaux réticulés qui deviennent ponctués, qui se montrent d'abord." (Ann. des Sc., tome xvii., ibid. p. 268; see also tome viii. 1847, p. 290.) "J'ai vu aussi quelquefois des vaisseaux isolés, non accompagnés des tissus qui entourent ordinairement ces organes, répandues au milieu des fibres du liber." (Ibid. tome viii. 1847.)

I have previously copied* from Dr. De Vrij a table showing the relative proportion of kinova-bitter in the different parts of the *Calisaya*, and I may here add a more recent observation of the same chemist, that the leaves of *C. succirubra* grown at the low elevation of Peradenia (1600 feet above the sea) contained twice as much kinova-bitter as leaves of the same grown at Ootacamund (7416 feet), preserving still the same inverse ratio to the proportion of alkaloids which pervades the whole structure of the plant.

The Mother-substance of the Cinchona.

This substance is found only in the wood; it does not coexist with the Cinchona-red, and but in a very minor proportion with the alkaloids, but on its breaking up into Cinchona-red the formation of the alkaloids seems in some way to depend. It is then, at all events, worthy of close investigation.

The Cinchona-red is produced by a process of slow oxidation in the bark of the plant. This process, as I have shown, is very gradual, and is by no means complete when the dried bark comes into the hands of the chemist. It must be remembered that this change does not commence in the wood, which retains its yellowish hue unchanged, but the bark assumes either a reddish† appearance (as in the species we are considering), or more or less tawny, if the Cinchona-red is masked by other principles. This Cinchona-red is found in all the valuable Cinchonæ, although in part replaced in the aricine-producing plants by a kindred substance of intensely orange colour.

The process which I found most advantageous to extract the colouring matter from the wood was to dissolve it out by ether, which, as a neutral substance, seemed incapable of exercising any influence on its chemical composition, and was consequently best adapted to give it into my hands in a state of purity, and, as far as first appearances went, of homogeneous composition. On evaporating the dissolving medium, the substance was left in appearance resinous, brittle, almost inodorous, and perfectly stable in its composition under all circumstances. It does not attract moisture nor absorb oxygen from the air, and thus differs sensibly from the Cinchotannic acid found by Schwartz in the *Calisaya* bark, and which he rightly described‡ as passing rapidly under the influence of ammonia and of the oxygen of the air into Cinchona-red. The present substance must nevertheless stand in very near relation to that of Schwartz, but also in equally near relation to another substance which he derived from the same bark, and which he calls Chinovic acid.§ Schwartz considered this to be identical with a substance (Quinovin) previously found by Hlasiwetz|| in the *Quina nova*.

The proof of the near relationship existing in this Mother-substance to both Cinchona-red and Kinovic acid is found, first in the action of alkalies, metallic oxides, or alkaloids, which produce the red colour by their action on the mother-substance. Thus the addition of ammonia to the light yellow ethereal solution gives rise at once to a fine rose-colour, and when all is evaporated down together, there remains a compound of kinovic acid and ammonia coloured by Cinchona-red, which appears as an excretory product. The powerful alkalies break up the substance in this manner at once, but the operation of earths and metallic oxides is more slow. Thus, when a piece of lime is dropped into the ethereal solution and allowed to stand in the sunlight, which seems to favour the process, the Cinchona-red is very gradually deposited on the lime, which assumes nearly the appearance of red coral; and in this case nearly the whole of the Mother-substance seems to pass in time into Cinchona-red, and it thus appears to contain *the elements* of cinchotannic acid; but when lime-water is made to act upon the same substance, it dissolves this with the

* Illustr. Nueva Quinologia, sub voce *C. magnifolia*.

† The appearance is *exactly* described by the Spanish name of the best Red Bark, *la teja*, i.e. resembling a tile; another kind, equally abundant, of a different aspect, which I have described, is called *la morada*, with equal propriety. This latter, according to Mr. R. Cross, who gives me the above information, is of a different species to the *C. succirubra* (? *C. conglomerata*).

‡ 'Annalen der Chemie und Pharmacie,' lxxx. p. 332.

§ 'Centralblatt,' 1852, p. 194.

|| Ann. der Chemie und Pharm. lxxiv. p. 138.

manifestation of a pink colour, which, combining with excess of lime, forms a pink lake. When the filtered solution is precipitated by hydrochloric acid, a separation of Kinova-bitter takes place, with its usual appearance, and apparently almost milk-white. When this is collected, however, and again acted on by lime, a pink lake, but of a fainter hue, is again formed, and so on for several repetitions before the product which I have mentioned is obtained pure, and free from colour.

I wish it to be understood that I do not assert the *homogeneity* of this mother-substance, nor suppose that it can be recognized as a *chemically pure body*, but I like to follow Nature in her operations, and to study the *becoming* as well as the *being* of her products.

The pure kinovic acid is easily obtained from kinova-bitter. If the Mother-substance is mixed with an ethereal solution of Quinine, a combination takes place which I have described as Kinovate of Quinine, and have represented the crystals it forms.* From this combination there seems to be a slow separation of Cinchona-red, as happens with lime above. I have no doubt that this is the state of combination in which the alkaloids exist, more especially in the Red Bark. It is this which explains the reason why aqueous infusions of Red Bark are deficient in strength, which is not so much the case when they are made from barks in which the alkaloids are united to kinic acid. It is, moreover, as I have before explained, chiefly this curious state of combination which renders the extraction of the alkaloids a matter of so much difficulty. The attempt to manufacture sulphate of Quinine on the spot where the trees are found has always failed (though often attempted in South America), and equally profitless has been the attempt to precipitate the alkaloids and send them over mixed with lime;—in this last case also other deteriorating effects were produced. Spirituous tinctures dissolve more of the alkaloids, but also of partially oxidized Cinchona-red, which gradually separates by slow oxidation.

The Mother-substance of the Cascarilla.

I am indebted to Señor Pedro Rada for specimens of the *Mula Cascarilla* or *Cascarilla Carua* of Weddell, consisting of leafy branches with very fine leaves of some 18 inches long, and also of sections of branches covered with bark. I was thus enabled to examine the wood in reference to its constituents as compared with that of the Cinchona. A peculiar colouring matter is very abundant in this Cascarilla, so as to form *apparently* a dark purple or almost black incrustation on the external portion of the bark. It is, therefore, to be expected that some analogous mother-substance should exist in the wood. This I found to be the case, for in treating the wood, rasped to a fine powder, with ether, and evaporating, I obtained a lemon-coloured, resinous-looking substance, similar in some of its properties to that of the Cinchona. The ethereal solution, treated with lime, gave a deposit of what might be called *Cascarilla-red*, and, when shaken up with caustic or with liquor ammoniæ, a fine, rich, characteristic colour was developed in the solution, and the supernatant ethereal solution became partly filled with crystals, the precise nature of which I could not determine. On the whole, the great contrast between the colouring matter in these allied genera seems to be that in the Cinchona the mother-substance is *very slowly* oxidized in connection with the formation of the alkaloids; but in the Cascarilla the process is more rapid, and perhaps more complete.

When the wood is treated with milk of lime, a considerable amount of kinova-bitter is obtained by the addition of acid to the filtered solution.

Products of the Cells.

It will be observed that none of the substances I have noticed are nitrogenized bodies nor capable of acting powerfully on the human frame. The additional step to the formation of alkaloid from these, I suppose to be taken in the cells of the bark, commencing more especially with the cambium. I have

* 'Microscopical Observations,' pl. ii. fig. 12 b.

sought to add the nitrogenous element to the mother-substance by means of heating a solution of it, together with chloride of ammonium, in a sealed tube, for twenty-four hours, at a temperature of 200° Fahrenheit, but found it entirely unchanged. Other tentative processes have not as yet proved more successful. I regret being unable to follow the curious chemistry of the parenchymatous cells of the liber and of the cellular envelope, but must refer to what I have before written* to show that the flow of the nourishing sap not only conveys to these the substances on which this chemical transformation is effected, but that also these products can be removed by the same circulation when the need of other parts requires, and the whole then becomes changed into the outside corky layer.

The hot and dry air arising from the valleys of the Patia, was believed by Karsten to have been the cause of the inferior production of alkaloid in the trees of *C. lancifolia* growing on the volcano of Pasto.† This might well be the case if the material was *used up* by the plant for its necessities thus created; as, in other cases, the provision of starch is consumed by the plant in flowering.

The alkaloids must be regarded as highly complex, and, so to speak, animalized products of the *general* respiration,‡ being in this way fitted to act powerfully on the animal economy (the blood having an alkaline reaction); as conversely acid gases of simple constitution (sulphurous, nitrous, etc.) are deadly poison to vegetables whose juice has an acid reaction.

In studying the effect of the processes of chemical action continually going forward in the cells, I am obliged to feel the insufficiency of our skill and the incompleteness of our present appliances for investigating the secrets of this wondrous laboratory of nature.

The determination of the constituent elements of organized structure by what we call analysis, must pass for what it is worth and no more. When we have dried all the molecules of water out of an egg, and then subject the remainder to analysis, we examine simply a spoiled product, differing so widely from the original that it can by no means be brought again into its primitive state, and all the remarkable capacities connected with its primitive organization are at an end. It is not different when we examine the vegetable cell; with the utmost care and delicacy of research, the most important points still remain unexplained. The microscope reveals to sight much which chemical analysis cannot follow.

Latest Remittance from the East Indies.

In the month of August of the present year, 1868, I received the eighth remittance of specimens from Ootacamund, and have sent a Report thereon to the Indian Government, which the reader will find reprinted in the Appendix.

I gather several points of instruction from the examination of these specimens:—

1. The permanence of the characteristics of species,§ as far as ascertained by the present investigation. After all the changes and the varied treatment of the *Cinchona succirubra*, it appears to remain exactly the same in all material points as in South America.
2. It appears that the renewed bark must derive its peculiarities from the nourishing sap, and not from the leaves, since the one-year-old renewed bark partakes of the five-years-old characteristics of the plant on which it grows.
3. The implication of the resinous principle with the alkaloids increases with age in the *C. succirubra*, and thus produces increased difficulty in their extraction.
4. On this account the Red Bark Tree should not be relied upon as forming the chief element in any plantation.

* 'Microscopical Observations,' pl. ii. fig. 12 b, p. 2.

† Analogous to *Kreatin* and *Neurin* in the animal economy.

‡ 'The Chinchona Species of New Granada,' p. 97.

§ See also under D. in the Appendix.

5. The cells of the root-bark seem to have a peculiar aptitude for the formation of Cinchonine, agreeing in this respect with the cells of bark grown under dense shade.

6. Cultivation of the Red Bark Tree for the sake of the roots would not answer as a commercial speculation, unless, from altered circumstances, Cinchonine were in greater demand than it is at present.

Conclusion.

In conclusion, I must resume some of the leading points, which appear to be shown with more or less clearness.

1. That the cultivation of the Cinchonæ in India promises complete success, but to ensure this, great attention must be paid to the choice of species.

2. That if properly conducted it will prove remunerative.

3. That Mr. M'Ivor's plan of mossing is an important discovery in the direction of intelligent culture.

4. That the renewal of the bark from the cambium leads to different conclusions as to the permanence of the supply of fresh bark, from those to be deduced from the theory of formation of the alkaloids in the leaves.

5. That no part of the tree—root, stem, or leaves—visited by the ascending sap, seems to be the place of deposit of the alkaloids.

6. That these are formed in the cellular tissue of the bark, beginning from the cambium outwards.

7. That the sources whence the materials are drawn for this elaboration are at once the nourishing sap descending in its usual course, and a lateral conveyance, through the medullary rays, of part of the deposit of the mother-substance in the wood.

8. That inasmuch as this mother-substance is characteristic of the Cinchonæ, and is the source of the Cinchona-red, it may also mainly conduce to the formation of the alkaloids, since it is probable that the characteristic principle of each plant is originally *one*.

9. That the above principle, deduced by M. Decaisne from his researches on Madder, is equally true as to Red bark.

10. That no explanation is at present offered of the tendency of the cells in the root of the Madder to secrete the peculiar colouring-matter, nor in the bark of the Cinchonæ to produce alkaloid.

11. That the electro-chemical properties of the cells are nevertheless greatly influenced by the respiration, and that by changing the character of this respiration we may artificially control their action.

12. That the *chlorophyllian* respiration does not favour, but that the *general* respiration does favour the production of alkaloids.

13. That the presence or absence of light has great influence (through the respiration) on all the above phenomena.

14. That the laticiferous ducts dwindle and disappear coincidently with the formation of the alkaloids.

15. That the liber fibres are not the place of deposit of the alkaloids.

16. That in the liber the alkaloids are found in the state of the greatest purity, but in the outside cellular tissue these are more abundantly stored up; especially this is the case as to Quinine.

Tottenham, 1868.

APPENDIX.

A. (Page 5.)—ADDRESS OF DR. WEDDELL TO THE BOTANICAL CONGRESS (1867) IN PARIS.

Sur la Culture des Quinquinas. Par M. H.-A. WEDDELL.

Messieurs,—C'est avec une vive satisfaction que je me vois chargé, par mon ami M. J.-Eliot Howard, de Londres, d'appeler l'attention du Congrès sur les échantillons que j'ai l'honneur de déposer sur le bureau. Cette satisfaction, vous la comprendrez et vous la partagerez, je crois, lorsque vous saurez que les écorces mises sous vos yeux ont été retirées de caisses débarquées, il y a quelques jours, sur les quais de Londres, et renfermant la première récolte que les plantations de *Cinchona* de l'Inde anglaise aient livrée au commerce européen. Ces écorces témoignent donc du succès d'une entreprise qui, au point de vue de l'humanité, peut être regardée à juste titre comme une des plus utiles de notre siècle.

Les progrès de la culture des *Cinchona*, dans les Indes, ont été exposés dans plusieurs ouvrages de date assez récente. Je demande néanmoins la permission d'en dire ici quelques mots qui, j'ose l'espérer, ne seront pas sans intérêt, surtout en vue des pièces qui vous sont soumises. Et puisque ces pièces me rappellent encore tout naturellement le nom de M. Howard, je dirai, en commençant, que, par ses profondes connaissances en quinologie, aussi bien que par son habileté comme chimiste, et par son noble désintéressement, notre éminent confrère a rendu à cette œuvre les plus importants services, et doit être mis au premier rang de ceux qui ont contribué à sa réussite. A la science, il en a rendu de non moins grands;* mais je me contenterai, en ce moment, de rappeler que c'est en grande partie à son tact persévérant que l'on a dû de connaître enfin l'origine botanique du vrai Quinquina rouge, dont vous avez précisément ici les écorces sous les yeux.

La première tentative de culture des *Cinchona*, dans les Indes britanniques, eut lieu en 1853,† époque à laquelle un certain nombre de plants de *C. Calisaya*, d'origine française, y furent transportés sous la surveillance de M. Fortune. Ce ne fut cependant que quelques années après, en 1859, que le gouvernement anglais se mit sérieusement à l'œuvre, en envoyant au Pérou M. Clements Markham. Ce voyageur, auquel on doit les plus grands éloges pour le zèle et la persévérance qu'il a déployés dans la mission difficile qui lui était confiée, partit d'Angleterre avec un habile jardinier (M. Weir), aborda au Pérou, par le port de Callao, et se dirigea ensuite sur celui d'Islay, pour gagner la province de Carabaya, où il suivit, à peu de chose près, l'itinéraire que j'y avais suivi moi-même, une douzaine d'années auparavant. Il y recueillit, non sans difficulté, un grand nombre de plants de *Cinchona* qui furent confiés à des caisses de Ward, mais qui moururent malheureusement tous pendant la traversée, ou peu après leur arrivée à Madras; perte considérable, mais qui ne fit pas, fort heureusement, périr l'entreprise elle-même. En effet, M. Markham n'avait pas voulu en confier le succès à ses seuls moyens. Dès avant son départ d'Angleterre, il avait eu soin d'enrôler au profit de l'œuvre quelques hommes aussi habiles que dévoués, parmi lesquels on doit citer en première ligne le botaniste Spruce,‡ auquel on dut d'obtenir bientôt de jeunes plants, et surtout des graines, de plusieurs espèces de *Cinchona*, dont l'expérience avait depuis longtemps démontré la valeur. La perte de la récolte de M. Markham se trouva ainsi amplement compensée.

Quelques-unes des graines obtenues de la sorte furent semées dans les serres du Jardin royal de Kew,§ en Angleterre; les autres, dirigées immédiatement sur l'Inde, y furent distribuées entre divers sites signalés comme étant les plus propres à fournir aux plantes à cultiver les conditions de sol et de climat qu'elles trouvent dans leur pays natal. Il est inutile de suivre les péripéties de cette culture dans ces diverses localités; bornons-nous à l'étudier dans celle qui a produit les échantillons que nous avons devant nous, c'est-à-dire, Ootacamund, dans les montagnes de Nilghiri. Cette plantation, placée sous la direction de M. M'Ivor, ne tarda pas, grâce à la rare intelligence de ce cultivateur, à atteindre un degré de prospérité qui doit nécessairement la faire prendre pour modèle de toutes celles qu'on pourra établir par la suite. Quelques chiffres montreront du reste, beaucoup mieux que toute description, les rapides progrès de l'établissement. Ainsi, quand M. M'Ivor s'établit à Ootacamund, en mars 1861, il y rencontra 635 plants de *Cinchona*, la plupart appartenant au *C. succirubra*. Eh bien! en avril 1862, il y en avait 31,495, et, un an après, 157,704. Ce dernier recensement avait eu lieu en avril 1863. Au mois de décembre de cette même année, le nombre des plants de *Cinchona* existant à Ootacamund était de 277,080! A partir de ce moment, on ne les compte, pour ainsi dire, plus; et, à l'heure qu'il est, c'est presque par millions qu'on peut les dénombrer. Dans la seule propriété particulière de Dova

* Le magnifique ouvrage publié par M. Howard sous le titre de 'Illustrations of the Nueva Quinologia of Pavon' (1 vol. in-fol. avec 30 planches coloriées) est connu de tout le monde.

† Le premier pas officiel fait en Angleterre pour introduire la culture des *Cinchona* dans les Indes britanniques l'a été à la suite d'une dépêche du gouverneur-général de l'Inde, en date du 27 mars 1852.

‡ C'est par le zèle infatigable de M. Spruce que le gouvernement a été mis en possession du *C. succirubra*, qui rivalise avec le *C. Calisaya* par l'importance de ses produits, et d'autres espèces du versant occidental des Indes de l'Équateur. M. Cross accompagnait M. Spruce, comme jardinier, dans cette expédition, et fit ensuite, seul, deux autres voyages quinologiques, avec le même succès: l'un au district de Loxa, l'autre à Pitayo, dans la Nouvelle Grenade. M. Pritchett visitait pendant ce temps les montagnes d'Huanuco, et recueillait des graines et de jeunes plants des espèces de cette localité classique.—Voyez, pour d'amples détails sur ce sujet, le très-intéressant volume de M. Markham, intitulé, 'Travels in Peru and India.'

§ Alors sous la direction du célèbre Sir William Hooker, lequel n'a jamais cessé, non plus que son illustre fils, le directeur actuel, d'apporter le plus vif intérêt à toutes les questions qui se rattachent à la culture des Quinquinas.

Shola, il y en a 900,000; et l'enthousiasme pour cette culture est tel, qu'indigènes et étrangers, rajas et paysans, tous veulent avoir leur plantation de Quinquinas. J'ajoute que cette immense multiplication a été obtenue par un système de bouturage par très-petits tronçons, grâce auquel, par exemple, un pied de *C. officinalis Uritusinga*, présenté au gouvernement par M. Howard, et arrivé dans l'Inde en avril 1862, a pu compter, dix-neuf mois après, 6850 rejetons.

Les résultats que je viens de faire connaître sont déjà bien remarquables, mais ceux dont il me reste à parler tiennent presque du prodige.

Aux débuts de cette grande expérience, c'est-à-dire, il y a quinze ans, on pouvait craindre que le rendement des écorces ne diminuât, par suite de la culture de l'arbre dans des conditions qui ne seraient pas tout à fait celles où il végète en Amérique; tout au moins devait-on avoir quelques doutes sur le résultat; eh bien! on est en droit aujourd'hui d'affirmer que la richesse des écorces de *Cinchona* cultivés dans l'Inde, sera non-seulement égale à celle des écorces américaines, mais arrivera même peut-être, dans certains cas, à être double et peut-être plus considérable encore. Ceci n'est pas aujourd'hui une hypothèse, mais un fait; et M. M'Ivor a obtenu ce résultat par un moyen si simple que je n'exagérerais pas en disant que les résultats obtenus tenaient presque du prodige. Pour y arriver, il lui a suffi, en effet, d'appliquer sur l'écorce de l'arbre une couche de mousse qui la garantît, pendant une certaine période de sa croissance, de l'influence combinée de l'air et de la lumière. Ainsi, voici par exemple une écorce de *C. succirubra* développée à l'air libre et âgée de quatre ans; son rendement en alcaloïdes est de 6.95 pour 100. Si, au contraire, six mois seulement avant de l'enlever, vous l'eussiez enveloppé d'une couche de mousse, ce rendement aurait dépassé 9 pour 100. Ce n'est pas tout. Ce que cette application de mousse, ce que ce *moussage* de l'écorce offre peut-être de plus intéressant à noter, c'est qu'il permet à l'aubier d'un arbre dénudé de son écorce, pour les besoins de commerce, d'en reproduire une seconde et même une troisième;* chacune de celles-ci étant non-seulement plus riche en alcaloïdes que l'écorce qui l'a précédée, mais étant proportionnellement plus riche en quinine, cette quinine étant en outre d'une extraction plus facile. Anatomiquement ces écorces diffèrent des autres par l'absence plus ou moins complète des fibres du liber. Enfin, un dernier fait qu'il faut signaler, parce qu'il peut résulter de la culture et qu'il pourra avoir une certaine importance quand on saura exactement sous quelles influences il se produit, c'est la conversion des alcaloïdes voisins l'un dans l'autre : † de la quinine, par exemple, en cinchonidine, ainsi que cela s'est vu dans le *C. Calisaya*, ou de la cinchonine en quinidine, comme M. Howard l'a constaté pour le *C. micrantha*.

Je termine ici ce que j'avais à dire sur la culture des Quinquinas dans l'Inde anglaise, et je demande la permission d'appeler, pendant quelques instants, votre attention d'un autre côté.

C'est à l'Angleterre, nous l'avons vu, que revient la gloire d'avoir offert au monde les premiers fruits de la grande entreprise dont je vous ai retracé quelques-unes des phases les plus intéressantes. Mais, ceci reconnu, il n'est que juste de revendiquer pour deux autres nations la part de mérite qui leur est due dans le développement de cette œuvre bienfaisante. Ces pays sont la France et la Hollande. Je commence par la France, et ici je vous prierai de m'excuser si je mets en avant mon propre nom. Peut-être ne le ferais-je pas si j'étais seul en fait dans le léger oubli dont je crois avoir à me plaindre, mais comme cet oubli porte surtout sur un établissement public, établissement auquel j'ai été fier d'appartenir, je crois qu'il est de mon devoir, en ce moment, de défendre ses droits. Ce que je réclame pour la France, c'est le mérite d'avoir suscité le mouvement qui a eu pour résultat les diverses tentatives faites pour cultiver le Quinquina, et d'avoir fait le premier pas dans la voie féconde où l'ont suivie, pour la devancer bientôt, la Hollande d'abord, l'Angleterre ensuite. Pour ce qui est de moi personnellement, je désire simplement constater que, quelles qu'aient été les suggestions faites antérieurement, ce n'est, en réalité, qu'à la suite de la publication de ma 'Monographie des Quinquinas,' en 1849, et du rapport dont elle a été l'objet; ce n'est que sous l'impression du cri d'alarme que j'y ai jeté, que l'attention des gouvernements a été éveillée, et que les premiers pas utiles ont été faits pour opérer le transport de la production et du commerce des Quinquinas du nouveau monde à l'ancien. Voilà, Messieurs, la part que j'ai eue dans cette œuvre. Celle qui appartient au Muséum d'Histoire Naturelle est bien autrement importante. Et, d'abord, ne dois-je pas dire que c'est comme voyageur-naturaliste de cet établissement que j'ai été à même d'étudier l'état des forêts de Quinquinas, et d'appeler l'attention sur la destruction qui en menaçait les espèces les plus précieuses? Ce sont ensuite les graines de *Cinchona*, recueillies et remises par moi au Muséum, qui, semées dans les serres de cet établissement, sous la surveillance de M. Houlet, y ont levé et ont donné les premiers plants de Quinquina que l'on ait vus vivants en Europe. Ce sont enfin ces plants qui ont servi aux premiers essais de culture qui aient été faits, soit en Afrique, soit en Asie. Dès leur apparition, on se préoccupa, en effet, des moyens de les transporter sous des climats que l'on pouvait supposer propices à leur développement, et les premiers qui soient sortis de France furent adressés, en 1849, à M. Hardy, directeur des pépinières des environs d'Alger, et furent livrés à la pleine terre, dans l'établissement du Hamma. C'est là le premier essai de culture du Quinquina, à l'air libre, qui ait été tenté hors de son pays natal. Il ne fut pas heureux, et l'on doit, par cette raison même, regretter plus vivement encore que le gouvernement français n'ait pas donné alors une attention plus sérieuse à une question d'une importance aussi manifeste, en prenant en main l'œuvre dont le Muséum avait eu l'initiative.

La Hollande commença ses essais vers le moment où la France suspendait les siens, en 1852, par conséquent environ sept années avant que l'Angleterre, profitant des fautes commises par l'expérience de ses devanciers, entrât sérieusement dans la même voie. Le gouvernement hollandais savait que le Muséum avait distribué dans le commerce français un certain nombre de pieds de *Cinchona Calisaya*, nés dans ses serres. Il s'en procura chez MM. Thibaut et Ketelée, et les fit transporter à Java. Ce sont les premiers qui aient respiré l'air des Indes. Ils provenaient, on le voit, du Muséum d'Histoire Naturelle. J'ai dit aussi,

* Les habitants de Loxa réussissaient parfois à obtenir de leurs arbres une seconde récolte, mais par un procédé bien moins parfait. Ils enlevaient l'écorce d'un seul côté du tronc. Les lèvres de la bande corticale laissée en place s'étendaient alors peu à peu et finissaient par recouvrir, plus ou moins complètement, la portion d'aubier dénudée.—Voyez Howard, *l. c. sub C. Uritusinga*.

† La valeur commerciale des alcaloïdes des Quinquinas, et par suite celle des écorces dont on les extrait, dérive en grande partie de leur rendement thérapeutique. Or, il résulte des rapports publiés récemment par des commissions siégeant à Madras et à Bombay, et dont l'objet est de s'assurer expérimentalement, et sur une grande échelle, de l'importance thérapeutique relative des quatre alcaloïdes de Quinquina actuellement employés, que les sulfates de cinchonine, de cinchonidine et de quinidine sont beaucoup plus efficaces qu'on ne le suppose généralement. Il est donc présumable que cette décision va donner du prix à bon nombre d'écorces que l'on a cessé d'exploiter, depuis que la croyance s'est répandue que la quinine possède seule à un haut degré les qualités dont on est obligé aujourd'hui de reconnaître l'existence, et seulement à un degré un peu moindre, chez ses trois sœurs, et en particulier dans la quinidine.

plus haut, que le premier envoi fait par l'Angleterre dans ses grandes possessions asiatiques était d'origine française. Les plants qui le composaient provenaient de la même source que ceux qui se trouvaient déjà dans les Indes néerlandaises : du Muséum d'Histoire Naturelle.

La Hollande ne s'en tint pas là. Dans cette même année 1852, elle fit partir pour le Pérou le botaniste Hasskarl, avec mandat d'y recueillir des plants et des graines de *Cinchona* et de les accompagner à Java; ce qui fut fait; mais, soit par une raison, soit par une autre, les progrès des plantations furent très-lents; si bien que lorsque, trois ans après, la direction des cultures vint à être confiée à M. Junghuhn, celui-ci n'y trouva que 351 arbres en pleine croissance. A partir de cette époque, cependant, la multiplication prend des proportions considérables, et, sans une circonstance qui est réellement à déplorer, les plantations des Indes néerlandaises n'auraient aujourd'hui rien à envier à celles de l'Inde britannique. Séduit par la plus grande rusticité d'un *Cinchona* d'espèce douteuse, né de graines rapportées par M. Hasskarl, on se prit à le multiplier au détriment d'autres espèces plus délicates peut-être, mais dont l'utilité était démontrée, et l'on reconnut, trop tard, que la plante qui avait coûté tant de soins n'avait que peu ou point de valeur commerciale :* de sorte que, bien qu'il y ait en ce moment plus d'un million d'arbres à Quinquina dans l'île de Java, la proportion des bonnes espèces y est relativement faible. Je n'exagère donc pas beaucoup en disant que l'opération devra y être reprise presque en entier, en n'y employant, cette fois, que les espèces ou variétés† dont l'expérience, ou mieux encore, l'analyse chimique, aura démontré la valeur. C'est en procédant ainsi que l'Angleterre est arrivée, presque du premier coup, à la solution du problème.

B. (Page 6).—FIRST REPORT, ETC. (Extract).

From J. E. HOWARD, F.L.S., to C. R. MARKHAM, Esq. (May 28, 1863.)

"1. I have great pleasure in informing you that the result of my examination of the bark of *C. succirubra* grown in India is very satisfactory. I have, thus far, only operated upon 500 grains, proceeding cautiously, as the quantity of bark sent is small. I find exactly the same constituents as in South American 'Red Bark,' and was able to obtain a first and second crystallization of very white sulphate of quinine, mixed (as is usual when obtained from 'Red Bark') with sulphate of cinchonidine. I have also obtained some cinchonine.

"2. This must be considered a very satisfactory and promising result, when the immature age of the bark is considered (viz. two years' growth), and especially when I add that the percentage product of alkaloid appears to me as great as would be met with in South America under the same circumstances."

C. (Page 22.)

On the Anatomy of the Bark of Cinchonas. By F. A. FLÜCKIGER. ('Wochenschrift für Pharmacie,' Bern, No. 47, 48, Nov. 1866.)

The bark of the cinchona, as is well known, does not show any very striking anatomical peculiarity in contrast to other bark. The structure of the liber is the most distinctive feature. . . . The peculiarity consists in this, that the liber fibres, which are unusually short, begin to close up when still very young. The cellular wall is generally so thickened by layers on the inner side that the original hollow space is greatly decreased, and almost obliterated. These layers are so bound to each other and to the primary wall, that it is impossible to discern their exact arrangement. The best way to do so is to make a horizontal or oblique section. The beautiful colours which these thickened bast cells take in polarized light show that the cellular tissue is under strong tension.

The corresponding structure in other barks is either much longer, thinner, and more flexible, and not pointed at the end, or else with the hollow remaining, and therefore not so stiff as the bast cells of cinchona. The latter never ramify, whilst other liber cells, as, for instance, those of the so-called "false cinchona," divide and form a kind of network.

The question as to the situation of the alkaloids in the bark arose after Weddell's first investigations in 1849. "Flat *Calisaya*" was formerly considered as undeniably the most productive bark, and this yielded Weddell the largest number of liber fibres, and these most evenly distributed; wherefrom he concluded that these had some connection with the produce of quinine. He carried out this view by many very careful experiments, which cannot be set down here for fear of being too lengthy. Suffice it to say that he considered cinchonine to be chiefly contained in the outer layers and quinine in the inner ones. The amount of the latter corresponded, he thought, with the number of liber fibres only up to a certain point, and he considered the most fruitful structure to be that shown by the smooth *Calisaya*, namely, many short, isolated liber fibres, regularly and somewhat thickly placed in the parenchyma of the inner bark.

He pointedly contradicts‡ the view that the woody liber fibres themselves could contain an appreciable quantity of alkaloid.

* Ce *Cinchona*, provenant des environs d'Uchubamba, dans le Pérou central, a été reconnu nouveau par M. Howard, et a été dédié par lui au gouverneur-général des Indes néerlandaises, sous le nom de *C. Pahudiana*. L'espèce avait été confondue, paraît-il, antérieurement, avec le *C. ovata* et avec le *C. carabayensis*, dont elle est bien distincte. Des échantillons de l'écorce de cet arbre, ainsi que de celles de presque toutes les autres espèces de *Cinchona* cultivées jusqu'à ce jour dans les Indes, forment partie de la magnifique collection quinologique exposée par MM. Howard et fils dans le Palais du Champ-de-Mars. On sera heureux d'apprendre que cette collection, que plusieurs d'entre nous ont examinée avec un si vif intérêt, a obtenu une médaille d'or du jury international à l'Exposition universelle.

† Il y a des espèces botaniques de *Cinchona* dont le type peut avoir une écorce pauvre en alcaloïdes, lorsque, au contraire, quelqu'une de ses variétés peut en avoir une très-riche, et vice versa. Le *C. lancifolia* et le *C. Calisaya* fournissent des exemples de ces anomalies.

‡ "La quinine a de préférence son siège dans le liber ou, pour parler plus exactement, dans le tissu cellulaire interposé aux fibres du liber, et que la cinchonine occupe plus particulièrement celui qui constitue la tunique ou enveloppe cellulaire proprement dite."—'Histoire Naturelle des Quinquinas,' p. 25.

Howard, one of the students of cinchonas best qualified to judge on chemical and pharmaceutical grounds, shares Weddell's conclusion, at all events so far that he does not consider the liber fibres, but the parenchyma, as the site of the alkaloids. I intend to explain Howard's views in another place, *as they almost entirely coincide with my own*.

Wigand asserts precisely the opposite view in his excellent 'Lehrbuch der Pharmakognosie,' page 112, "Alkaloid, that is to say quinine, has its seat within the liber, in the liber fibres." No other pharmacist expresses himself with so much decision on this subject, and he grounds his assertion on a course of acute and careful experiments.*

Wigand's assertion demands the greater consideration, since it is a repetition of Schacht's saying,† "I consider it probable that all alkaloids are products of the bast cells, and that quinine and chinchonine are only produced in the liber fibres of cinchonas."

With the first clause of this general assertion we have nothing to do; let us consider the second in its relation to cinchonas.

By experiments, which I need not repeat, Wigand discovered that the liber fabric had a power of absorbing and retaining the dye of cochineal in the same manner as a dyer's mordant. As it followed from his experiment that the liber fibres and not the parenchyma possessed this faculty, he concluded that the former must necessarily be the site of the alkaloid. I have, however, followed his experiments, and cannot say much for them. Wigand summarily rejects Weddell's argument, that the thickness of their cellular walls renders this quality impossible. He considers his own method rather intricate, and says it would be well, if possible, to find a simpler one.

He first found that the well-known reaction of Gräbe became evident upon heating a cross-section of cinchona bark; and further, that it was possible so to divide pounded bark in a sieve as to obtain separately the parts richest in bast cells and the parenchyma. It was then evident that the latter was the poorest in alkaloid.‡ What follows will show that I must be allowed to doubt the validity of both these arguments in favour of Wigand's hypothesis.

I miss the microscopical proof that there had really been a division in the manner spoken of, and acknowledge that I was unable to accomplish it by the same means. In the common *C. Calisaya plana*, for instance, the parenchyma is usually entirely absent. Wigand's own confession,§ "If it were possible entirely to clear the parenchyma from the liber fibres, it would probably yield no alkaloid," shows that he himself was not fully satisfied with the result of the sieve experiment.

If, starting from the fact that the liber fibres are heavier than parenchyma, a piece of bark is taken, with rather long, numerous, and, if possible, isolated liber fibres, contained in tender parenchyma, a much more effectual separation will take place by washing.

I chose a variety of *C. Calisaya (Boliviana)* which is very brittle, smooth, and open, and which, in contradistinction to ordinary *C. Calisaya*, contains a good proportion of parenchyma and many laticiferous vessels. I touched small triturated portions of this bark with a little cold distilled water, rinsed away the loose parenchyma, rubbed the remainder again very gently, and treated it in the same way. Finally, after a little help with the pincers, I obtained liber fibres, which showed, when microscopically examined, only inconsiderable remnants of parenchyma, and were themselves uninjured.

The separated parenchyma was, however, less pure, it being almost impossible to clear it entirely from isolated liber fibres. The *C. Boliviana* thus dealt with yielded plentifully the red sublimate of Gräbe's experiment, when heated in a glass tube, and a tolerable quantity of alkaloid came from the bark when touched with cold spirits of wine.

The separated liber fibres showed none of the reaction of Gräbe, and even hot spirits of wine drew no alkaloid from them, whilst the parenchyma gave results in both respects similar to those of the unchanged bark. I made the same observations with *C. lancifolia*. It seems to me that this simple experiment proves, at least, that the woody liber fibres are not the sole or principal site of alkaloid, but far rather the parenchyma is so. There are, it seems to me, very few possible objections against this proof.

Wigand's assertion, that the liber fibres turned red when heated, is no doubt the result of his having worked with parenchyma as well, when the red sublimate from the latter might easily colour the liber fibres; but it may be said that Gräbe's reaction is not a sufficiently delicate test to be of much account.

The question is not, however, to prove the absolute absence of alkaloid in the liber fibres, but much more its preponderance in the parenchyma. Nevertheless, I tried a few experiments which proved that in dried sago meal less than one per cent. of sulphate of quinine cannot be discovered by Gräbe's reaction. The delicacy of the method, however, goes further with the bark itself, since it gives positive results if, for instance, *C. Boliviana* is mixed with five times the weight of sago. Since by Gräbe's proof no alkaloid was to be found in the liber fibres, but was present in the parenchyma, can it be doubted that the latter yields the principal part of it. But the fact that spirits of wine drew no alkaloids from them deserves to count for much more. If alkaloid is contained in parenchyma, no one wishes to assert that the liber is wholly destitute of it. Even should this be the case in the living plant, it is highly probable that as the bark dries, small quantities may be absorbed by the liber fibres. In fact, my liber fibres, which seemed by ordinary treatment to contain no quinine, show slight traces of it by fluorescence. Of how much account it is, however, to obtain slight traces of quinine in this optical way, can be imagined when it is remembered that the one-hundred-thousandth part of a milligram discovers itself in this manner. It is hardly necessary to remark that parenchyma, filtered with sulphuric acid, showed very evident fluorescence. A most serious fault might be found with the means of procuring my liber fibres, since of course cold water, even in the very smallest quantities, takes some alkaloid from the bark. The circumstance can only be thought of no consequence when it is remembered that I used it with great caution for a very short time. And at the same time it cannot be imagined that the liber fibres should thereby lose all their alkaloid and the parenchyma retain it. But even grant that an even amount of alkaloid is lost in the process by both structures, this does not in the least alter the conclusion *that the parenchyma contains the larger portion*.

* 'Botanische Zeitung,' vol. xx. pp. 137-143.

† Schacht, 'Anatomie und Physiologie der Gewächse,' Berlin, 1840, vol. i. p. 400.

‡ The opposite is shown by Howard's experiments on *China rubra dura*. Compare 'Nueva Quinologia,' Microsc. Obser. fol. 5.

§ 'Botanische Zeitung,' vol. xx. p. 140.

D. (Page 29.)

Account of the State of the Cultivation of the Cinchona in Java in the Second Quarter of 1868. By C. VAN GORKOM.

During this quarter there were obtained about 10,666 plants of *C. Calisaya* (of which about 5000 were from Bolivian seeds), 13,845 *C. succirubra* (mostly from seeds from Ceylon), and 9840 *C. Condaminea*, so that at present the account of the plantations contains—

<i>C. Calisaya</i>	509,582
<i>C. succirubra</i>	27,578
<i>C. Condaminea</i>	28,874
<i>C. lancifolia</i>	573
<i>C. micrantha</i>	386
Total	566,993 Plants.

Of these there are in the different establishments in connected gardens—

<i>C. Calisaya</i>	330,809
<i>C. succirubra</i>	5,003
<i>C. Condaminea</i>	18,068
<i>C. lancifolia</i>	573
<i>C. micrantha</i>	343
Total	354,796

The state of the weather was less favourable for the youngest plantations; the continuous drought must also have half-checked the extension of the plantations. On the other hand, the preparation of the woodland was greatly promoted, and in two months sufficient land will be got ready for the following year. Free day-labourers were paid for 11,160 days' labour. The number of fully-engaged and more or less skilled workmen amounts to 120, of whom about one quarter are continuously employed in the nursery garden.

The development of the plantations of 1866 and 1867 is very satisfactory. On the Tilu and Tankuban-Prahu Mountains it may be called unusually good; on the Malawar Mountains the gardens are rather behindhand. Without any particular reason being manifest, the leaves of the *C. Calisaya* pucker and dry up, and their power of life appears to slumber. In other establishments this has only exceptionally been the case. In 1866 a similar sickness showed itself in the former year's plantation; nevertheless the consequences were not serious, and this plantation has so far extended itself since, that in the year 1871 some thousand kilogrammes of bark may be expected to be gathered therefrom, in order to bring these first proofs of the Java cultivation to market. It is to be hoped that some seasonable showers will bring the Malawar plantation again into its normal state.

Many *C. Condaminea* plants already begin to blossom, and from single *C. lancifolia* plants we may expect fruit towards the end of this year. Seeds of the *C. Calisaya* were continuously gathered in still larger quantity, even under the plants which were produced in 1865 from American seeds. Some plants of the *C. Calisaya vera* are loaded with ripe fruit. Through the friendly and efficacious assistance of Dr. Thwaites, of Paradenia (Ceylon), the stock of *C. succirubra* and *C. Condaminea* plants was largely increased. This help is very highly prized, and its continuance will be very welcome in future. The *C. Calisaya* seeds received from Bolivia have relatively produced bad results, for only 5000 seedlings were produced therefrom.

Most of the raising-houses have required considerable repairs: two new contrivances were completed, and measures taken that the kinds of *Cinchona* which have not produced any seeds in Java should afford young plants with greater quickness.

First, in September and October great numbers of seeds of the *C. Calisaya* will be sown, since further steps must be taken to protect the plantations against ruin in a rainy season, in order to have from nine to twelve months after the sowing of the seed, the plants strong enough to plant out in the open ground.

Seeds of the *Cinchona* have been continuously desired by private individuals, but no results have yet shown a happy treatment. If people would trust with confidence in the cost of the transport, these attempts would certainly succeed better, and the universal sympathy for private plantations would be in consequence aroused and increased.

Mr. Van Gorkom says, in reference to the *Calisaya*:—"Dr. Scheffer has confirmed my supposition that the seeds ripened in Java of the plants raised by Junghuhn (5000 plants) are not *Calisaya*; indeed, this sort of *Cinchona* appears, like the *Pahudiana*, to be a sort hitherto unknown. It is not described by Weddell. Miquel is closely examining it. These trees grow splendidly, and contain the double quantity of alkaloids (0.7 = 1.3 per cent.) compared with the *Pahudiana*. Would the trade purchase well such a bark? Should this question be answered in the affirmative, I could easily bring 10,000 pounds into the market, for I have caused the plantations of this sort in the year 1864 to be lightened, and have constantly kept the eye upon them, so that the beautiful high and strong trees should remain. The greater part of these are eight years old, and hundreds of these are to be found which could give three to five pounds of bark, whilst I will take as a mean produce only two pounds."

(Obligingly sent by Dr. Hasskarl.)

E. (Page 29.)

Report of an Analysis of the Eighth Remittance of Bark from India. By J. E. HOWARD, F.L.S.

TO THE UNDER-SECRETARY OF STATE FOR INDIA.

September 1st, 1868.

SIR,—I have to report on specimens of bark collected in March of the present year, and sent to me for analysis, as follows:—

No. 1, *C. succirubra*, being “the third harvest of renewed bark,” is most interesting, as it showed more completely than any sent hitherto the aspect of the red bark from South America, and has in all respects a superior appearance. In examining it chemically, I found that it presented also more exactly the counterpart of that composition which I have described as being commonly observed in the analysis of the older bark of this species. I hoped to obtain a larger produce than last time, but was disappointed in finding a smaller amount of salts of quinine, viz. 6.15 per cent., against 8.45 per cent. in the specimen of renewed bark from the same tree on which I had the honour to report in February, 1867.

The above figures give the *relative* commercial value of the two specimens; but, as I thought it desirable to obtain all the information in my power, I endeavoured, in two experiments, with a sufficient quantity of bark ($\frac{1}{4}$ lb.) in each, to arrive at the most correct results. From the first I obtained quinine as alkaloid, capable of being formed into, and equivalent to 5.33 per cent. of sulphate of quinine. From the second, by a process somewhat varied, I obtained in crystallizations of refined oxalate 4.80 per cent., and remaining in the liquor as more soluble (in part, perhaps, oxalate of cinchonidine) 0.60, together 5.40 per cent. oxalate of quinine. In both cases there was an inevitable loss through the product being more exactly purified; and, therefore, this must be borne in mind in comparing these figures with those previously given; but, even at this lowest or *minimum* scale of production, the results are really surprisingly good, though not equal to the hopes entertained by Mr. M'Ivor.

The explanation of a smaller produce of *sulphate of quinine* appears to me to be found in the *idiosyncrasy* of this particular species, which I have described to the best of my power in my ‘Illustrations of the Nueva Quinologia,’ *sub voce C. succirubra*.

I am pleased to find that Mr. Broughton, in his First Report, corroborates what I have said as to the difficulty of obtaining the alkaloids in a pure state from this species, a difficulty which increases with the age of the tree. On this account, I must again urge the necessity of carefully ascertaining what species are likely to yield the best *permanent* results.

The precipitated hydrated alkaloids, in a subsequent examination of a small portion of the present bark against a re-examination of a portion remaining from the second harvest, gave me for the *second harvest* of renewed bark,—

Alkaloids dried at the temperature of the air	. . .	10.60
Of which soluble in ether, quinine, etc.	. . .	8.70 }
„ „ insoluble in ether, cinchonine, etc.	. . .	1.90 }

For the *third or present harvest* of renewed bark,—

Alkaloids dried at the temperature of the air	. . .	11.20
Of which soluble in ether, quinine, etc.	. . .	9.40 }
„ „ insoluble in ether, cinchonine, etc.	. . .	1.80 }

It will be seen that the proportion of alkaloid has increased, but this would be no guide to the commercial value, which is almost entirely regulated by the proportion capable of being converted into crystallized salts. More valuable commercial information, consequently, will be gained from the following corrected analysis:—

Quinine (as sulphate)	. . .	5.33
„ uncrystallizable	. . .	2.00 (?)
		7.33
Cinchonidine	. . .	1.14
Cinchonicine	. . .	0.53
		9.00

I have attached a (?) to the weight of the proportion of uncrystallizable quinine, which it was impossible to ascertain exactly from so small a quantity of bark. Moreover, from its great implication with resinous colouring matter, I am led to doubt the possibility of obtaining any part of it as crystallized sulphate of quinine on a large scale. This uncrystallizable portion is, therefore, unimportant, and not to be reckoned, from a commercial point of view, as possessing any value to the purchaser of such bark for manufacturing purposes.*

The analysis of No. 2, “Root bark from a tree of *C. succirubra* seven years old,” presented much interest, as bearing on the question as to which of several modes of cultivation is to be preferred, since it has recently been proposed to cultivate the plant, like madder, solely for the roots.

I consequently have forwarded about half the sample of No. 2, and also No. 3 (of which a very small quantity was sent from India) to Dr. de Vrij, as it was desirable thus to arrive at a consentaneous agreement on the value of the root bark, which I have always regarded unfavourably, judging from the root bark of the *C. Calisaya*, var. *Josephiana*, occasionally found in the market.

* The weight of the crystallizable, and consequently more valuable, portion, was ascertained by the following process:—The 6.15 per cent. (as above) having been precipitated, the precipitate was dissolved in ether, separating thus the cinchonidine and the quinine, then dried at 212° F. It must be understood that quinine thus obtained from the *C. succirubra*, although sufficiently pure to pass the tests required in commerce, retains some cinchonidine, which can be separated by solution in acid and subsequent treatment with iodide of potassium.

The analysis was troublesome, although the hydrated alkaloids were obtained in a state more free than often from colouring matter. The weight of the precipitated alkaloids appeared to be 12.75 per cent., but this hopeful amount did not yield proportionate results, probably from an amount of wax and resin being carried down with the alkaloids. I obtained with difficulty a small crystallization of sulphate of quinine, and the remaining liquor, when precipitated, dissolved in ether, and the solution left to concentrate by evaporation, furnished crystals of cinchonidine adhering to the sides of the vessel, and at last uncrystallizable quinine containing a portion of quinidine.

The remarkable feature was the large production of fine cinchonine, almost insoluble in ether, yielding good crystals from spirit of wine, and these, when formed into sulphate, giving the very characteristic salt. In all this, the root bark is decidedly superior; but, it will be observed, it is *cinchonine*, and not *quinine*, that (at all events in this species) is the product of this root bark. I give the total as follows:—

Quinine (as sulphate)	1.75
„ uncrystallizable	4.50 (?)
	6.25
Cinchonine	3.00
Cinchonicine, water, and gum resin	3.50
	12.75

This root bark would not be of more value than that mentioned above (of the *C. Josephiana*), unless it were wanted for the extraction of cinchonine.

No. 3. I shall transmit the report of the analysis when I receive it from Dr. de Vrij.

No. 4 consists of four pieces of fine-looking crown bark, apparently not intended for chemical analysis.

Nos. 5, 6, and 7 are interesting to me, and will, I hope, furnish some facts for a work which I am publishing, "On the Quinology of the East Indian Plantations." They appear to be intended rather for microscopical examination than for chemical analysis. The seeds of No. 7 have been sent to Kew.

I beg to remain, yours very truly,

JOHN ELIOT HOWARD.

SUPPLEMENT.

Copy of a Letter from Dr. DE VRIJ to J. E. HOWARD, Esq., containing Analysis of No. 2 Root Bark.

The Hague, August 30th, 1868.

The sample of No. 2 *Cinchona succirubra*, root bark, from a tree seven years old, with your letter of the 21st instant, duly reached me, and immediately I set at work to analyse this bark, which was very welcome to me, particularly because now you have the opportunity to judge by yourself of the richness of the root bark, at least, of the cultivated cinchonas.

I found in the bark 11½ per cent. of alkaloids, and 0.467 per cent of cinchona bitter (kinovic acid). The part of the alkaloids soluble in ether amounts to 4.31 per cent. of the bark. Although these 4.31 per cent. are soluble in ether, they do not entirely consist of quinine (crystallizable), but contain another alkaloid also soluble in ether. As you expressed your wish to obtain the results of my experiments within about ten days, I have not been able to ascertain with certainty which is this alkaloid which accompanies the crystallizable quinine in its ethereal solution. I suspect it is the amorphous alkaloid which I always find in the Indian barks, but am not yet quite sure of it. I obtained beautiful herapathite from the part of the alkaloids dissolved by ether, so that there is no doubt that this root bark contains really crystallizable quinine. In treating the total amount of alkaloid with ether, I had some reason to expect to obtain also cinchonidine. In this I was, however, frustrated, for I could not find till now with certainty its presence. At this moment that I write this letter my result is that the mentioned bark is rich in alkaloids, of which the part *insoluble* in ether consists chiefly of *cinchonine*. If cinchonidine is perhaps also present, it can only be a very small quantity, not to be compared with the large quantity which I obtained from the stem bark of *C. succirubra*.

Copy of a Letter from Dr. DE VRIJ to J. E. HOWARD, Esq., containing Analysis of No. 3 Root Bark.

September 18th, 1868.

Together with your valued letter of September 3rd, I received the No. 3 of root bark from *C. succirubra*. . . . As the amount of the powdered bark dried at 212° F. was only 19.5 grammes, I divided this quantity into two parts, viz., one of 10 grammes (the quantity which I always use), and one of the remaining 9.5 grammes. From the first I obtained 1.202 grammes, and from the second 1.088 grammes of alkaloids. The average percentage of alkaloids in *this* red bark is therefore 11.743 per cent., whilst the amount of kinovic acid is 0.676 per cent. The combined amount of the obtained alkaloids, viz. 2.29 grammes, was dissolved in dilute acetic acid, by which treatment only an imponderable trace of dark brown resinous matter remained undissolved. As the acetic solution proved to contain no quinidine, it was shaken with caustic soda and ether. The following day the ethereal solution, which was lemon-coloured, was evaporated, and the residue dried at 212° F. Its amount was 0.931 gramme; this root bark contains, therefore, 4.774 per cent. of alkaloid soluble in ether. I obtained from these 0.931 gramme beautiful herapathite, but found, in the meantime, that the largest part of this alkaloid soluble in ether is *not quinine*, but an amorphous

alkaloid. I am still occupied with researches to find out the real nature of this amorphous alkaloid. . . . The remaining alkaloids, which were not dissolved by ether, proved to be *cinchonine*, with only a trace of cinchonidine. In this root, as in the former, I found the cinchonine particularly fit to crystallize, and consequently I obtained beautiful sulphate of cinchonine from it.

J. E. HOWARD, Esq., to C. R. MARKHAM, Esq.

For the guidance of the Indian Government, I send the foregoing interesting and well-executed analysis, and add that it accords most nearly with the previous analyses by Dr. de Vrij and myself of No. 2 *Root Bark* of larger size, but of the same parcel, and that these specimens of root bark would command but a low price in the London market, from the causes before stated. I do not think the root bark of *this species* would repay cultivation.

ADDENDA ET CORRIGENDA.

MR. BROUGHTON'S REPORT, AUGUST, 1868.

SINCE the foregoing sheets were sent to press, I have received from Mr. Broughton a copy of his latest Report,* dated 17th August, 1868.

I am pleased to find that the contents of this letter tend greatly to the confirmation of the views I have advanced, especially in the following particulars:—

1. In reference to the value of the *C. succirubra* as a species for cultivation, which I have always thought over-estimated (and never more so than in recent accounts from Jamaica), Mr. Broughton says:—

“My experience of the Red Bark plantations does not lead to the conclusion that the amount of Quinine has shared in the increase observable in that of the other alkaloids. To this subject I shall subsequently return.”

“Bark of *C. succirubra*, grown in the Wynaad at an elevation probably not exceeding 2400 feet, was *thinner* than that of Neilgherry growth, and that of good appearance gave but 0·5 per cent. of Sulphate of Quinine, and 2·9 of Sulphate of Cinchonidine, showing that Quinine is formed in much less quantities at low elevations.” The whole of Mr. Broughton's experience leads to the conclusion that “a high mean temperature is *adverse to the yield of Quinine*, but *not to that of Cinchonidine*.”

“The bark of two trees, after a sample had been analysed, was covered in one tree with a shield of tinned plate, and in the other with black cloth. The object was to keep the bark in darkness, while access of air was not impeded. The result of subsequent analyses were as follows:—

	Tree covered with tinned plate.		Tree covered with black cloth.		
	Original bark.	Bark after ten months' protection.	Original bark.	Bark after six months' protection.	Bark after ten months' protection.
Total alkaloids	5·29	8·10	5·04	6·91	7·92
Quinine	2·16	1·65	2·26	2·03	2·34
Chinchonidine and Chinchonine	3·13	6·45	2·78	4·88	5·58

“The foregoing experiments agree in showing that deprivation of sunshine has had the effect of increasing the amount of alkaloid in the bark. The alkaloid was obtained crystallized with nearly the same readiness as in mossed bark. The amount of Quinine has *not*, however, been increased, as in the case of mossing. This is a circumstance which I did not expect, and it is opposed to deductions from other experiments. It is, however, a fact, and will doubtless be explained by increased knowledge of the subject.”

The trees covered with black cloth or with tinned plate, in this experiment, would not thereby be shielded from the heating effect of the sun's rays, and probably on this account coincide in their product of *Cinchonidine* with those which I have described as grown in sunshine.

“It is a fact that, in the Chinchona barks of South India (considered as a whole), the replacement of Quinine by Chinchonidine obtains to a greater proportion of the total yield of alkaloids than in those of South America. The actual amount of the substitution varies greatly in single trees, both according to its variety and the conditions to which it is exposed. The practical effect of this peculiarity is compensated for by the large total yield of the alkaloids. For medicinal purposes, it appears, from the recent medical trials, that it is of little importance which of the two alkaloids are produced. Nevertheless, the causes which produce the replacement are obviously of the greatest interest in connection with Chinchona cultivation. There must be several proximate causes, and it will, I think, be evident from the foregoing experimental results, that they are in progress of being elicited. Thus it appears that *a low mean temperature within certain limits is favourable to the production of Quinine*,† as is also

* Proceedings of the Madras Government Revenue Department, September 22, 1868, No. 334. Read the following letter from J. Broughton, Esq., Quinologist to Government.

† The italics are mine, to direct special attention to these important observations.—J. E. H.

the loose cellular structure of the bark produced by artificial means. To these must be added a circumstance that I have long observed, more especially among the varieties of *C. officinalis*, that trees which are from their position fully exposed to sunshine have a proportionally larger amount of Chinchonidine than those grown in shade.

"Mr. Howard, to whom I communicated this observation, informed me that it quite agrees with his experience. The yield of Quinine in the Ceylon Crown barks was greater in those grown in shade than in those fully exposed. Dr. De Vrij has observed the same peculiarity.

"The same fact harmonizes with the opinion prevailing in South America, that the bark of Uritusinga varies in quality according to the aspect of its situation with respect to the sun. If it be the heat of the sunshine that produces these effects, it will be seen that exposed bark would in many respects be under the same conditions as that grown in a warmer climate. The sunshine, which is powerless to warm the dry and diathermanous air of the Neilgherries, falling on the bark, at once raises its temperature.

"These observations derive additional force from the consideration, that it is in this respect of effective heat-giving sunshine that the climate of the mountain ranges of South India differs from that of the Chinchona regions of South America. With the same annual mean atmospheric temperature, the climate of the Neilgherries differs from that of the bark regions, in having six months of unclouded sunshine when the singular dryness of the atmosphere robs the rays of none of their heating power. The bark countries of the Andes are, unlike ours, situated in a region of perpetual trade-winds, which, as our monsoons, bring their abundant rains and fogs during the greater part of the year to interrupt the sunshine. The travels of Markham, Karsten, Spruce, Boussingault, and many others bear full testimony to this."

The elevation of 6000 to 7000 feet appears to be most favourable to the yield of Quinine in the *C. succirubra*; above the latter height it diminishes.

"The fifth year of the life of the Red Bark trees is marked by a great increase in the number of the liber fibres of the bark, by which that portion becomes thoroughly developed. There appear to be some grounds for the conclusion that this development is not favourable to the yield of Quinine."

"Frequent analyses made of the Red Barks during the last eighteen months have clearly shown that the yield of alkaloids varies according to the season of the year. The ratio that the amount of Quinine bears to the other alkaloids appears also to vary. Periodic analyses were begun fourteen months since, for the purpose of ascertaining the times of maximum and minimum yield, but at least a year more must elapse before I obtain sufficient data to decide this important subject. I may, however, state that the point of maximum yield falls within the period comprised between the beginning of February and the end of May."

I have remarked on the great variability which I have found in the products of the *C. succirubra* from South America, which may partly depend on the above cause. If I were forming a plantation, I should certainly not depend on this species as my mainstay.

2. Mr. Broughton agrees with me in a favourable estimate of the Crown Barks, from which, however, must be deducted the disadvantage of a slower growth, and a consequent—perhaps one-third—less formation of bark than in the *C. succirubra*. The largest yield of Quinine in these barks occurred at the height of 8000 feet.

"The trees planted at the lowest slopes of the latter, yield barks which are also inferior in other respects, since they contain resinous and colouring matters which increase the labour of purifying the alkaloids. The cortical fibres are also more numerous in the low-grown Crown Barks. I have also detected Quinidine in these barks. The Quinine is in great part replaced by Cinchonidine, exactly as in low-grown Red Barks."

"I have already expressed my conviction of the great value of our Crown Barks. Further investigation has given no reason to alter that opinion. The Quinine which they contain yields a pure white crystalline sulphate with ease. Many specimens I have met with have been actually free from "uncrystallizable Quinine." Hence the Quinine is frequently so pure as to yield its theoretical amount of crystallized sulphate. I have met with specimens of Crown Bark which yield upwards of five per cent. of purified alkaloid.

"Mr. Howard (whose correspondence and assistance have been of great service to my work) has informed me that he has satisfactorily identified a sub-variety of our *Chinchona officinalis* with that which yielded the bark known as *Amarilla del Rey*. This is a sort which has long enjoyed a high reputation among Pharmacutists and Quinine manufacturers, and its possession is a very fortunate circumstance. It appears very easy to work, and yields Quinine readily, crystallizable as sulphate. In actual amount, however, it does not appear to differ essentially from its companion sub-varieties.

"Among the Crown Barks which were grown from seeds brought by Mr. Cross, are a few scattered trees, which present a marked difference from the rest of their companions. The leaves are of a narrow lanceolate shape. My attention being directed to the study of those varieties whose numerical importance claimed the earliest observation, it was not till recently that I made an analysis of this variety. Surprised by the result, I took the precaution of making an analysis of the adjoining trees of *Chinchona officinalis*, in order to eliminate the possible influence of peculiar conditions of soil, site, etc.

"The percentages of the respective alkaloids stand thus:—

	Bark of Lanceolate species.	Bark of adjoining trees.
Total alkaloids	8.0	4.48
Quinine	7.15	2.06
Chinchonidine and Chinchonine	0.85	2.42
Sulphate of Quinine obtained crystallized	7.37	Undetermined.
Do. Chinchonidine obtained crystallized	0.15	Do.

"The specimen, therefore, was of the finest bark in our possession. I do not think I over-state, when I add that, in yield of Quinine, it is of the finest quality that has ever been recorded. It possesses every characteristic constituting excellence. It yields alkaloids in such purity that the first crystallization gives sulphate of Quinine, which stands the usual tests as well as the refined salt. I would earnestly recommend that the plant be extensively propagated, and as rapidly as possible. The possession of this species is a most fortunate circumstance."*

I have also had the honour to present the Government with young plants from a small tree in my possession, with which Mr. M'Ivor was so much pleased, that he took out a layer which he himself had made of it. I name this provisionally *C. Forbesiana*, to commemorate Mr. David Forbes, who, after many adventures (which I have described in a paper sent to the Botanical Congress in 1866, page 199), brought the seed to England. I may possibly describe both these kinds more particularly in a future part. For the present, I will only add that the analogy of the leaf of the *C. Forbesiana* is with the *C. lancifolia*, but that of the flowers, which have unfortunately not advanced with me beyond the state of buds, seems to be with *C. micrantha*.

3. In reference to mossing the bark, and the reproduction of the bark after it has been removed from the trees, Mr. Broughton has the following remarks confirmatory of the views expressed by myself:—

"The bark of trees that have been subjected to the mossing treatment introduced by Mr. M'Ivor has been so abundantly examined by Mr. Howard, from specimens supplied at intervals for that purpose, that repetition by myself of the experiments on the same limited scale appears almost supererogatory. The following analyses may be adduced as quite corroborating former ones:—

	No. 1. Bark of <i>C. succi- rubra</i> sixteen months under moss.	No. 2. Bark of same trees renewed under moss sixteen months.
Total alkaloids	10.72	8.22
Quinine	4.31	5.14
Chinchonine and Chinchonidine	6.41	3.08
Total sulphates obtained crystallized	9.27	4.67
Sulphate of Quinine	4.02	3.87
Do. Chinchonidine	5.25	0.80

"The barks yield by mossing a greatly increased amount of alkaloid, and in a state which permits them to crystallize with facility as sulphates. The bark No. 2, renewed under moss, was thinner than natural bark, and *lost more weight on drying*. It should be remembered, however, that the renewed bark was sixteen, while the natural bark was sixty-six months old. This specimen was remarkable for the large amount of Chinchonine it contained. Had the sulphate of this base been reckoned among the total sulphates, their amount would have been upwards of six per cent. As already remarked by Mr. Howard, freshly-renewed bark contains a considerable amount of uncrystallizable Quinine.† I have continually observed this peculiarity of young bark, whether it be obtained from young trees directly, or produced by "renewal" on older trees. It would seem that it is as uncrystallizable Quinine that the alkaloids are first formed by the natural processes in the plant. Thus, from the 3.23 per cent. of Quinine found in some young Red Bark two and a half years old, but 1.97 of Sulphate of Quinine was obtainable crystallized; while in some bark sixteen months old, but one-fifth of the Quinine found would give a crystalline sulphate.‡

"The process of mossing the bark appears to require trial on a scale in which the increase, both of bark and alkaloid, could be systematically determined, and the *cost*, compared with other methods of cropping the bark, such as coppicing, etc. These points are obviously necessary to an estimation of the practical value of the method, and at present are only guessed at. The repeated treatment of single trees, and analyses of the bark after so many concurrent experiments, seems comparatively useless labour, while there exist so many other questions of a chemical nature to be settled. Unless, therefore, Government are pleased to direct otherwise, I shall only give the subject that attention which its actual practical working demands, or that its connection with the histological chemistry of the plant may require."

4. I have mentioned that Mr. Broughton agrees with me that the liber fibres are not the seat of the alkaloids. Mr. Broughton adds, to a paragraph already quoted, the following information:—

"The opinion of authorities as to the principal seat of Quinine in the bark has been divided. Weddell, Wigand, Schleiden, and others have concluded, on theoretical grounds, that the liber is the part of the bark in which the alkaloids are situated; Howard, on the contrary, by direct trial, has satisfied himself that the main seat of the alkaloids is in the cellular portions of the bark which are external to the liber. Having far greater facilities for determining the question than any other chemist has

* Mr. Broughton suggests that "it is not improbable that the species may be the *C. Pitayensis*, whose excellence it possesses." Mr. Batcock has brought home a large collection of specimens of Chinchona, and among them this important species appears represented by leafy branches of foliage, resembling the *C. lancifolia* of Dr. Karsten, but that rather in the general habit of the plant than in the exact shape of the leaf. It is certainly *not* the *C. Pitayensis* as represented in a specimen brought by Cross, and in my possession, of the *Quina roja* of the Piñon of Pitayo, but may *probably* belong to one of the forms of *Cinchona lancifolia* in the region of Popayan; that called the *Calisaya of Santa Fé* is very rich in Quinine in its native habitat at the head of the valleys of the Cauca and Magdalena.

† But see the microscopical observations for my views on this point.—J. E. H.

‡ In these young barks the injurious resin abounds.—J. E. H.

hitherto possessed, I repeated the experiment that Mr. Howard had made, using, instead of the dried South American bark, the bark of *C. succirubra*, fresh from the tree. The liber was separated from the external cellular portion, and the two portions were then submitted to analysis. The analyses were made at a season favourable to the yield of alkaloids.

	First series.		Second series.	
	Liber.	Cellular portion.	Liber.	Cellular portion.
Total alkaloids	5.94	7.98	6.85	8.00
Quinine	0.7	2.25	0.85	3.25
Chinchonidine and Chinchonine	5.24	5.74	6.00	4.75
Sulphate of Quinine	Undetermined.	Undetermined.	0.9	2.8
Do. Chinchonidine	Do.	Do.	4.1	4.2

A similar experiment was made with bark five and a half years old that had been under moss for seventeen months.

	Liber.	Cellular portion.
Total alkaloids	9.80	11.83
Quinine	2.89	5.49
Chinchonidine and Chinchonine	6.91	6.34
Crystallized Sulphate of Quinine obtained	2.44	5.1
Do. do. Chinchonidine obtained	4.74	4.84

"The whole of the above trials corroborate those of Mr. Howard, in showing that the external cellular part of the bark is markedly the richest in Quinine, and, to a less extent, richer in total alkaloids. When the bark becomes older, and the liber more woody, it is probable that these qualities will be still more apparent. It is remarkable that mossing, which increases the yield of Quinine, also has a tendency to thicken the cellular or less organized portion of the bark. The freshly-renewed barks, which, as shown above, contain principally Quinine, consist nearly entirely of cellular tissue. Hence, existing evidence is adverse to allowing the bark to obtain an age when liber would be formed at a greater rate than the cellular tissues of the bark."

5. Mr. Broughton's account of the green colouring-matter of the leaves agrees with those presented by myself to the reader. The lamented death of Dr. Herapath prevents the possibility of the completion of his researches, but I am inclined to believe that Mr. Broughton's observations, when finished, will coincide with those recorded by Dr. Herapath with his usual accuracy, copies of which he sent me in letters now in my possession.

6. Mr. Broughton agrees with preceding chemists, in looking upon the formation of the alkaloids as depending upon ammonia, and has the following good practical suggestion:—

"Ammonia has been present in every specimen of Indian bark that I have examined. The hypothesis has been propounded that this substance, which is itself really an alkaloid, is a step in the formation of Quinine, etc., and is, so to speak, the frame-work of their constitution. The idea of an essential connection between ammonia and the vegetable alkaloids dates from the early part of the century, and advance of knowledge has but increased its probability. As far as I am aware, the action of ammoniacal manures (so largely employed in European agriculture) has never been systematically studied, when applied to the alkaloid-producing plants, although the idea of supplying the elements required in the elaboration of these peculiar products is a plausible one. I would suggest that small plots of the two leading varieties of *Cinchonæ* in our possession be each manured with guano in one case, and in the other with common sulphate of ammonia, such as is sold in Europe for agricultural purposes, commencing when the plants are a year old. This is an experiment in cultivation that must be tried sooner or later, since the question of the action of manures is one that obviously suggests itself. The chemical study of the effect, even if it be a negative one, will be of great interest."

7. Mr. Broughton was the first to ascertain, and to publish (paragraph 20) the existence of alkaloid in the heart-wood of *C. succirubra*. His amount, 0.08 to 0.11 per cent., agrees well with mine.

UEBER DIE CHINAKULTUR AUF JAVA.

I HAVE received, under this head, the German translation of a paper in the Dutch periodical 'Gids,' of May, 1868, in which the writer gives his account of the progress of the cultivation of the *Cinchonæ* in Java. The Dutch have the honour of leading the way in this useful enterprise, and therefore it is the more to be regretted that the mistakes, which were certain to be incurred in a

new undertaking, should have been rendered more disastrous by the party spirit with which the whole subject appears to have been agitated, even in the Legislature.

It is extremely unpleasant to come in contact with such a state of things, and I find that I am censured for not being sufficiently one-sided in the dispute. The writer in 'Gids' says "Mr. Howard, who described the unfortunate sort as a new species in his noble work on the Cinchonæ, although he at first, with reason, brought its usefulness into question, afterwards took a position of weakness and uncertainty as the conflict began to wax warm," etc.

To this I have only to reply that I have published such information as came to my hands as correctly as I could, and intend still to do so. I see no occasion to alter my account of the species given in the 'Nueva Quinologia,' and still believe that it is without value if looked at simply as a source for the extraction of Quinine; but as regards the *root-bark*, I have, personally, no information to oppose to the favourable estimate elsewhere entertained, and must therefore maintain a position of "uncertainty" till this is removed by those who can decide the question. If the *C. Pahudiana* be looked upon in another point of view, viz. as a possible source of bark for pharmaceutical purposes, I have shown in my reports, given to the Government of British India, on specimens from Ootacamund, that the quill bark is not only *not* worthless, but that such quills as those sent by M'Ivor were actually preferred to other kinds sent with them by dealers most competent to judge in London; and this not without reason, from their taste, appearance, and chemical composition. I cannot, therefore, agree with those who recommended the superfluous labour of cutting down the trees; neither can I rank this plant "among the best sorts of all," as, it seems, some have attempted to do. The trees, having now many years' growth, might, perhaps, furnish quill bark fit for the home market; and I shall be surprised if it is not at least equally valued there with the bark of the so-called *C. Calisaya*, which, I am afraid, will prove "unfortunate" also; at least if it produces but 1·3 per cent., as described by Van Gorkom.

I have now specimens of the *C. Pahudiana* in healthy growth, and am confirmed in my view of its being a new species, "quite distinct," as Dr. Weddell avers, from the *C. Carabayensis*.

Dr. de Vrij remarks :—

"Tandis que le gouvernement néerlandais, éclairé par ses savants conseillers (voyez 'De Gids,' mai 1868), considérait comme superflue la présence d'un chimiste, chargé spécialement d'éclairer sans discontinuité de ses lumières et de ses expériences la marche de la culture des cinchonas et faisait détruire (ce qui a été exécuté par les ordres du gouverneur général Hoet Van de Beele à la fin de 1863) le laboratoire de chimie qui avait été érigé à grands frais à proximité des plantations de cinchonas, le gouvernement anglais a été précisément d'une opinion tout opposée et a envoyé dans ce but en 1866 M. Broughton à Ootacamund. La représentation nationale des Pays-Bas paraît toutefois partager l'opinion du gouvernement anglais: cela résulte de ce fait que la deuxième chambre des États-Généraux a donné le 14 juillet 1865 son approbation au rapport de la commission choisie dans son sein pour examiner les pièces produites par le ministre des colonies relativement à la culture des cinchonas à Java: or ce rapport se termine de la manière suivante.

"Pour atteindre le résultat désiré, il sera du reste nécessaire d'étudier sans discontinuité dans des conditions diverses avec tous les moyens fournis par la science les différentes sortes de cinchona poussant actuellement à Java, afin de pouvoir ainsi arriver à connaître dans quelles circonstances il se forme dans l'écorce une quantité de quinine aussi grande que possible."

"Il est fâcheux que le gouvernement n'ait paru tenir aucun compte de ce désir et que nous soyons par suite encore actuellement fort peu édifiés sur les conditions dans lesquelles a lieu dans les différentes espèces de cinchona la formation de la plus grande quantité possible de quinine."

I have only to add, in justice to Dr. Vrij, that it did not occur to me, whilst referring in page 6, to the solicitude with which I conducted the first experiment on bark of *C. succirubra* from Ootacamund, to state that Dr. de Vrij had *previously* obtained and described alkaloids from the plantations in Java. (See the 'Répertoire de Chimie,' October, 1860, p. 315.)

M. HARDY, SUR LA CULTURE DU QUINQUINA EN ALGÉRIE.

THE above pamphlet has been sent me by M. le Dr. J. L. Soubeiran. It is valuable to all who have any intention of commencing Cinchona plantations in any extra-tropical region. It has confirmed me in a fear, which the experience of the past summer of 1868 has induced in my mind, that I have spoken rather too sanguinely in the early portion of this work of the possibility of any member of the family becoming at all acclimatized in our regions. The heat and drought of summer and the frosts of winter seem almost alike inimical to the success of the enterprise.

CULTIVATION OF CINCHONA IN TEXAS.

DR. THOMAS ANTISELL appears to have prepared a memoir on this subject, which forms part of the Commission of Agriculture for 1866.

Seeds of the *C. succirubra* and *Condaminea* were procured by the United States Minister residing in Ecuador. The latter only germinated in 1864, in the experimental garden of the Department of Agriculture at Washington, but owing to unfavourable circumstances the plants were but weakly, and it was intended to transport them to more propitious regions.

It had been supposed that Texas might present favourable localities, but these, according to Dr. Antisell are more likely to be found towards the frontiers of Mexico, below the zone of the *Sequoia*. ('Journal de Pharmacie et de Chimie,' Jan. 1869.)

ERRATUM.

Page 11, line 29. "By" should be "of."

* 'Journal de Pharmacie et de Chimie,' Jan. 1869, p. 24.

QUINOLOGY OF THE EAST INDIAN PLANTATIONS.

INTRODUCTION.

THE transplantation of the Quinine-producing trees from their native soil and climate and their naturalisation in various regions of the world may now be looked upon as accomplished, and the fact reflects much credit upon the enterprise and skill of those who have been engaged in the transfer. It is an illustrious example of what may be done to counteract the effects of the manner in which the bountiful resources provided in the natural order of the world around us are not unfrequently misused. It is probable that eventually every useful plant of the forests, and all their living inhabitants, as far as they can be of service to the human race, will have to be cared for in a similar manner; but it may soon be too late to remedy some part of the evil. In many portions of the once thickly populated and richly cultivated regions of the Eastern world desolation reigns; and many varied natural products spoken of in the early records of Egypt are scarcely to be met with at the present time. Around the shores of the Mediterranean, where once forests clothed the mountains, the denudation of the land has apparently deteriorated the climate; and the restoration of these forests has become a subject of national anxiety—the *Eucalyptus* (in its varied forms) affording some hope of a better state of things being brought about in Algeria and elsewhere by its introduction. In North America the wasteful consumption of wood awakens alarm. The noble herds that once roamed the prairies seem destined very soon to pass away, together with the Red Indian, to whose sustenance they contributed. To complete this rapid survey with a return to the regions of the Andes, we are assured that the Alpaca, a gentle and beautiful creature, whose wool has been made so serviceable of late, is likely, unless some care is taken, to disappear,—together with the Chinchilli, whose valuable fur has made this creature the object of too eager pursuit. It would be well if Mr. Ledger's plan* for the introduction of the former into the mountain pastures of the Nilghiris could

* See Mr. Ledger's Letter.

be adopted. It is a subject of congratulation that at all events the source of a medicine the most universal, and not to be produced by art, should have been rendered secure; and it is very satisfactory to find that the trees affording us Quinine and other precious alkaloids have not suffered at all in the transit; and that the only change has been of the beneficial nature which careful cultivation is almost certain to induce. There is not the slightest reason now to fear any degeneration in the plants, or diminution in the supply of their products.

At the same time, it should be clearly understood that the success—though complete—has not been quite of the character that was expected. It was supposed that the rich and valuable *Calisaya* of Bolivia was in danger of extermination, and that when this source of supply was exhausted the price of Quinine would be very much enhanced: as it was not thought that sufficient material could be found in any other quarter.

This exhaustion of the Bolivian forests, though it may be steadily progressing, has not yet reached its consummation. Indeed, it appears that fresh districts have been recently explored with some considerable success. Nevertheless, it is quite clear that if the world's supply of Quinine had to be derived from these wastefully conducted and improvidently exhaustive cuttings, the result above mentioned would soon follow.

In the interim, many other things have happened. The great Pitayo forests have been opened up, and to a considerable extent exhausted; although one new district, that of La Cruz, affords some fresh cuttings. The Red-Bark districts of Ecuador and those of Peru never have afforded any very large supplies of Quinine-producing bark, so that they need not detain us; but when we come to the immense territories of New Granada, the case is quite different. When first brought under contribution these districts acquired rather a bad reputation; for, in truth, the *Quina naranjada*, or true *Lancifolia* bark of Mutis, was not well adapted for the purpose of the extraction of Quinine. The *Quina amarilla* of Mutis or *C. cordifolia* earned for a long time a still worse character, notwithstanding its designation of 'yellow bark,' and the early application of this misleading name to *Calisaya*, which is not yellow at all. The *Quinquina rose d'Ocaña*, which was unknown to Mutis, and which I have described as probably the product of *C. rosulenta* (Howard), is only to be looked upon as a possible source of material for the extraction of Cinchonidine; if ever this alkaloid should be sufficiently valued to render such an operation commercially profitable. It has been denominated '*Quinquina à Quinidine*,' but erroneously; for the true Quinidine-producing barks are rather the different varieties of *C. Pitayensis*. The *Quina roja* of Mutis is a bark of no medicinal interest, not being the product of any variety of *Cinchona*, but rather of a *Cascarilla*, or, as now more correctly denominated by Dr. Weddell, '*Buena*.' The *Quina blanca* is also useless, proceeding from the *Buena macrocarpa*.

It remains that all the barks of New Granada, as described by Mutis, were of no value in a commercial point of view, but nevertheless there exist in that country in great abundance materials of the most important character. Foremost amongst these barks, of superior quality, is the *Calisaya* of *Sta. Fé*, which I have described in the Bulletin of the 'Société Botanique de France;' having retained the position assigned to it by Dr. Weddell as a variety of the *C. lancifolia*, rather by way of

convenience than otherwise; for its peculiarities are so marked that it ought, perhaps, rather to be looked upon as a distinct species. Whatever may be eventually decided in this respect in a botanical point of view, there can be no doubt that, commercially, the 'soft barks' of New Granada, of which this is the best and the most important, have wrought in the last fifteen years quite a revolution in the prospects of the supply of bark suited for the extraction of Quinine. Not only are the forests most extensive, reaching, as it is said, nearly to the confines of Brazil, but these are declared to be cut with economy, so that the trees would afford fresh shoots, allowing for renewed cuttings after the lapse of ten or fifteen years. The character of the bark on these young shoots of *Calisaya of Sta. Fé* is of first-rate quality, as I have shown elsewhere. In addition, there are several sorts of bark proceeding from sources not yet botanically described, of which some are very useful in their production of Quinine, as also many others of inferior value. Some of these, derived from varieties of *C. cordifolia*, have been made useful for the extraction of Quinine. The amount collected may be judged of from the return of the export from the port of Santa Martha alone, during the year 1873, of 14,829 *serons*; the word 'seron' standing here for packages of various descriptions, since not a little comes in 'bales.' The true 'serón' (when this Spanish word is applied to the package of bark) is formed of a bullock's hide, sewed in a fresh state with thongs of the same material round the enclosed contents. These should weigh 4 arrobas (or say 128lbs.), but it would be unsafe to calculate from these data alone the exact weight, which will, however, be seen to be very considerable.

It follows, as a necessary consequence from what has been stated, that the success of the Indian Government in this great enterprise has been of quite a different character from what could have been anticipated. There is no scarcity, but, on the contrary, a very great abundance of Cinchona bark of inferior descriptions imported from South America, together with a sufficient quantity of superior quality to supply the requirements of the Quinine manufacturers; so that no such state of things exists, or is likely to exist, as that which was anticipated when the plantations were commenced in India. Under these circumstances, the only commercially profitable investment of capital must be connected with the production of a superior description of bark, such as will continue to command a relatively high price in the market. The first consideration for the planter must be the selection of a suitable climate and soil, and elevation above the sea; and, last and not least, the choice of those kinds of Cinchona trees which are known to yield the favourite alkaloid (Quinine) in as large a quantity and as pure a form as possible; for it is obvious that the great abundance of bark derived from trees that can only be expected to produce the alkaloids which are considered inferior must, whilst this state of things lasts, keep the price at so low a point as greatly to disappoint the expectations of the unskilled cultivator. It is to be regretted in this point of view that so much stress should have been laid on the amount of the per-centage of alkaloids, as, for instance, in the case of the Red Bark (*C. succirubra*), a kind which it is very easy to propagate, but which is found to be commercially profitable only under certain circumstances of specially advantageous cultivation, or when the operation of the renewal of the bark has been successfully carried out. In general, although the quantity of alkaloid produced may be large,

the proportionally great amount of Cinchonidine, and of other less profitable alkaloids, leads to much disappointment in the commercial result. The renowned Calisaya has not yet been a success in British India, and, so far as my knowledge extends, has not even begun to be imported from thence. I understand that it is now decided to bestow more attention on this species both at Ootacamund and in the Darjeeling plantations. I know not that the climate in either situation is sufficiently favourable, or whether the result will be satisfactory. I have examined *one* sample from the latter district, which promised well in appearance, but was disappointing in the result. I am inclined to believe that the climate is too dry for four or five months on the Nilghiris, and that the monsoon winds are very unfavourable to these delicate trees.

The grand success of the English plantations has been found in the cultivation of the different forms of the *C. officinalis*. These yield on the Nilghiris, and also in Ceylon, a produce that leaves little or nothing to be desired, and which must be satisfactory to the grower. The only drawback that I know of is the slower development of the trees, and their tendency (as in South America) to assume too much of a slender and spindly growth. They are said not to succeed in the climate of Darjeeling. Mr. McIvor writes me from Ootacamund, under date 16th August, 1875: 'The extent planted with *C. Uritusinga*, the plant sent out in charge of Mr. Lyall, is over 70 acres, and originally 65,000 plants were planted, but of course the failures should be deducted, and this will leave in round numbers 60,000 plants, the progeny of the one you gave to the Indian Government.' A planter writes me from Ceylon: 'Perhaps four-fifths of the Cinchona plants in Ceylon are *succirubra*. Agreeing with you that the cultivation is likely to be overdone, I wish to devote my attention to the Crown and Yellow barks. Of *C. officinalis* I have a good supply. * * * I am now anxious to get the best kinds of Calisaya.'

It seems probable that the Dutch cultivators in Java will henceforth take the lead in the production of the finest bark. They were first in the field, and have toiled on through many difficulties, surmounting obstacles of a very discouraging nature, until they were able to supply themselves with the seed of Mr. Ledger's collection.

In a sale which took place at Amsterdam on the 30th June, 1875, they obtained extraordinary prices for the best lots, quite warranted by the quality of the bark, and the more remarkable from the circumstance that between the 5th of June and the 5th of July there were imported from South America the unusual quantity of 3,500 *serons* of bark, a considerable portion of which was of first-rate description; also that there was at the time an exceptionally small demand for Quinine.

The object of the Indian Government in promoting at so much expense and with continued and persevering interest the naturalisation of the Quinine-producing trees in India have thus been partially attained; and henceforth it is probable that the bark derived from them will figure as one of the most remarkable and remunerative products in the list of exports from India. It must also be a satisfaction to think that, instead of spreading misery and demoralisation, this product at any rate will conduce to the health and welfare of mankind;

and its introduction into British India will shed lustre on the sway of the gracious Sovereign, whose beneficial reign will in this respect be long remembered by the natives of India.

It is but justice to state, that the motives of those who have been most energetic in the prosecution of this enterprise embraced very especially the desire to place within reach of all the natives of British India the means of combating fever by cultivating for themselves these precious trees. It was at one time thought that even the leaves might afford medicinal help without further preparation. This picture, so attractive to the imagination, is destitute of all foundation in reality, for the leaves are practically devoid of the febrifuge alkaloids; and even if they were otherwise constituted, the trees would not grow in the hot plains of India, where fevers most prevail. Another form of the same benevolent intention seems to partake of the same illusory character. It has been supposed that the adoption of a cheap process for the extraction and precipitation of the alkaloids in a mingled form would present an efficacious febrifuge at so low a cost before the people of India, that the object above referred to might in this manner be obtained. It happens, however, that the people of India can be supplied with febrifugal alkaloid of equal power and efficacy at about half the cost of the mere production of the above-mentioned precipitate; so that even if the Government were to give the bark for nothing, they could not, without further sacrifice, meet the competition of European manufacturers. It is also to be borne in mind, that it is not to be supposed that the natives would have confidence in any medicament not considered good enough for Europeans; and it cannot be thought that the medical faculty amongst us would ever be reconciled to a preparation of so uncertain a composition as that of the mixed alkaloids, to the production of which so much capital and energy have been recently diverted. Many years must elapse before all the problems connected with the growth and cultivation of the *Cinchona* trees and the most efficacious production of the alkaloids can be fully solved; and in the meantime the attention of chemists employed by Government might seem to be more advantageously directed to the solution of these questions than to the establishment of manufacturing processes.

The reader will perceive from the slight sketch I have given the great practical importance of a sufficient knowledge of the different sorts of *Cinchona* to ensure success in the result of the undertaking. It does not seem to be generally understood by those who embark in the culture of these plants, that many of the kinds are not more adapted for the production of febrifuge alkaloid than would be the varieties of the common willow. It is not enough to secure even the very best species, such as the *Calisaya*, unless it be the special form in which the alkaloids are produced to the most advantage. I hope that the present volume will guide the cultivator in his choice, and thus secure him from loss, or at least suffice to show that it needs much cautious discrimination in commencing plantations of *Cinchona*. In the account of *C. Pahudiana* given in my 'Illustrations of the Nueva Quinologia' (1862), my opinion is recorded as unfavourable to the excessive cultivation of this tree (or rather group of trees, in which I now include the *Hasskarliana*), as likely to prove a source of disappointment to the Dutch Government. The relative value of the bark is now understood to be inferior, and although it is,

after all, much better than *some* of the kinds of Calisaya, much loss has been the result of its introduction. To a certain extent, as I have already said, the same disappointment is pretty sure to befall the growth of *C. succirubra*. On the other hand, the Pitayo sorts, though collected at considerable expense, have scarcely met with the attention they deserve, and the Calisaya of Sta. Fé has not yet been introduced into India, although it promises a quicker return for the outlay of planting than any other species.

It now remains for me to show how far the benevolent intentions of the Government in reference to the natives of India are likely to be carried out.

His Grace the Duke of Argyll, in a despatch dated 16th December, 1873, thus places before the mind two ways in which the desired result might be attained :

‘The means of supplying the Cinchona febrifuge to the people of India in a cheap form and in sufficient quantity is a question which must always be considered as paramount in the conduct of the plantations. The object is to be attained in two ways, which must supplement each other: first, the manufacture from bark on the spot; and, second, for some years to come at least, the purchase of the febrifuge in the cheapest available form in Europe.’

The first mode has been in part abandoned, and the Quinologist employed by the Government at Ootacamund has resigned his office. If the adverse opinion which I gave when consulted on the subject in 1864 (which will be found in the Appendix) had been followed, it would have saved many thousand pounds’ useless expense. Mr. Wood, the Government chemist, is stated* to be engaged at Calcutta in perfecting the processes for preparing the mixed alkaloids from the bark grown at Darjeeling. This will no doubt result in the acquisition of fresh experience, and also in confirmation, at considerable cost to the country, of the opinion of the Committee appointed 22nd June, 1874, to report on the efficiency of the late Cinchona factory† at Ootacamund. It is as follows :—

§ 32. “Mr. Howard holds out hopes that the Sulphate of Cinchonidine—an alkaloid, which is very largely produced in the red barks grown in India—may in time be produced so as to sell in this country for one rupee per ounce. We have no doubt that a medicine of known and certain composition such as this is, resembling Sulphate of Quinine in taste, form, and appearance, would be preferred by the majority of practitioners to the Amorphous Alkaloids, which are always varying in composition, and which have no physical resemblance to the ordinary quinine salts. We have already shown that, according to the present prices of raw material, the Government can purchase nearly three times the amount of this salt for the cost of the same amount of rough mixed Alkaloids, and while the price of Cinchonidine remains low, according to the latest quotations, it is abundantly clear that Government cannot continue to manufacture locally at a profit.

(Signed) “T. R. COCKERELL, Commissioner.

“W. R. CORNISH, F.R.C.S., Sanitary Commissioner at Madras.”

* *Pharmaceutical Journal*, November 7, 1875.

† The Government Order thereon states that the Committee having met, visited the factory and examined the persons concerned, submitted the results of their inquiries in the Report recorded above. The Committee show that, “on the most favourable calculation, the Government are paying twice as much for the ‘Amorphous Quinine’ as it was worth;” “further, not only is the cost of manufacture thus excessive, but the article produced is of inferior quality. Of the efficacy of the mixed Alkaloids as a febrifuge there can be no doubt, but

In reference to the second mode of attaining the desired end, 'that every native druggist's shop in India should be supplied with this febrifuge remedy at the price of one rupee per ounce, and that thus fever should be comparatively banished from the land,' I am happy to say that this object may be said to be very nearly attained. Every year adds to the perfection of the processes employed by the European manufacturers, and at the same time the competition is so great that they are willing to supply the alkaloids at a price much lower than was expected to be the case at the time of the despatch referred to. The Madras Government have just bought by public tender 16,000 oz. of sulphate of Cinchonidine, at a price not much over one sicca rupee per ounce. On this one contract, supposing the medicine to be of equal efficacy with Quinine, the saving to the revenue will be about 3,000L., and it may be imagined how great would be the economy if the whole supply of the totality of India were reduced in the same proportion.*

Whatever the quantity of this alkaloid required, there is no fear of any scarcity arising in the supply; and there is consequently no probability of any advance in the price obtained by the manufacturers.

But it is not quite indispensable to resort to Cinchonidine to secure the end in view. If the good of the Indian plantations were the object contemplated, it would be necessary to limit our calculations to this one alkaloid, as Cinchonine is not sufficiently abundant, except in the grey barks, *Peruviana*, *micrantha*, and *nitida*, cultivated to a small extent in India; but if the supply of a cheap and efficient alkaloid be the object, this latter would, under present circumstances, meet the requirements; for Cinchonine happens to be, in the price of its preparations, considerably less than one rupee per ounce.

There can be no doubt that Cinchonine, though it may have its inconveniences, will generally cure fevers even in India, and with patients 'saturated with malaria and ill-fed;' for out of 559 cases treated with sulphate of Cinchonine 546 were cured, and only 13 failed.

After this it may be superfluous, but is, I hope, allowable, to add my own opinion, as depending upon the results of some considerable experience. I have for the last 30 years been in the habit of dispensing these alkaloids gratuitously to those who have applied, amounting on the whole to a large number of cases, including some who had brought back the disease from hot climates. I have naturally preferred the cheaper alkaloids, all of which I have used, and for some time have given nothing but Cinchonine in its combination as Muriate, which is a convenient form. I have never seen this medicine fail. Briquet, in his *Traité Thérapeutique du Quinquina et de ses Préparations* (p. 468), thinks 'that it is more feeble than Quinine by one-third or

the drug, as prepared and issued, is of uncertain composition. Sometimes it is rich in Quinine, at others Cinchonidine and Cinchonine predominate. This is obviously a very serious objection, and the form in which the preparation is issued is also inconvenient. Under these circumstances it is obvious that the manufacture should at once be abandoned."

* His Grace the Duke of Argyll observes, in a despatch to his Excellency the Right Honourable the Governor-General of India in Council, dated India Office, London, 16th December, 1873:—"Five years ago a Cinchona Commission was appointed to report upon the efficacy of Cinchona Alkaloids other than Quinine, and the Report of the medical men who composed it was practically unanimous. Cinchonidine, Quinidine, and even Cinchonine were pronounced to have the same febrifuge qualities as Quinine, yet the Report has not been acted upon. From 1869 to 1873 your Government has indented for 11,392 lbs. of Quinine, and except in 1869, when the other Alkaloids were sent out for experimental purposes, only 220 lbs. of Cinchonidine and Quinidine. The subject is one of very considerable importance, and I request that your Government will take the suggestions contained in Mr. Howard's letter into consideration, and furnish me with your views."

a quarter,' but that there might be an advantage economically in its use. I should say that I allow for this difference in prescribing, following in other respects the mode of treatment pointed out by this author, and always give it in dilute solution. I have never taken any pains to make the remedy known, but only to guard against its being sought for unworthy purposes, or to aid mendicancy. A large portion of those relieved have been persons employed in gathering in the harvest in the low-lying parts of Kent, Essex, Lincolnshire, and other fenny districts, the disease being always (in my belief) the result of malaria.

But if, after all, these medicaments should seem to be above the reach of the impoverished people of India, science is still not without further resources, since the celebrated chemist, Dr. de Vrij, who has devoted himself particularly to the study of the alkaloids of bark, has recently taken out a patent for the preparation of the amorphous alkaloid, (first brought into notice by Sertuerner, and called by him 'Fiebertödter,' *fever-killer*), from the residuary liquors of the Quinine manufacture.

This affords a most efficacious febrifuge, and can be supplied at a cost of much less than half a rupee per ounce.* The cheapness of the remedy may be fairly assumed to be thus provided for, but there remains the difficulty of bringing effectually under the notice of the different populations the possibility and almost certainty of their being cured of intermittent fever at the expense of a very few *annas*† for each case. I suppose that with Sulphate of Cinchonidine the object might be attained in most cases for a total expense of sixpence of English money, and for less with the other alkaloids.

The Indian Governments of Madras and Bombay, in consequence of a suggestion made in my Report of the Fourth Remittance of Bark from India (Aug. 1, 1865), appointed Commissions to ascertain the febrifuge value of Cinchona alkaloids other than Quinine. From the preliminary Report of these Commissions I extract the following notice, which alone gives the exact statement of the quantity of the alkaloid used in the cure :

TABLE 2.—SHOWING THE RESULTS OF TREATMENT OF PAROXYSMAL FEVER BY CINCHONIDINE.

Name of medical officer	District	Type of fever			Result	
		Quotidian	Tertian	Remittent	Cured	Failed
1. Dr. Rees and Mr. Wade	Goodaloor	137	16	1	154	—

Remarks.—These cases were nearly all cured by from one to two doses of eight to ten grains.

Two doses of ten grains each now cost the Government, for the medicine itself, a fraction more than a penny, and allowing what is necessary for other expenses including dispensing, it will be admitted that the statement I have made above is fully warranted.

In the Completed Return 'on the properties of the Cinchona Alkaloids,' Dr. Jackson, of Meerut, reports, that the Sulphate of Cinchonidine was given in 273 cases, of which 154, or 56·41

* Full information respecting this is given in the 'Histoire de la Chinioïdine, considérée au point de vue chimique et thérapeutique d'après les travaux de M. le Dr. de Vrij.' Collas, Paris, 1869.

† The old standard *Sicca rupee* may be taken at 2s., and the *anna* at one-tenth of the rupee.

per cent., were successful after one dose. One hundred and nineteen cases, or 43.59 per cent., were for several days under treatment, or an average period of 5.47 days.

Dr. Jackson's experiments with Cinchonidine were made in September, October, and part of November, a season when the fever became much more obstinate than it had been during the earlier months of the year when the other alkaloids were tried. He thus concludes his Report: 'Of the three alkaloids, I am of opinion, and my native doctors are the same, that Cinchonidine is by far the most valuable.'

These careful observations from the South and from the North of India possess peculiar interest, the last perhaps especially so, as bearing on the question of native appreciation of the remedy.

We have thus the new medicine produced from the plantations of India at a price as nearly as may be of a Rupee per ounce, and it remains for the Government of India to diffuse information on the subject. It is possible that the fame of the remedy might be in some way associated with the visit of his Royal Highness the Prince of Wales to the places where it is grown. The Peruvian bark, when first introduced to Europe, had to encounter much prejudice, and to overcome many difficulties similar to those which may attend the general diffusion of Cinchonidine in India. It cannot be too generally known that this alkaloid in all probability contributed to the cure of the Countess of Chinchon, and, as remarked by Mr. Markham, in his elaborate and interesting Memoir* of this lady, 'it is now understood that owing to its being at the same time as efficacious as and much cheaper than Quinine, the Cinchonidine will eventually be the chief agent by which health and the cure of fevers will be diffused among the vast population of British India.'

'The Countess of Chinchon returned to Spain in the spring of 1640 with her husband, and bringing with her a supply of that precious *Quina* bark, which had worked so wonderful a cure upon herself, and the healing virtues of which she intended to distribute among the sick on her lord's estates, and to make known generally in Europe. The bark powder was most appropriately called Countess's powder (*pulvis comitessæ*), and by this name it was long known to druggists and in commerce. Dr. Don Juan de Vega, the learned physician of the Countess of Chinchon, followed his patient to Spain, bringing with him a quantity of *Quina* bark, which he sold at Seville at 100 reals the pound.'

'After their return from Peru, the Count and Countess of Chinchon usually resided at the Castle of Chinchon. The Countess administered Peruvian bark to the sufferers from tertian agues on her lord's estates, in the fertile but unhealthy vegas of the Tagus, the Jarama, and the Tajuna. She thus spread blessings around her, and her good deeds are even now remembered by the people of Chinchon and Colmenar in local traditions.'

In like manner the good endeavours of Her Majesty's Indian Government, crowned after

* 'The Countess of Chinchon, and the Chinchona Genus. A Memoir of the Lady Ana de Osorio. By Clement R. Markham, C.B., F.R.S.' London, 1874, pp. 44, 45.

large outlay with such abundant success, ought to be recorded in the minds and in the traditions of the two hundred millions whose benefit has been thus perseveringly sought. No more appropriate occasion could be afforded for the graceful acknowledgment of the benefit on the part of the native princes than that which is presented by the visit of his Royal Highness to India.

In conclusion I have to express my obligations to his Excellency M. J. W. Van Lansberge, Governor-General, to M. Van Gorkom, the able Director of the Plantations, and to M. Moens, the Chemist of the Dutch Government, for a beautiful collection of specimens of the flowering and fruit-bearing branches of varieties of *Cinchona* cultivated in Java, and for much friendly information. I have also to thank C. R. Markham, C.B., Dr. Weddell, Dr. Hooker, and other gentlemen mentioned in these pages for kind assistance in prosecuting the objects of this work.

TOTTENHAM :

November, 1875.

INFORMATION RESPECTING THE PRESENT STATE OF
THE PLANTATIONS IN INDIA.

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CINCHONA CULTIVATION.

(Copy.*)

USE OF CINCHONA AS A FEBRIFUGE.

India Office, 17th October, 1873.

SIR,—I am directed by the Secretary of State for India, in Council, to convey to you his best thanks for the valuable assistance you have frequently given, both by advice and by performing difficult and laborious analyses, in the promotion of Cinchona cultivation in British India. The important and costly works you have published on the Cinchona genus have been of essential use both to those who collected plants and seeds of various species in South America, and to the cultivators in India. Your analyses, and the valuable remarks with which they are illustrated, have furnished excellent guides to those who are in charge of the plantations; and the numerous occasions, during a course of years, on which you have given advice and assistance of various kinds have furthered the progress of the undertaking very materially. His Grace desires me to assure you, that the services which you have so zealously and constantly rendered, are fully appreciated, and that your aid is considered, by Her Majesty's Government, to have furthered, in no small degree, the success of this undertaking, which will hereafter be most beneficial to the people of India.

With regard to the present supply of Cinchona alkaloids for India, a question has been submitted for the consideration of the Secretary of State, with reference, on the one hand, to a sensible reduction of the cost of that supply, and, on the other, to increasing the value of the red bark species, by supplementing the Quinine supplied to India with Cinchonidine. I am to request that you will be so good as to furnish his Grace with your views on this point, and with any details that are likely to be useful in the consideration of the question.

I am, &c.

(Signed) C. R. MARKHAM.

J. E. Howard, Esq.

No. 96A, Revenue.

Tottenham, 21st October, 1873.

SIR,—In reply to the communication received from you, dated the 17th instant, conveying to me the thanks of the Secretary of State for India, in Council, I beg that, in the first place, you will transmit, in return, the expression of the lively satisfaction with which I receive the

* The spelling of the word "Chinchona" being altered.

said acknowledgment. In the next place, I wish to assure Her Majesty's Government, that I shall esteem it alike a duty and a pleasure to give, to the best of my ability, the assistance required on the present occasion.

I feel that I cannot do better than to preface my reply to the question now submitted to me, by a reference to the observations* of his Grace, the Duke of Argyll, on the Report of the Committee of Medical Officers appointed to examine the febrifuge properties of Cinchona alkaloids other than Quinine.

His Excellency, the Secretary of State, remarks, that Quinine, though one of the most indispensable medicines used in India, is also one of the most expensive; and that it is very desirable that the results of the above inquiries should bear fruit. "The Cinchona febrifuge alkaloids should now be made available in India, to a much larger extent, than has hitherto been practicable, and thus save, to a considerable extent, the expense of Quinine."

The lapse of four years since the above recommendation was issued, has only served to demonstrate its importance. The price of Quinine has advanced, and also that of the most important barks from which it is extracted; and from the gradual exhaustion of the South American supply of these, coupled with the increasing demand for Quinine, there is quite a possibility of a still higher point being reached.

Owing to the high price, the stocks appear to have been kept low, so that the outburst of the Burdwan fever came upon a medical staff unfurnished with the requisite supplies to meet the emergency.†

It is impossible to doubt that many lives might have been saved if the above recommendation had been acted on.

In the meantime the demand for Cinchonine has so largely increased in all quarters of the world, that I do not suppose the present low price will be long maintained; and the limited amount of its production leaves abundant room for Cinchonidine as *the* alkaloid suited to meet the need of the Government of India.

At home the increased confidence in Cinchonidine, and its consequent use, is very marked, most especially and satisfactorily in our large hospitals; I am inclined to suppose that it is found in most cases not inferior to Quinine, though it is probable the latter medicine is resorted to in the most serious and difficult cases. I have reason to believe, however, that there are instances in which the therapeutic action of Cinchonidine is preferable to that of Quinine.‡

There is great reason to suppose that it contributed to the cure of the Countess of Chinchon, as the Loxa barks abound in this alkaloid, and not, as has been erroneously stated, in Cinchonine; and I see no reason why this particular medicine should not eventually be made to fulfil the benevolent desires of Her Majesty's Government, and so diffuse health and cure through the vast Native population of India.

For, the supply of the Cinchonidine-producing-material will shortly become, in a practical sense, unlimited, and this cannot be said of the other alkaloids; so that, it would appear, the price may always be kept at a reasonably low rate. A great quantity of bark is imported from South America, at prices scarcely remunerative, containing this alkaloid, and all the red bark, the

* Dated 4th March, 1869. "Return" ordered to be printed 9th August, 1870, page 269.

† See the "Calcutta Gazette" of July 30th 1873.

‡ In confirmation of this opinion I refer especially to the mature opinion of Dr. Bensley, that Cinchonidine has "secured for itself a position *perhaps the most exalted of all*" the alkaloids. See No. 507, 29th October, 1868, "Properties of the Cinchona Alkaloids," Government of India, Home Department. I may also refer to the favourable opinion of the late Dr. Royle, who tried it, at my suggestion, in his own family.

produce of *Cinchona succirubra*, may be ranked in the same class. I had hoped that by skilful management the tree might have been led to form Quinine instead of Cinchonidine; but this expectation does not seem likely to be realised. Nothing can be better for pharmaceutical purposes, than the beautiful red bark, now sent home from Ceylon, to say nothing of other sources of supply; but even in the skilful hands of Mr. McIvor the renewed red bark, such as I now have before me, is not cured of the above tendency. Mr. McIvor informs me that he hopes to send home bark of this description, containing 3 per cent. of sulphate of Quinine and 2 per cent. of sulphate of Cinchonidine. I think it much more probable that the proportions will be reversed.

In an account which I have just received of the cultivation in Java, I find, from the analysis of M. Moens, that the proportion there of Cinchonidine to Quinine in the red bark, is as 6.36 per cent. of Cinchonidine to about 2 per cent. of other alkaloid.

It follows, as a matter of course, that it is a point of immense importance to the success of the Cinchona plantations in India, that Her Majesty's Government should follow up those steps which have been so judiciously taken, by encouraging the consumption of the sulphate of Cinchonidine. This is needed, especially, to give the Native practitioners confidence in the medicine, which cannot be said, as yet, to be introduced into India.

It is, perhaps, not too much to say, that such a measure might increase the value of those plantations which consist exclusively of red bark to a degree varying from 10 to 50 per cent., according to circumstances.

I am afraid, considering the quality of some of the bark sent over, that the higher proportion would be attained only by those who have attended to the directions given as to the height above the sea level (and so forth) of their plantations. I wish that the cultivators could be induced to replace a portion of the red bark trees they are now cutting down with the sort of *Calisaya* which is giving such splendid results in the island of Java. This would, at all events, increase their chances of success, and, at the same time, augment the supply of Quinine-producing bark for the future.

I will now endeavour to answer the question as to supplementing the Quinine supply to India by Cinchonidine. I am glad that *supplementing* rather than *superseding* is looked to, as I believe that it requires time before the medical practitioner would willingly consent to be deprived altogether of Quinine. I should certainly recommend, however, that in supplementing the supply, Cinchonidine should be largely resorted to. I suppose that sulphate of Cinchonidine could, at the present moment, be obtained by public tender at about one-third the price of sulphate of Quinine, but a sudden and new demand might at once increase the price, to some small extent, though not permanently.

I see by the "Times" of this morning, that the Burdwan fever has again broken out; and I shall therefore have to consider the question of the possibility of a very large demand occurring under similar circumstances. I do not suppose that this could be at once supplied, but that it would require time and due notice to the manufacturers. The apparatus used is always costly, and the staff highly paid; and I should not like to find the Government placed in any difficulty, as to the supply, owing to the unwillingness of the Quinine manufacturers to turn their trade into another channel. This is supposing that the quantity demanded should be so large as to require the extraction of the Cinchonidine from bark bought for the purpose. All this *could* and *would* be done, but it cannot all be effected in a day.

I understand that Her Majesty's Indian Government desire that every Native druggist's shop

in India should be supplied with this febrifuge remedy at the price of one rupee per ounce, and that thus fever should be comparatively banished from the land.

It is a magnificent conception, and I see no reason why it should not eventually be realised, I do not say by Quinine, but by the cheaper alkaloids. I do not recommend Her Majesty's Government to purchase Quinidine, because the supply is so limited, that the price already approximates to Quinine. I have no objection to recommend Cinchonine, yet it will not so much benefit the Indian plantations; but I do recommend the sulphate of Cinchonidine as the very best means within my knowledge for carrying out the benevolent intentions of Her Majesty's Government.

There is, as I have intimated, so very large a supply of the material from which this particular alkaloid is obtained, that it would be impossible for the manufacturers, eventually, to keep up the sulphate of Cinchonidine beyond a moderate price. At present, the barks from South America, rich in this product, come in at so low a price that, from some particular parcels, it is possible the medicine might be procured even at the very figure above indicated.

In conclusion, I may say that I am deeply impressed with the importance of the subject now under the consideration of Her Majesty's Indian Government. It is, I believe, the one thing needed to place the Cinchona Plantations on the vantage ground of certain and ascertained success. It exactly meets and removes the difficulty which I pointed out on the occasion of the first analysis of the Indian *Cinchona succirubra*. It will, moreover, be of signal advantage on the score of economy, if only the present amount of febrifuge alkaloid is required; or if considerations of the public good should prevail to enlarge the supply, it would extend the benefit to three times the number of individuals; it would, moreover, be the means of commending to the whole world a medicine which needs only to be known to be preferred in certain cases even to Quinine. It should not be forced upon the medical practitioners, but introduced gradually and with discretion.

I think that the present is a very favourable time for the Government, if they resolve upon the matter, to issue tenders for the first supply.

I have the honour to be, Sir, your obedient servant,

(Signed) JOHN ELIOT HOWARD.

Clements R. Markham, Esq., C.B., F.R.S.

CINCHONA CULTIVATION.

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STATEMENT SHOWING QUANTITIES OF QUININE SULPHAS AND CINCHONIDINE SULPHAS SUPPLIED TO INDIA FROM 1867 TO 1873,
AND PRICE FOR THE SAME.

	Quantity.		Price per oz.	Value.		
	lbs.	ozs.		£	s.	d.
BENGAL.						
1867.						
Quiniæ sulphas	1,083		4s.	3,465	12	0
1868.						
Quiniæ sulphas	500		3s. 11d.	1,566	13	4
Do. do.	1,617		4s. 5d.	5,713	8	0
1869.						
Quiniæ sulphas	1,000		5s. 3d.	4,200	0	0
Do. do.	1,068		5s. 2½d.	4,458	18	0
Cinchonidinæ sulphas	150		3s.	360	0	0
Do. do.	350		3s. 1½d.	875	0	0
1870.						
Quiniæ sulphas	1,160		6s. 2¾d.	5,780	13	4
Do. do.	1,200		6s. 5½d.	6,200	0	0
Do. do.	1,100		5s. 2d.	4,551	5	0
1871.						
Quiniæ sulphas	850		6s. 7¼d.	4,497	18	4
Do. do.	846		6s. 7d.	4,448	11	0
Cinchonidinæ sulphas	220		2s. 6d.	440	0	0
1872.						
Quiniæ sulphas	500		7s. 6d.	3,000	0	0
Do. do.	500		6s. 10½d.	2,754	3	4
Do. do.	760		6s. 2d.	3,749	6	8
Do. neutral sulphate of	60		5s. 4½d.	258	0	0
Do. sulphas	950		6s. 2d.	4,686	13	4
Do. do.	40		5s. 4½d.	172	0	0
1873.						
Quiniæ sulphas	60	10	7s. 10d.	379	18	4
Do. do.	2,546		8s. 6d.	17,312	16	0
BOMBAY.						
1867.						
Quiniæ sulphas	500		4s. 2d.	1,666	13	4
Do. do.	200		4s. 6d.	720	0	0
1868.						
Quiniæ sulphas	760		5s. 1d.	3,090	13	4
1869.						
Quiniæ sulphas	750		5s. 2¼d.	3,112	10	0
1870.						
Quiniæ sulphas	700		6s. 1d.	3,412	10	0
Do. do.	810		5s. 10d.	3,796	17	6
1871.						
Quiniæ sulphas	400		7s. 5d.	2,370	0	0
1872.						
Quiniæ sulphas	722		7s.	4,043	4	0

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QUINOLOGY OF THE EAST INDIAN PLANTATIONS.

STATEMENT SHOWING QUANTITIES OF QUININE SULPHAS AND CINCHONIDINE SULPHAS SUPPLIED TO INDIA FROM 1867 TO 1873,
AND PRICE FOR THE SAME.—(Continued).

	Quantity.	Price per oz.	Value.
MADRAS.	lbs. ozs.		£ s. d.
1867.			
Quiniae sulphas	200	4s. 3d.	680 0 0
Do.	67	4s.	214 8 0
Do.	461	4s.	1,475 4 0
1868.			
Quiniae sulphas	645	4s. 11d.	2,537 0 0
Cinchonidine sulphas	133	5s.	532 0 0
1869.			
Quiniae sulphas	150	5s. 3d.	630 0 0
Do. do.	200	5s. 8d.	906 13 4
1870.			
Quiniae sulphas	130	6s. 8d.	693 6 8
Cinchonidine sulphas	208	2s. 6d.	416 0 0
1871.			
Quiniae sulphas	360	6s. 7d. $\frac{1}{2}$	1,917 0 0
Do. do. bleached	15	8s. 3d.	99 0 0
Do. do. unbleached	25	7s. 3d.	145 0 0
1872-73.			
Quiniae sulphas	300	6s. 3d.	1,500 0 0
Do. do.	183 6	8s. 6d.	1,246 19 0
Total of Cinchonidine	1,061	3s. 1d. .083	2,623 0 0
Do. Quinine	23,419	5s. 11d. $\frac{1}{2}$.5	111,452 15 10
			£114,075 15 10

This statement was sent me without being calculated out. I have added the column under the head 'Value,' from which it will be seen that the possible margin for economy in the use of Cinchonidine in the place of Quinine has been great.—J.E.H.

DISCOVERY OF THE "CALISAYA VAR. LEDGERIANA."

Extracts from Letters from Charles Ledger, Esq., to John Eliot Howard, Esq., London.

Argentine Republic,
22nd December, 1874.

SIR,—My brother, Mr. George Ledger, has forwarded to me your pamphlet, "The Cinchona Plantations in Java," and as my name is therein mentioned, you may, perhaps, feel interested in receiving from me some practical information acquired during a residence in South America of 38 years.

* * * * *

The price of bark having risen to a very high figure, owing to the monopoly in Bolivia, several attempts were made to discover the "real *Calisaya*" in the Valleys of Carabaya (Peru) In the commencement of 1845, I was established in Puno, capital of Department of same name, Carabaya being a province thereof.

I was invited by the Prefect General Coloma, and several influential inhabitants—natives and foreigners—to form one of a large expedition, then fitting out, with the hope of discovering bark of superior quality to such as had, up to that time, been brought from there. The project seemed plausible; “the Valle de Carabaya” is a continuation extending north of the “Yungas” of Bolivia, and as, at that time, Don Villamil (a Bolivian gentleman, possessing a thorough knowledge of bark and, for the time, a political refugee in Peru) was said to have discovered the legitimate “*Calisaya*” in the “Valle” of Huanuco, much further north still, I, with many others, entertained no doubts but that we should succeed in discovering large quantities of best “*Calisaya*,” making rapid fortunes. The enterprise was entered into by all of us full of enthusiasm, determination, and energy. On the 16th of March, 1845, we started from Puno; each member had contributed \$500 to the general fund, had a servant, a saddle and pack mule; with two guides, our company formed a total of fifty-six. My servant was named * * *

* * * I had had him for some time previous in my employ, engaged principally in sorting and packing bark and alpaca wool. He was from a village of Bolivia, and had a good knowledge of bark (he had pointed out to me twenty-nine qualities). Several of us had been in the best bark-producing places of Bolivia, and could distinguish no difference between the trees growing there and in Carabaya; no difference in the leaves and appearance of the bark; but, on assay, the difference was great indeed. We totally failed in discovering a single tree producing the “real *Calisaya*,” and returned to Puno after fifty-seven days of excitement, danger, toil, and disappointment. Our expenses were returned to us by the Government, and we were “thanked” for our trouble. One night being on guard, with my servant close to me, I said, “Do you think we shall find the true bark?” He immediately replied, “No, Señor, the trees hereabouts do not see the snow-capped mountains” (Nevados de la Cordillera). I could hardly contain my laughter at the moment; but when in bed about an hour after I could not sleep for thinking of his answer to my question, and ever since I have very often thought of it.

* * *

The seed sent by me in 1865, “*Calisaya* red bark,” is not (as you say) the *Morada* of the Spaniards—it was the *Rojo*. My servant assured me the greater part was from *Rojo* trees; he had put into one bag, mixed, the seed from fifty trees, the collection of several days. From 1843 to 1852 he was in my employ; from 1848 to 1852 he accompanied me wherever I went (on foot, keeping up with my mule and often making fifty, fifty-five, and sixty miles a day), selecting and packing the bark I bought. He was very much attached to me. When engaged in my Alpaca expedition, Mrs. Ledger was anxious to send me important letters and some money. She sent for him some 400 miles from Tacna, delivered the letters and sixty-five ounces (doubloons) to him, and sent him off in search of me in the Province of * * *. In thirty-two days’ time he found me out, having brought the money all the way (about 700 miles), done up in his hair. All the Indians take great pride in wearing their hair very long, plaited in two tails.

* * *

All my own experience, corroborated by my servant, goes to saying, without any doubt, that the best time for collecting seed (I speak of the Valleys of Bolivia) is in the month of April; in May, the seed has generally fallen out. I have seen many trees in full flower in December, but I never saw seed ripe before April.

I have always understood the “red” bark to be the best of all in its yield of Quinine; for one tree of the *Rojo* you will meet with fifty of the *Calisaya*. The leaves of the *Rojo* are of a bright

scarlet colour underneath, and of darker green on the surface than those of other good descriptions. In 1851, while on the Peru-Bolivian frontier purchasing "bark," I picked out of some 2,000 qqs. 45 qqs. that my servant and I thought to be superior to the rest (being *Rojo*). These thirty serons I had marked separately, and they were consigned to Mr. P. Normand, Paris, calling his attention to its superior quality. It was said to be too good in appearance; the slabs (tablas) being so large and thick, doubts were thrown out as to its legitimacy, and it was withdrawn from sale. On receiving this unexpected report I immediately wrote to Mr. Normand to sell it under assay; this was done, the lot fetched 12 francs a pound, and I was congratulated accordingly. You may perhaps remember my brother showing you, in 1866, a sample of bark I sent him requesting your report thereon. This was taken from a parcel of some 200 qqs. brought to Tacna from Santa Cruz (confines of Brazil). I was requested by a Mr. Blondel to examine it. I said, "The appearance, taste, and brittleness I like; I am very suspicious of where it comes from." Mr. Blondel finally advanced 40 dols. per qql., sending it to France for sale on account of owner, a Mr. Lopez, insuring it at 80 dols.

Owing to some delay in getting across the Isthmus of Panama only four serons were in time for the steamer, waiting at Aspinwall for arrival of mail with specie, &c. from West Coast. Well, by the same mail that brought your report of the worthlessness of the sample, came advices of the four serons having been sold, on arrival at Havre, for 7 francs per lb., to a chemist. With such accounts from Havre, your report was laughed at. The following mail confirmed, however, your opinion; the chemist had refused to complete the purchase.

* * * * *

In March of 1861, I sent my overseer * * * * *, who had been with me for nine years, and during the time of my Alpaca enterprise, and also others of the men who had gone with me to Australia in 1858, with orders to get as many alpacas as possible out of Bolivia, and to the coast, ready for my arrival in 1862. At the same time I ordered him to send directions to get for me 40 to 50lbs. of the *Rojo* bark seed, such as we had seen together in 1851, when endeavouring to reach the Amazonas through the Province of Caupolican; particularly such as we saw on the trees close to the river Mamore.

In June, 1865, * * * * * delivered the seed he had collected. He then told me the best bark trees had not produced ripe seed for four years previously. When the trees were full of flower, and very promising, a frost (*helada*) in April destroyed it all. The inferior sorts had not suffered. He had been cutting bark with assistants, and patiently waited for an opportunity for complying with my orders, obtaining only the best sorts. 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 until 1865, and this assertion seems now to be corroborated by the result of Schuhkraft's remittances in those years. After paying him well (costing me since 1861 about 150*l.*), he returned to his home in Bolivia, having engaged with me before leaving to obtain more seed of the *Rojo*, the *Morada*, the *Naranjada*, and the *Calisaya* of Moco-Moco, as soon as he could do so to his satisfaction. From time to time I received news from him; on leaving Tacna in 1869 to come here, I had not given up hopes of his sending, or handing himself, the promised seeds to my agents in Tacna. In December, 1870, a friend of mine from La Paz was here with a troop of mules, *en route* for Bolivia; he remained here about three months, fattening up his mules and getting them into fit condition for the long journey to La Paz (800 miles). This gentleman had formerly been Sub-Prefect of the Yungas, residing at * * * * *; feeling assured

that he would do anything in his power to serve me, I wrote a few lines to my servant * * * by him, sending him \$200, and he duly received the money and letter. Poor * * * is dead also (my overseer having been previously murdered); he was put in prison by the Corregidor of Coroico, and 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 donkies, his blankets, and everything he had—dying very soon after. His son came personally to account for monies received. He had refused to get seeds for others who applied to him so to do. Although the authorities were very strict in prohibiting seeds from being taken out of the country, he offered to obtain some for me. Seeing the danger to which these poor fellows were exposed, having no direct application for any, feeling also that I had been miserably recompensed for what I had previously done, I told him to collect no more on my account or for any one else. You cannot but feel with me, how sad has been the fate of my faithful servants; one served me for eleven, the other for thirty years.

After having witnessed the great precautions taken by different parties to “pack” the seed of the *Cinchona* for transmission to Europe, failing in almost every case to arrive in live state; it is wonderful, indeed, how the seed, sent by me in 1865, produced such splendid results. Where my servant collected it, was 120 leagues from * * *, 130 leagues from * * * to La Paz, 90 leagues from La Paz to Tacna—1,020 miles. From La Paz to Tacna the road is across the Cordilleras, which he passed in mid-winter, when it freezes very hard. It was delivered put up in two slight bags.

I had it turned out into a sheet, exposing it daily for two hours to the sun for about a month. It was then bagged, put into a box, and covered with raw hide. Had it not been for my kind brother, Mr. George Ledger, exerting himself in carrying on a long correspondence, after all this valuable seed would most likely have been lost. * * *

I have always been particularly struck by the wonderful sagacity and foresight shown by the Jesuits when possessing influence and power in these countries. Whenever bark trees were cut down or “stripped,” not a particle of the smallest branch was lost. Moreover, they imposed the moral obligation, appealing to the superstitions of the Indians, thereby compelling the Cascarilleros or “cutters” to plant five cuttings (in shape of a cross ·:·) for every tree destroyed. I have repeatedly seen these plantations; always, when passing them, my Indians would go down on their knees, hat in hand, cross themselves, and say a prayer for the souls of the “Buenos Padres.”

Owing to the reckless destruction of every tree to be met with during the last fifty years (no fresh ones having been planted as in time of the Jesuits), the distance the bark has to be carried through the forests on backs of Indians (in bundles of 50 lbs.) to where donkies can enter,—in 1851, the year I was last in the “Monte,”—was very great. It is, I am assured, much greater now.

In 1850, I was partner in an expedition in search of legitimate Calisaya in the valley of Santa Aña, Department of Cuzco. A Mr. George Backhouse penetrated a considerable distance into the “Monte,” and reported having discovered large “manchos” (patches) of good bark, although, making every allowance for the specimens not being properly dried (for this requires skill, attention, and great care), I did not approve of them. I forwarded from Puno to Cuzco, in 1851 (January), supplies of money, knives, axes, beads, calicoes, &c., to Mr. Backhouse. Before they reached his camp he had been murdered by the wild Chunchu Indians; all the supplies were stolen, the bark collected (said to be more than 1,000 qqs.) all destroyed, some sixty pounds of gold dust (according to Journal

that poor Mr. B. kept, and that fell into my hands) missing ; I suffered the loss of \$7,000, my brother Arthur also losing \$3,500. I cannot but feel that I have met with most inadequate acknowledgment after all my exertions, outlays, and dedication of so many years.

Surely after the success attending the seed sent by me (in 1865), the Government of India and the Government of the Netherlands should award me a sum of money commensurate with the importance and value of service rendered.

Before concluding this long letter I cannot but mention a circumstance recalled to my mind by reading in your pamphlet the word "Ootacamund." When in Australia, in 1860, reading ("Household Words") a description of the country, climate, natural grasses, people, and customs of "Ootacamund," I was most forcibly impressed with the adaptability of such country for the successful breeding of the alpaca. Again, in reading what you say, I cannot but think, that if in the valleys or slopes the Cinchona flourishes, would not the alpaca thrive also on the upper plains? In Peru and Bolivia it is where this noble animal thrives best, viz. on the high table-lands, the Cinchona flourishing in the valleys below. Now it occurs to me, that, possibly, Her Majesty's Secretary for India might see the desirability of endeavouring to propagate the breed of this truly valuable animal in India on the high table-lands of Ootacamund.

* * * * *

Palermo, November 4th, 1875.

I am not positive the leaves of the *Rojo* bark trees are red *underneath* when the seed is ripe. When in flower they are so, as I have seen them when, in May, 1852, I with my servant got seed from a remarkably large "*Rojo*" tree. * * *

I well remember noticing the dry leaves (or nearly dry) strewed about under the tree, and in the yard of the priest's hut, being of *dark purple* colour. I remember this so well, as in handling several my servant said, "Let us collect some and take out with us; they will be of use to Don Miguel. * * * He did collect a quantity, and, applied as a poultice, healed his sore shin in three or four days. The upper part of the leaves was *yellowish* at the edges, dirty green in the middle. I have always understood the "*Rojo*" bark to be the best. I well remember, too, remarking how the bark on the thin branches was covered with a kind of moss (lichen*) of a silvery white and brilliant scarlet colours.

CORRESPONDENCE FROM JAVA.

Extract of Letter from K. W. Van Gorkom, Esq.

Dated, Bandong (Java), 10th March, 1874.

The introduction of the "*Calisaya Ledgeriana*" at the end of 1865 was indeed our best success; and, in a few years, we shall have upwards of two millions of this superior species.

Mr. Moens despatched, in December last, a letter to you, which will, we trust, give you a clear and complete review about Cinchona cultivation; as your copies of our quarterly and annual reports have been also, since 1873, regularly despatched to your address.

I further have the pleasure to advise you of having despatched by post, this day, a packet

* The *hypochmus rubrocinctus* probably, the presence of which used to be considered an indication of the best bark.

with four samples of bark from "Ledgeriana," all these having been analysed by Mr. Moens, and yielding 7, 8, 9 or 10 per cent. pure Quinine. I am also preparing an extensive herbarium of all our species and varieties of Cinchona, and I shall be very glad to send you a complete collection by one of our packets the next month.

It will, dear sir, at all times, afford us much pleasure to render you any assistance in our power, for your glorious Quinological studies, and we shall always be glad to receive your most important and valuable information.

Bandong, 5th December, 1873.

With much interest I have read your paper in "Pharmaceutical Journal and Transactions," which you were so kind to send to me.

I also will try to give you, in this letter, a complete account about our plantations, that you may see how far the information you got from our reports is right.

The superiority of Ledger's Calisaya is now beyond all doubt; and I hope Mr. Broughton will find, upon close examination, that amongst the *Ledgerianas* of Ootacamund, there are some nearly as good as ours. If this happened not to be so, I am at a loss to find a reason for it. As far as I can see from the correspondence with Ledger, his brother has only sent *one* box of seeds, from which we got a part and Mr. M. the remainder. When the seeds arrived at Bandong, Mr. Van Gorkom tells me, and the box was opened, he feared the seeds would not germinate, as there was a strong smell of ammonia about them, probably a beginning of putrefaction; 20,000 plants we, nevertheless, raised from them, whilst I see from McIvor's Report (1865-66), that with him about 60,000 seeds germinated. McIvor found many varieties amongst them, and also that some of these would not stand the climate of Ootacamund and died off rapidly. How many were left ultimately cannot be seen from the reports. McIvor also says (Report '66-67), "The growth of *C. calisaya* is unsatisfactory . . . with these exceptions all our varieties of *C. calisaya* or Bolivian barks are delicate, liable to disease and damp,' &c. We also have many varieties amongst our *Ledgerianas*. In three plantations, Reong-Goenong, Tjie-Berem and Nagrak, they grew as well or better than all the other Cinchonas; but in another plantation, Tjie-Nieruan, they were much affected with disease, a sort of canker, which, though it did not prove fatal to the trees, hindered their growth during the first years. Now, the surviving are all stout, fine trees, which promise to grow almost as well as *succirubra*,—under ultim. Septr. there were left about 7,000 of these trees. The bark sold in this year (240 kilograms) and 1,472 kilograms that will be sold next year, probably in January, were gathered from trees, that were cut because they grew too near to each other. They have been planted at six feet (Parisian) apart, and this proves now to be too short a distance, so one row is cut alternately. So doing, we get also, during at least a year, a great deal of young shoots from the stumps, which are taken as cuttings and succeed very easily, whilst it is very difficult to take cuttings from calisayas when they are too old; quite different from *succirubra*, whose branches, if put only on a moist ground, will very easily make roots at every intermedium.

As soon as the excellent quality of Ledger's Calisaya was known to us, and when we were satisfied about the question, whether the average amount of Quinine in the greater part of the trees was as satisfactory, Mr. Van Gorkom at once resolved to discontinue the culture of all the other Cinchonas, with exception only of *C. officinalis* (because in one of the existing plantations the other Cinchonas cannot stand the climate); to cut all the now existing trees as soon

as they are fit to give a good bark crop, and when their place can be taken by *Ledgerianas*. The greater part of the seedlings and cuttings of our old *Calisayas* (Hasskarl's, Schuhkraft's, Madras) that still remained in the propagating houses or in the nursery grounds, were thrown away and *Ledgerianas* propagated as fast as possible by cuttings and seeds from the best trees. All other *Cinchonas* have been cut in the neighbourhood of the seed-giving *Ledgerianas* to prevent their degenerating. Seeds are taken only from those trees, whose superiority has been proved by examinations: there are at present about twelve such trees, with an amount of Quinine averaging from 5.28 to 10.9. When a tree gives less than 5 per cent. we do not take seeds from it. There are at present 40,000 young *Ledgerianas*; and before the end of this year, we hope to get about 50,000. I am happy to say that there has not been one moment of hesitation about the course we were to follow; as soon as Ledger's superior quality was sufficiently known, Mr. Van Gorkom and I were quite of the same opinion. V. G. is a chemist, pupil of Mulder as I, and so he could better see the consequences of my examinations.

Now, dear sir, I hope you will agree that we are not so conservative as you thought; that the measures taken to keep *Cinchona* cultivation in the right way are as radical as could be desired; and that we are no such Chinamen to stick to worse *Cinchona* barks, when we can have good ones. As to our other *Calisayas*, I think they will never give barks for quinine manufacturers, though I certainly think with Mr. Jobst that they are excellent medicinal barks, and far better than *Pahudiana* and the greater part of the S. American barks used for that purpose. If you would be so kind to read once more what I have written, you will see that I had it present to my mind, that the market may be glutted if over-supplied with medicinal barks, since I said, quoting the paper of Mr. Jobst (certainly one of the most experienced men in this matter), . . . and *if* we can sell of these barks some thousands packages (as Mr. Jobst assured) every year, not only all the expenses of *Cinchona* culture can be repaid within a few years, but there may also be a considerable profit. As I have not and cannot have sufficient knowledge of the bark trade, in Europe, I ought to trust Mr. Jobst's opinion and think I may safely do so. I have just received a copy from Jobst of his paper in "Berichte der Deutsch Chemis. Gesells. zu Berlin über Javanische Chinarinden."

He says, "The barks have been sold a little, but not much cheaper, though the auction has been held too late, and this may have been the reason that the barks of Java (of which there was no stock at all, so that orders could not be executed) might have lost the ground they hardly conquered." And on page 3 (1131), Jobst says, "though they can be used only as medicinal barks, but as such highly valued, and it needs not to be feared that the market will be over-supplied with these barks, as really good American medicinal barks are rare."

So let us hope that these medicinal barks will pay the expenses of introducing *Cinchonas* into Java, until we can bring every year a great quantity of Ledger's bark in the market and so make quinine much cheaper than it is now.

I omitted to tell you that all the *Ledgerianas* with 6.10 per cent. quinine have green leaves. We have also a good deal with red (purple) leaves, but they do not flower as yet. I have examined one, and found it not better than the other Ledgers. We also remarked that often from the seeds of trees with green leaves, we get an offspring with red leaves and have many of them amongst all the *Calisayas* (Hasskarl's, Schuhkraft's), &c.

From the trees derived from Hasskarl's sending, the greater part gives a bark containing about 0.9 Quinine, 0.6 Cinchonidine, 0.3 Quinidine, 1.2 Cinchonine, 0.6 amorph. alk., total 3.6 per cent. This is

the average amount from a great number of varieties. I have not yet terminated these examinations, and know there are some varieties (sorts) amongst them far better than these.

The trees, which contain a large amount of Quinidine, are all, it appears, descended from the tree, got from Messrs. Thibaut & Ketchlaer in Paris, grown from seeds collected by Weddell himself. There are not many left at present, but enough to propagate them, if such might be deemed necessary. Then we have another half million of trees, which I fear will more disappoint us than all the other sorts. They were raised from seeds sent by Schuhkraft, Esq., our Consul at La Paz; Schuhkraft wrote that this was the species which gave the *morada* bark, and Miquel told us they were partly from *C. Calisaya* var. *Josephiana*, partly from *C. Calisaya* var. *Boliviana*. There are many varieties of these trees, of which some with red leaves, though there are *Josephianas* amongst them, the greater part, I think, cannot be this variety.

I had examined some barks of these trees in 1872, and from that examination I came to the conclusion that these barks contained about 2 per cent. quinine, and though this is certainly not a high amount, it would, however, be sufficient to use the bark for quinine manufacturing. But, as you may see from our quarterly reports of this year, I afterwards examined many samples with worse results, and taking two samples out of a quantity of 1,289 kilogrammes, which will be sold in Amsterdam next year (chests 231 — 240), I only found 0.42 quinine, 0.21 cinchonidine, 0.32 quinidine, 0.54 cinchonine, and 1.43 amorph. alkaloids, so that it appears that the worse varieties were in far greater quantity amongst these trees than the good ones. Of course the propagation of this sort is also discontinued.

When I wrote in 1872 (September), 'the larger half of the present *C. calisaya* trees,' etc., I knew these were all raised from seeds received from Bolivia, but I made the mistake to confound the *Ledgerianas* with the Schuhkrafts. All I wrote there is yet true, but only with regard to the *Ledgerianas*. The 270 kilogrammes sold in Amsterdam in this year (four packages) were all Ledger's, whilst there has not yet been one kilogramme of Schuhkraft's in a previous sale of Java barks. I hope the above will help you towards the understanding of the question, what sort of barks may be expected from our plantations for the first years and what are our hopes for the future. I hope and expect the time of disappointment will soon be past. As to the other Cinchonas, we shall have at the end of this year about 180,000 *succirubras*, 9,000 *calopteras*, 70,000 *lancifolias*, 450,000 *officinalis*, and 1,000 *micranthas*, besides some thousands of *Pahudianas* spread in the forests where Junghuhn planted them. All these trees grow perfectly well in all the plantations, with exception of *C. lancifolia*, which appears to be the most delicate, and which requires more care and a better soil than the other specimen. The *succirubras* appear to stand any climate, and the trees grow as fast as any of the plants proper to Java. The culture of *succirubra* is very seducing, as it is so exceedingly easy. Our highest tree is at present 12.3 meters in height, with a circumference of 0.7 meters (planted April, 1863). From a sample of the crop of this year I got the average amount: 1.3 quinine, cinchonidine 4.81, cinchonine 2.1, amorph. alk. 1.00: the trees were 4.6 years old. *C. officinalis*, of which we also possess many varieties, has the same average amount of the same alkaloids as in Ceylon and Madras. Till now, we could find only one tree, resembling the *angustifolia* variety of *Bonplandiana*, holding about 6 per cent. quinine. *Caloptera* and *micrantha* are in small number. From all these barks I have sent samples to Mr. Broughton, who asked for them; if perhaps you should like to have samples, taken from living trees, and a herbarium of all our varieties, I shall be happy to send them.

Till now the examination of the different sorts of Cinchonas takes the greatest part of my

time: amongst other researches I am now also repeating Mr. Broughton's researches about barks taken periodically throughout a year from the same trees, to ascertain the influence of the seasons. Some years ago, Mr. V. Gorkom had grafted two *Calisayas* upon two *Pahudianas*: the grafts succeeded very well, and I now took the barks for examination. This shewed that the *Calisaya*, as well as the *Pahudiana*, kept their alkaloids, as if they had grown separately. The *Calisayas* contained no quinine or cinchonidine, but quinidine, cinchonine and amorph. alk.; the *Pahudianas*, quinine, cinchonidine (much), no quinidine, cinchonine, and amorph. alk. I think this is an experiment of considerable interest, and we shall repeat it, if possible, with *micrantha* and *Calisaya Ledgeriana*. I think the result most agrees with your idea, that the alkaloids are formed in the cellular tissue of the bark.

(Copy.)

Bandong, 7th September, 1874.

DEAR SIR,—I quite agree with you that we cannot quite trust to the produce of the seeds of *C. Ledgeriana*, and we would certainly like better to take cuttings of it, were it possible to get them, from our best trees. But this seems to be very difficult, as our best gardeners have almost no success with them. Till now we could only get cuttings from trees, which were cut down because they stood too near to each other; the stumps of these trees give a good deal of young shoots, and with these our gardeners are very successful, so that we could obtain in this manner about 10,000 young plants, now planted in the open ground. I think we shall be able to get more cuttings from these young plants, and do not fear the good qualities of *C. Ledgeriana* will be lost in the future. We have, at present, forty-three *Ledgeriana* trees, from which seeds are taken, the barks having been analysed by me. The descendants of each of these trees are kept separately in the plantations, registered upon the maps of the plantation; and, besides this, each separate group is provided with a label, upon which the pedigree of the tree is written. So we shall have, within six or seven years, a physiological experiment about the question whether the seedlings degenerate, from which it will be possible to make good conclusions. The seedlings of *Ledgerianas* have a quite peculiar character, which remembers the mother plants. The leaves have the same soft, velvety appearance as the young leaves of the parent, and till now I cannot find great variations in the descendants of the same trees.

Mr. Van Gorkom says he does not fear a degeneration if there is due care taken that the trees are not impregnated by the pollen of other *Cinchonas*. He appeals to the fact, that our *Succirubras* and *Officinalis*, all grown from seeds obtained from the Madras plantations, have an average amount of alkaloids, which in quantity and quality appears to be the same as that found in the Nilghiris.

So *C. Pahudiana* has not at all altered its qualities since it has been brought to Java, and the descendants are the true portraits of their ancestors. There is only one kind (?) of *Cinchona* from which the descendants show such great variations from the type of the mother trees, that it is often difficult to know them, viz., our so-called English *Calisaya*, obtained from Madras seeds. I presume this is the same hybrid as the one of which you speak in your interesting paper ('Pharmaceutical Journal and Transactions'), a hybrid between *calisaya* and *succirubra*. Now, the descendants of these trees appear to return to the type of either of the mother plants, some resembling the *succirubra* or sometimes the *micrantha* type, others the *calisaya* type. They are now too young to be analysed; but I hope to have in future the opportunity to trace the origin of this hybrid in the chemical constitution of the bark of its descendants. The same is not observed in the descendants of *Hasskarliana*, and I think this to be the strongest proof that this species is no hybrid.

If it is true, as you suppose, that the product of cross-breeding is always worse than the mother

plants (*i.e.*, as to the quality of the bark), it would be possible to get better plants by taking the seedlings of a hybrid, because part of these would certainly incline to return to the mother type.

If the variation amongst *Ledgerianas* could be a consequence of cross-breeding, we could hope to return to a mother type, a species of *ur-calisaya* with perhaps 20 per cent. of pure quinine.

Amongst our old *Ledgerianas* there are certainly great variations. As to those about which you speak in 'Pharmaceutical Journal,' No. 210, with a very small amount of alkaloids, I feel sure they were no *Ledgerianas* at all, but other *calisayas* planted between the *Ledgerianas* when young plants of these had died.

But then there are some, though only a few, with red flowers, and containing either cinchonidine or cinchonine, which appear to be true descendants from Ledger's seeds. You will find the most typical forms in the herbarium we have sent to you, and which leaves Batavia on the 10th instant.

The numbers in analyses are pure alkaloids, in bark dried at 125° Cels., in 100 parts.

Besides the *Ledgerianas*, I call your attention to the *calisayas*, Nos. 1, 2, 4, 7, and 8, a variety having an average amount of more than 2 per cent. quinine with three-fourths cinchonine, and from which I have just found we have two or three plantations with about 30,000 trees.

Then, also to the *C. Calisayas* obtained from seeds sent by Schuhkraft, a kind of no great value.

Yours very faithfully,

MOENS.

STATE OF THE PLANTATIONS IN JAVA, END OF SECOND QUARTER OF 1875.

From printed reports regularly sent me by the authorities in Java, it appears that up to the end of April the weather was so dry as to put a stop to the planting of young trees; but it was very favourable to the drying of the bark. During the second quarter there were planted out 10,977 *C. Calisaya v. Ledgeriana*, and 18,150 *C. officinalis*.

At the different establishments there were more than 12,000 kilogrammes of bark ready to be sent off, and for the most part packed. The packing is partly in chests, but also partly in bags made of jute, the comparatively light weight of the last being found of great advantage.

For the exhibition at Philadelphia in 1876, there have been prepared 11 cartoons, with herbarium specimens and barks of 11 different sorts of Cinchonas, 9 photographs of the bark establishments, 9 chests and bales with Cinchona barks, 11 sawn-off stems of Cinchona trees, and a collection of alkaloids and their salts, which are prepared from Java barks.

JAVA, END OF JUNE, 1875.

Plantation	Mountain	Height in Feet	Plants in Nursery					Plants in open ground					Total of Plants
			C. Calisaya and Ledgeriana	C. succirubra	C. officinalis and Varieties	C. lancifolia	C. micrantha	C. Calisaya and Hasskarl.	C. succirubra and caloptera	C. officinalis and Varieties	C. lancifolia	C. micrantha	
Lembang . .	Tangkoeban-Prahoë	4,104	200	—	—	—	—	133,100	14,400	—	—	200	147,900
Nagrak . .	Ditto . .	5,331	9,600	—	10,000	—	—	166,100	42,200	66,200	4,300	60	298,360
Tji-Bitung . .	Wajang . .	5,010	18,300	—	38,900	—	—	139,600	26,500	38,900	2,200	—	264,400
Tji-Bürrüm . .	Malawar(East)	5,118	19,700	—	6,500	2,100	—	197,700	23,500	41,500	1,300	—	292,300
Tji-Niroean . .	„ (West)	5,137	30,900	—	500	7,300	—	251,600	46,300	47,900	9,400	200	394,100
Rioeng-Geonoeng	Tiloe . .	5,010	19,100	—	8,600	—	—	247,500	32,200	34,400	18,800	—	360,600
Kawah-Tjiwidei	Kendeng-Patoeha	6,069	—	—	33,300	—	—	—	—	231,300	—	—	264,600
Total of individual sorts . . .			97,800	—	97,800	9,400	—	1,135,500	185,100	460,200	36,000	460	
Total			205,000					1,817,260					2,022,260

STATE OF THE PLANTATIONS, END OF SEPTEMBER, 1875.

In the three months of this quarter the weather was unusually dry. In the higher plantations there were, in July, one wet day; in August, two to five; and in September, four to six days of rain. The strong east wind did much mischief in the Nagrak plantation. In consequence of this dry weather the harvest of bark could be easily gathered in, so that at the end of August it was all finished. There were, on the whole, 68,000 trees barked, and 87,000 Amsterdam pounds of dried bark obtained. The plantations from which the harvest was gathered in were prepared to be planted in the next season with better sorts of Cinchona, and especially with the *Ledgeriana*. The trees which had been felled on the first clearing of the forest, having been piled up in rows, and for the most part rotted away, were removed; the plantations assumed a more regular appearance, and the new plantation could be made in more perfect order.

It will be seen that the number of trees in the open ground is diminished when compared with the preceding quarter. This is, doubtless, owing to the proportion cut down for the bark harvest. On the other hand, the number of the *Ledgerianas* is increased by 1,887 young plants in the nurseries.

Plantation	Mountain	Height in metres	Plants in Nursery					Plants in open ground					Total of Plants
			C. Calisaya and Ledgeriana	C. succirubra	C. officinalis and Varieties	C. lancifolia	C. micrantha	C. Calisaya and Hasskarlana	C. succirubra and Caloptera	C. officinalis and Varieties	C. lancifolia	C. micrantha	
Lembang . .	Tangkoeban-Prahoë	1,251	230	—	—	—	—	133,126	14,411	—	—	200	147,967
Nagrak . .	Ditto . .	1,625	9,675	—	10,000	—	—	164,700	42,200	66,275	4,302	62	297,214
Tji-Bitoeng . .	Wajang . .	1,527	18,352	—	38,973	—	—	137,515	25,831	38,919	2,195	—	261,785
Tji-Bürrüm . .	Malawar(East)	1,560	20,653	—	6,577	2,150	—	187,002	23,511	41,545	1,328	—	282,766
Tji-Niroean . .	„ (West)	1,566	31,670	—	530	7,300	—	241,075	42,115	47,959	9,411	250	380,310
Rioeng-Goenoeng	Tiloe . .	1,625	19,107	—	7,800	—	—	242,500	31,000	32,900	18,800	—	352,107
Kawah-Tjiwidei .	Kendeng-Patoeha	1,950	—	—	28,500	—	—	—	—	231,333	—	—	259,833
Total of individual sorts . . .			99,687	—	92,380	9,540	—	1,105,918	179,068	458,931	36,036	512	1,981,982
Total			201,517					1,780,465					

CINCHONA CULTIVATION.

57

(ANALYSES OF CINCHONA BARK GROWN IN JAVA, BY M. MOENS.)

Number	SORT OF CINCHONA	Place of Growth	Water	Neutral Tartrate of Alkaloids dried at 100° C.	Quinine	Cinchonidine	Quinidine	Cinchonine	Amorph. Alkaloid.	Total Alkaloid	Sulphate of Quinine as computed
1	Cinchona succirubra . .	Tji-Niroean . .	13.50	6.66	1.50	3.82	—	2.2	0.38	7.91	2.02
2	" " . .	" " . .	13.47	6.11	1.10	3.83	—	1.82	0.22	6.97	1.48
3	" " . .	" " . .	12.69	6.72	1.10	4.12	—	2.15	0.30	7.67	1.48
4	" " . .	" " . .	13.23	8.01	1.55	4.53	—	2.28	0.32	8.68	2.08
5	" " . .	" " . .	13.92	7.95	1.31	4.79	—	2.15	0.34	8.59	1.76
6	" " . .	" " . .	13.43	6.33	1.12	3.78	—	1.87	0.44	7.21	1.49
7	" " . .	" " . .	16.44	8.21	1.41	4.67	—	2.22	0.54	8.84	1.89
8	" " . .	" " . .	13.75	6.82	1.10	4.13	—	2.87	0.60	8.70	1.48
9	" " . .	" " . .	12.41	6.01	0.90	3.90	—	2.67	0.55	8.02	1.21
10	" " . .	" " . .	10.82	5.51	0.84	3.36	—	2.28	0.32	6.80	1.09
11	" " . .	" " . .	11.80	5.59	1.01	3.32	—	2.55	0.54	7.42	1.36
12	" " . .	" " . .	12.10	6.07	0.86	3.79	—	2.37	0.57	7.59	1.16
13	" " . .	" " . .	12.74	7.24	0.83	4.64	—	2.67	0.37	8.51	1.08
14	" " . .	" " . .	14.30	6.12	0.74	3.88	—	2.89	0.77	8.28	1.00
15	" " . .	" " . .	14.20	6.16	0.62	4.06	—	2.89	0.68	8.25	0.83
16	" " . .	" " . .	12.50	5.48	0.63	3.53	—	2.78	0.58	7.52	0.85
17	" " . .	" " . .	10.57	6.18	0.44	4.28	—	2.53	0.45	7.70	0.59
18	" " . .	" " . .	11.42	5.80	0.67	3.79	—	2.72	0.68	7.86	0.90
19	" " . .	" " . .	15.00	5.76	0.67	3.65	—	2.74	0.70	7.76	0.90
20	" " . .	" " . .	13.63	5.95	0.82	3.70	—	2.26	0.81	7.59	1.08
21	" " . .	" " . .	13.23	5.87	0.77	3.69	—	2.63	0.38	7.47	1.03
22	" " . .	" " . .	13.68	6.28	0.68	3.81	—	2.77	0.32	7.58	0.92
23	" " . .	" " . .	13.71	5.89	0.69	3.77	—	2.79	0.32	7.57	0.93
24	" " . .	" " . .	12.53	5.92	0.72	3.75	—	2.87	0.51	7.85	0.96
25	Calisaya Ledgeriana .	" " . .	12.11	10.43	7.89	0.58	—	0.59	0.61	9.67	10.62
26	" " . .	" " . .	13.34	12.86	9.81	0.40	—	—	1.04	11.25	13.20
27	" " . .	" " . .	13.03	11.61	8.75	0.45	—	0.48	0.44	10.12	11.78

The Analyses of the Barks of *Calisaya Ledgeriana*, from No. 25 to 27, were taken from trees, which are set apart for the production of seed.

29	Cinchona Calisaya Ledgeriana .	Tji-Berem . .	14.47	7.07	5.74	—	1.38	0.10	2.03	9.25	7.72
30	" " . .	Tji-Niroean . .	12.55	7.59	5.42	0.52	0.10	0.18	0.73	6.95	7.29
31	" " . .	Rioeng-Goenoeng .	12.30	11.16	9.06	—	—	0.10	1.40	10.56	12.19
32	" " . .	Tji-Niroean . .	13.47	12.28	9.97	—	—	traces	1.90	11.87	13.42
33	" " . .	" " . .	15.07	11.59	9.41	—	—	0.14	1.45	11.00	12.66
34	" " . .	" " . .	11.14	11.28	7.50	1.24	—	0.21	1.04	9.99	10.09
35	" " . .	" " . .	12.05	11.58	7.40	1.65	—	0.60	1.09	10.74	9.96
36	" " . .	Tji-Berem . .	12.67	8.61	6.99	—	—	0.10	0.63	7.72	9.41
37	" " . .	" " . .	14.68	11.75	8.46	0.80	—	0.35	1.03	10.64	11.38
38	" " . .	" " . .	14.89	9.71	7.43	0.43	—	0.32	0.45	8.63	10.00
39	" " . .	" root-bark . .	13.82	7.64	4.81	1.30	—	2.11	1.04	9.26	6.47
40	" " . .	" " . .	12.92	8.28	5.07	1.56	—	1.93	1.10	9.66	6.82
41	" " . .	Tji-Niroean . .	12.17	2.61	1.15	0.93	0.40	1.24	1.45	5.17	1.51
42	" " . .	" " . .	11.89	1.53	1.11	—	0.86	1.02	0.87	3.86	1.49
43	" " . .	" " . .	12.30	2.94	2.24	traces	0.16	0.39	3.11	5.90	3.01
44	" " . .	Tji-Berem . .	12.59	2.30	1.03	0.73	0.20	1.13	1.23	4.32	1.38
45	" " . .	Tji-Niroean . .	13.50	4.04	2.94	traces	0.82	0.50	1.16	5.42	3.95
46	" " . .	" " . .	14.28	3.38	2.56	—	0.72	0.40	1.25	4.93	3.41
47	" " . .	Tji-Bitong . .	12.86	2.73	1.59	0.22	0.13	0.45	1.01	3.40	2.11
48	" " . .	Tji-Berem . .	13.89	4.05	2.26	0.90	0.14	0.69	0.59	4.58	3.04
49	" " . .	" " . .	14.52	4.26	2.97	traces	0.82	1.04	1.06	5.89	3.99
50	" " . .	Rioeng-Goenoeng .	13.28	2.20	1.40	0.29	0.07	2.11	1.10	4.97	1.88
51	" " . .	" " . .	13.42	2.23	0.64	1.14	0.10	0.49	0.85	3.22	0.86
52	" " . .	offshoots } from No. 4	Nagrak . .	16.00	0.27	0.21	—	0.22	0.05	0.60	0.28
53	" " . .	" " 5	" " . .	15.12	0.37	0.32	—	0.12	0.17	1.02	0.43
54	" " . .	Anglica .	Rioeng-Goenoeng .	12.27	4.02	1.42	1.60	—	1.83	0.93	5.78
55	" " . .	" " . .	13.41	4.30	1.83	1.38	—	1.80	1.00	6.01	2.47
56	" " . .	Tosari . .	15.93	3.27	0.31	2.30	traces	0.71	2.54	5.86	0.42
57	" " . .	Sumatra, West coast	15.21	1.09	0.40	0.37	traces	0.54	2.04	3.35	0.54
58	" Caloptera . .	Tji-Niroean . .	14.08	1.68	0.73	0.55	0.12	2.70	1.57	5.67	0.98
59	" Succirubra . .	Nagrak . .	11.35	9.08	1.71	5.25	—	1.45	1.30	9.71	2.30

* * These Tables are not only valuable as illustrating the products of the Cinchona, but as attesting the great care and chemical skill which M. Moens has brought to bear on the subject.

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HERBARIUM FROM JAVA.

From M. MOENS, Java, 1874.

‘Memorandum.—Specimens from *Cinchona* plants grown in Java, Herbarium for Mr. J. E. Howard.’

Remarks J. E. H.

No. 1. *C. Calisaya*, grown from seeds obtained from plants, collected by Hasskarl, 8 years age. Plantation, Tjie-Nieroean. Bark contains:—

Quinine	5.60
Amorphous alkaloid	1.26
	— 6.86
Quinidine	2.14
Cinchonine	0.48
	— 9.48

Resembles the best sorts. Flowers small and white apparently. Leaves 6 in. by $1\frac{3}{4}$ the largest, small *ad.* 4 in. by $\frac{3}{4}$. Small scrobicules at the axis of the veins. The Quinidine being equally contained in No. 41 the original tree is to be noted. Has there been a hybrid formed here introducing the Quinine? Plantation about 5,137 ft. elevation.

No. 2. *C. Calisaya*, grown from seeds obtained from plants collected by Hasskarl, 12 years of age. Plantation, Nagrak.

Quinine	2.29
Amorphous	1.13
	— 3.42
Quinidine	2.61
Cinchonine	1.22
	— 7.25

A poor bark, but the Quinidine would bring up its value. Of No. 1, 2, 4, 7, and 8, the Dutch Government have about 30,000 trees.

Very minute scrobicules, flowers long and with conspicuous margins—leaves 6 in. by $1\frac{1}{2}$. Capsules large and more like *C. officinalis*. Plantation 5,331 feet elevation.

No. 3. *C. Calisaya*, grown from seeds obtained from plants which were grown from seeds sent by Schuhkraft (from Bolivia). Plantation, Tjie Nieroean. Age, 6 years.

Apparently a form of *C. Josephiana*. Large flowers. Capsules large oblong. Leaves 5 inches by 2. Pubescent under side.

No. 4. *C. Calisaya*, same origin as No. 1. Age, 12 years. Plantation, Nagrak.

Cleft in side of tube like *Pahudiana*.

Quinine	2.05
Amorphous	0.81
	— 2.86
Quinidine	1.56
Cinchonine	0.58
	— 5.00

(Soil of Plantation decomposed trachyte. Dr. de Vrij.)

No. 5. *C. Calisaya*, grown from seeds obtained from plants collected by Hasskarl—other variety. Plantation, Tjie-Nieroean. Age, 9 years.

Much resembles No. 41, or Hasskarl's original tree. Leaves obtuse, barely scrobiculate, $4\frac{1}{2}$ by $1\frac{3}{4}$. Capsules as last.

Quinine	2.23
Amorphous	0.80
	— 3.03
Cinchonidine	0.30
Quinidine	0.23
Cinchonine	0.70
	— 4.26

HERBARIUM FROM JAVA—continued.

No. 6. *C. Calisaya*, grown from seeds sent from Bolivia by Schuhkraft. Age, 9 years. Plantation, Tjie Nieroean. Apparently a form of *C. Josephiana*. Leaves, triply scrobiculate, pubescent on the lower side. Leaves $5\frac{1}{2}$ by $1\frac{1}{2}$. Capsules oblong round, flowers large.

No. 7. *C. Calisaya*, grown from seeds obtained from plants collected by Hasskarl. Age, 12 years. Plantation, Nagrak. Leaves with very small scrobicules, slightly pubescent on the lower surface—5 to 6 inches long, $1\frac{3}{4}$ wide. Capsules resembling those of *C. micrantha*. The bark also has somewhat the appearance of 'grey bark.' Flowers small (?).

Quinine	1.42
Amorphous	2.00
	— 3.42
Cinchonidine	0.82
Quinidine	0.15
Cinchonine	1.56
	—
	5.95

No. 8. *C. Calisaya*, grown from seed obtained from plants collected by Hasskarl. Age, 12 years. Plantation Nagrak. Leaves with very small scrobicules. Flowers with conspicuous margin, tube rather long. Capsules rather rounded—leaves $4\frac{1}{4}$ by $1\frac{3}{4}$. Dr. de Vrij thought this a hybrid.

Quinine	3.11
Amorphous	0.57
	— 3.68
Cinchonidine	0.61
Quinidine	0.51
Cinchonine	0.89
	—
	6.69

No. 9. *C. Calisaya Anglica*, grown from seeds obtained from Madras, in 1866. Probably a hybrid between *C. Calisaya* and *C. succirubra*. Plantation, Reong Goenoeng. Plantation 5,010 feet elevation.

Quinine	1.42
Amorphous	0.93
	— 2.35
Cinchonidine	1.60
Cinchonine	1.83
	—
	5.78

No. 10. *C. Calisaya Ledgeriana*, grown from seeds bought from Ledger, in 1866. Flower pale white—under side of the leaves of a pale purple colour; nerves red. Flowers short, pure white, anthers exserted, lips of corolla large, conspicuous. Capsules small, oblong, hirsute, with large and perfect crowns.

Quinine	9.06
Amorphous	1.40
	— 10.46
Cinchonine	0.10
	—
	10.56

HERBARIUM FROM JAVA—continued.

No. 11. *C. Calisaya Ledgeriana*. Origin as 10. Same as 10. Leaves somewhat more ovate ;
Leaves green under side ; nerves red. Flower pure 7 inches by 3. Form C.
white. Plantation Tjie-Nieroean.

Quinine	9.91
Amorphous	2.09
	— 12.00

No. 12. *C. Calisaya Ledgeriana*. Origin as 10. Only difference in the more obtuse leaves.
Flower pure white, under side of leaves green. Planta-
tion Nagrak. The flowering branch figured under *Var.*
Ledgeriana. Plate form B.

Quinine	7.49
Amorphous	1.41
	— 8.90

No. 13. *C. Calisaya Ledgeriana*. Seed from Same as No. 12. Leaves rather smaller, $3\frac{1}{2}$
Ledger in 1866, flower pure white, under side of the inches by $1\frac{1}{3}$.
leaf dark purple.

Quinine	9.97
Amorphous	1.73
	— 11.70

No. 14. *C. Calisaya Ledgeriana*. Origin as No. Same as No. 12. Leaves rather longer, also
10. Plantation, Tjie-Nieroean. tube of corolla.

No. 15. *C. Calisaya Ledgeriana*. Origin as No. Same as No. 10.
10. Plantation, Tjie-Nieroean.

No. 16. *C. Calisaya Ledgeriana*, origin as No. 10. Leaves 6 inches by 3 inches, but the younger
Flowers pure white, leaves at the under side purple, much more narrow. A new variety ?
nerves red.

Quinine	5.42
Amorphous	0.73
	— 6.15
Cinchonidine	0.52
Quinidine	0.10
Cinchonine	0.18
	— 6.95

No. 17. <i>C. Calisaya Ledgeriana</i> , origin as No. 10.	} 17. Leaves 6 inches by 2 inches. Same as No. 10.
No. 18. Plantation, Tjie-Nieroean.	

No. 19. *C. Calisaya Ledgeriana*, flower light red. A new variety, same as No. 16 ?
Plantation, Reong Goenoeng. Origin as 10.

Quinine	3.82
Amorphous	1.20
	— 5.02
Quinidine	1.91
Cinchonine	1.03
	— 7.96

No. 20. *C. Hasskarliana*, grown from seeds
obtained from plants collected by Hasskarl. Planta-
tion, Nagrak.

HERBARIUM FROM JAVA—continued.

No. 21. *C. Hasskarlana*, origin as 20.

No. 22. *C. Pahudiana*. Age, 16 years. Grown from seeds obtained from plants collected by Hasskarl. Resembles entirely No. 20. Plantation, Tjie-Nieroean.

No. 23. *C. Pahudiana* var. *lanceolata*. Age, 15 years. Origin as 22. More like in form of leaf to *C. Carabayensis*, Wedd.

No. 24. *C. officinalis*, grown from seeds from Java plants, which were raised from Madras seeds. Age, 5 years. Plantation, Nagrak.

No. 25. *C. officinalis*. Origin as 24. Plantation, Nagrak.

No. 26. *C. officinalis*. Origin as 24. Plantation, Nagrak.

No. 27. *C. officinalis* (var. *angustifolia*), grown from seeds obtained from Madras. Plantation, Reong Goenoeng. This seems to be exactly the same as the var. *angustifolia* of Ootacamund, from which the seeds were obtained.

Quinine	5.86
Amorphous	0.45
	— 6.31
Cinchonidine	0.74
Cinchonine	0.62
	— 7.67
	—

No. 28. *C. officinalis*. Origin as 27. Plantation, Reong Goenoeng.

Quinine	5.19
Amorphous	0.20
	— 5.39
Cinchonidine	1.85
Cinchonine	0.86
	— 8.10
	—

No. 29. *C. Calisaya*, grown from seeds sent by Schuhkraft. White flowers. Age, 9 years. Plantation, Tjie-Nieroean.

Quinine	1.83
Amorphous	2.30
	— 4.13
Cinchonine	0.58
	—

No. 30. *C. lancifolia*, grown from seeds sent by Dr. Karsten. Age, 17 years. Plantation, Tjie-Nieroean. Quite different from the specimen of *C. lancifolia* given me by Dr. Karsten.

No. 31. *C. caloptera*, grown from seeds obtained from plants collected by Hasskarl. Age, 9 years. Plantation, Tjie-Nieroean.

HERBARIUM FROM JAVA—continued.

No. 32. *C. micrantha*, grown from seeds sent from
Madras. Plantation, Nagrak,

Quinine	. . . (a trace)	
Cinchonidine	. . . . .	0.85
Cinchonine	. . . . .	4.18
		<hr/>
		5.03
		<hr/>

No. 33. *C. succirubra*, grown from seeds obtained
from Madras. Flower, light red. Plantation, Tjie-
Nieroean.

No. 34. *C. succirubra*, grown from seeds from
Madras. Flower, white. Plantation, Tjie-Nieroean.

No. 35. *C. succirubra*. Hairy leaved variety Leaves pubescent beneath.
hybrid?). Origin as 33. Plantation, Tjie-Nieroean.

No. 36. *C. cordifolia*, grown from seeds sent by
the Dutch consul in Venezuela. Has not yet flowered.
Plantation, Tjie-Nieroean.

No. 37. *C. Calisaya*, grown from seeds sent by Leaves with very small scrobicules, chiefly
Schuhkraft (Bolivia) in 1865. Plantation, Lembang. at the axils of the smaller veins.

Quinine	. . . . .	0.40	Resembles <i>C. Josephiana</i> . Plantation,
Amorphous	. . . . .	0.63	4,104 feet elevation.
		<hr/>	
		1.03	
Cinchonidine	. . . . .	0.46	
Cinchonine	. . . . .	2.74	
		<hr/>	
		4.23	
		<hr/>	

No. 38. *C. Calisaya*. Origin as 37. Plantation,
Lembang.

No. 39. *C. Calisaya*. Origin as 37. Plantation, A form of *C. Josephiana*; leaves pubescent
Lembang. on the under side, sparingly scrobiculate.
Flowers, very light red.

No. 40. *C. Calisaya*. Origin as 37. Plantation,
Lembang.

Quinine	. . . . .	2.34
Amorphous	. . . . .	1.39
		<hr/>
		3.73
		<hr/>

No. 41. *C. Calisaya*, cutting from original tree Leaves very round at the point, but similar
collected by Hasskarl. Plantation, Tjie-Nieroean. to form B of the *C. Ledgeriana*;
Age, 8 years. sparingly scrobiculate, flowers not deve-
loped. This specimen resembles entirely
that collected by Hasskarl at Vilque-
bamba, Prov. Carabaya, and described by
Miquel as *C. Calisaya*, Wedd. (but ?)
it is evident that the tree has not lost its
characteristics by the transfer to Java.

Quinidine	. . . . .	1.69
Cinchonine	. . . . .	2.23
Amorphous	. . . . .	1.59
		<hr/>
		5.51
		<hr/>

HERBARIUM FROM JAVA—continued.

No. 42. <i>C. Calisaya Ledgeriana</i> .	Origin as No.	The fruit bearing branch figured under B
10. Flowers, light red.	Plantation, Tjie-Berem.	form of <i>var. C. Ledgeriana</i> . Plantation
Quinine	10.90	5,118 feet elevation.
Amorphous	1.72	
	— 12.62	
Cinchonidine	1.25	
Cinchonine	0.44	
	—	
	14.31	
No. 43. <i>C. Calisaya Ledgeriana</i> .	Origin as No.	This, if included under the <i>var. Ledgeriana</i> ,
10. Plantation, Tjie-Berem.		as I think it ought, should be marked
Quinine	8.46	as a distinct form.
Amorphous	1.03	
	— 9.49	
Cinchonidine	0.80	
Cinchonine	0.35	
	—	
	10.64	
No. 44. <i>C. Calisaya Ledgeriana</i> .	Origin as No.	Leaves 6 inches by 2½. Sparingly scrobiculate.
10. Plantation, Tjie-Berem.		Nearly the same as last.
Quinine	7.43	
Amorphous	0.45	
	— 7.88	
Cinchonidine	0.43	
Cinchonine	0.32	
	—	
	8.63	

HERBARIUM FROM MR. BROUGHTON, June, 1874.

Varieties of *Calisaya* gathered at Nedivuttum, Ootacamund.

No. 1. <i>C. Calisaya</i> .	Resembles the <i>var. Ledgeriana</i> (Java collection).
No. 2. Ditto	Small fruited.
No. 3. Ditto	Leaves only.
No. 4. Ditto	Comp. with <i>C. amygdalifolia</i> , Wedd.
No. 5. Ditto	Purple under side of leaf.
No. 6. Ditto	Resembles the <i>Ledgeriana</i> of Java.
No. 7. Ditto	Leaves only.
No. 8. Ditto	Very small fruited.
No. 9. Ditto	Ditto
No. 10. Ditto	Ditto
No. 11. Ditto	Resembles No. 12 of Java collection.
	Very small capsules.
No. 12. Ditto	Comp. No. 15 and No. 17 Do.

HERBARIUM FROM MR. BROUGHTON—*continued*.

No. 13. ?	Only leaves, 4 inches long and $\frac{1}{2}$ -inch wide.
No. 14. <i>C. Calisaya</i> , Wedd.	Only leaves.
No. 15. Ditto ?	
No. 16. Ditto	Resembles the <i>morada</i> of P. Rada ; capsules very small.
No. 17. Ditto ?	Leaves $6\frac{1}{2}$ inches long and 3 wide.
No. 18. Ditto	Resembles the <i>var. Ledgeriana</i> of Java.
No. 19. Ditto	Resembles <i>var. Ledgeriana</i> .

.. These specimens have not the healthy and vigorous appearance common to those of the Java Herbarium.

HERBARIUM FROM HASSKARL.

(From Carabaya.)

Mr. Hasskarl having obligingly presented me with duplicates of his botanical collection, the result of his mission to collect Cinchona plants for the Dutch East Indies, I shall here give a short account of the same, as bearing on what precedes.

No. 1. Cascarilla Calisaya, Wedd., arbor vetust. In valle majori, Prov. Carabaya ad Vilquebambam. November, 1853. Agrees with No. 5 of the Herb. from Java. Junghuhn seems to have taken it for the *C. Josephiana*.

No. 1.* *C. Calisaya*, Wedd., var *Joseph. acc.* ad B. Cascarilla Calisaya arbor juvenil. In apricis insolatis vallis Sandiæ. February, 1853. This and the preceding are described together by Professor Miquel in his work 'de Cinchonæ speciebus quibusdam.' It is a Quinidine-producing sort, and allied by the form of the capsules to the *C. Josephiana*, Wedd. (as correctly remarked by Miquel). The character of the leaves 'ad axillas costularum et ad axillas venarum e costulis ortarum scrobiculata' Miq. also seems to indicate this near alliance. The very obtuse leaves, however, do not quite agree with the *C. Josephiana*, Wedd. On the whole I conclude that we have here a Carabayan form of *C. Josephiana*, differing somewhat from the Bolivian.

No. 2. ? ? Ichu Calisaya de valle Sandia et regionibus maius ad meridiem sitis Provinciæ Carabaya. November, 1853. This sort is called by Miquel *Cinchona Calisaya Hasskarlii missionis*, and described as a *varietas rugosa* of *C. Calisaya*. It appears to me to be one of the forms of *Ichu Calisaya* as described by Hasskarl, but very much nearer to the *C. Carabayensis*, Wedd. than to any known form of legitimate Calisaya. It has nothing in common with the specimens sent me of Hasskarl's Calisaya grown in Java. It is more like the *C. rugosa* of Ruiz and Pavon. See Triana, 'Nouvelles Etudes,' &c. p. 63.

HERBARIUM FROM HASSKARL—continued.

No. 3. *C. ovata* Vhl. *Cascarilla amarilla* ad oras Rio Grande. November, 1853. Miquel links this with other specimens of Hasskarl, and describes it under the new designation of *subsessilis*. It seems to me to agree, as far as a dried specimen can show, with *C. pubescens*, and by the bark to be allied to the var. *Pelletierana*, Wedd.

No. 4. *C. pubescens* Vhl. *Pelletierana*, Wedd. *Cascarilla naranjada*, in altioribus partibus vallium Provinciae Carabayæ. November, 1853.

No. 9. *C. Boliviana*, Wedd. *Cascarilla morada*, seu *Casc. morada fina*, ad oras Rio Grande. November, 1853. Described by Miquel as *C. euneura*.

No. 12. *C. pubescens* Vahl. *Cascarilla pucequepo* seu *verde morada*, in locis profundis ad oras flum. Grand. Prov. Carabaya. Miquel ranks this specimen under *Cinchona ovata*, R. and P.

No. 13. *Pimentelia glomerata*, Wedd. *Casc. punta di lanza*. *Cascarilla Echenique*. In locis altis Provinciae Carabayæ. Miquel refers this apparently ("*referendum videtur*") to the *C. amygdalifolia*, Wedd., but without any authority; and certainly the bark does not belong to a *Cinchona*. The specimen differs wholly from Dr. Weddel's specimen of *C. amygdalifolia*.

The following specimens are from the environs of Uchubamba, Department Jauja.

No. 16. *Cinchona amygdalifolia*, Wedd. *Casc. baya* seu *casc. amarilla*. Escalera Sn. Rafael, en el camino de Jauja, prope Uchubamba, Peruv. And. This specimen is referred by M. Triana to *C. purpurea* in a note in his handwriting thus: "ressemble à la plante qui je considère doit représenter le *Cinchona purpurea* Pav."

No. 17. *Celastrinea*? *Cascarilla bobo*, se cala de las lomas, prope Uchubamba ad alt. 5,400. July, 1853. Probably *Lucuma Arguacoensium* Krst.

No. 18. *Cinchona ovata* R. and P. arbores juveniles. *Cascarilla crespilla chica*. In apricis prope Uchubamba November, 1853. *C. Pahudiana* (How.) with bark.

No. 18*. *Cascarilla crespilla chica*. Same as last, but with capsules and the bark.

No. 20. *Condaminea*. B. Candolii. *Cascarilla*? Escalera Sn. Rafael, en el camino de Jauja prope Uchubamba. July, 1853. M. Triana wrote respecting this specimen: "Cet échantillon me semble répondre très bien à l'esquisse du *C. lanceolata* faite à Madrid d'après l'exemplaire authentique."

No. 21. δ *lanceifolia*, Wedd. *Casc. azahar*. Escalera Sn. Rafael, en el camino de Jauja prope Uchubamba. July, 1853. Perhaps the same as the "*blanca de Faday*." *C. lanceifolia* var. d. Mutis, Icon. VI. Quinologie.

HERBARIUM FROM HASSKARL—*continued*.

No. 22. *C. pubescens* Vhl. *Cascarilla crespilla* This seems to be considered as related to the *cascarilla crespilla chica*, and there is certainly a degree of resemblance indicating some near affiliation.

No. 23. *C. purpurascens* Wedd. ? ? In montibus Quite unknown to me.
prope Uchubamba.

No. 24. *Cascarilla*. *B. Calisaya indigenorum* This is the plant called *Comadre de Calisaya* (godmother of the Calisaya), because when found it indicates that the real Calisaya will soon be met with. It resembles much the *Cinchona undata* of Karsten, in Java, and I very much doubt its having been introduced by Hasskarl into that colony. Consequently, the account which Miquel gives of its bark having yielded to M. Moens 4.960 per cent. of alkaloid (of which 2.845 Quinine), may have no reference to this form, but rather to others introduced by Hasskarl—such as are represented in the Herbarium from Java.

* * I have just received from Mr. McIvor a very perfect herbarium of the Cinchonas cultivated by him, including illustrative specimens of the hybrids which he has produced. I do not think it necessary to describe these in detail, as my object is very specially to illustrate the varieties of *Calisaya*, and the reader will see the extent of the field of research from the materials given above. McIvor's Calisayas do not seem to me to be of the *Ledgeriana* type. I shall not revive here the controversy into which I was unwillingly drawn in reference to the merits and the status of the *C. Pahudiana*, as especially since the death of Professor Miquel this question has lost much of its interest.

"Hi motus animorum, atque hæc certamina tanta
Pulveris exigui jactu compressa quiescent."—Georgic. lib. iv. l. 86–87.

NOTE ON COCHININ OR CONQUININE.

I have taken the liberty to alter the German term *Conchinin* in my correspondents' letters, as I entirely decline to use this newly coined and barbarous word, which is designed to supersede the Quinidine of Pasteur, and which it is proposed already to transform into *Conquinine*. In the "*Comptes rendus des Séances de l'Académie des Sciences*," tome xxxvii. 25, vii. 1853, M. Pasteur describes this alkaloid in his "*Récherches sur les Alcaloides des Quinquina*," and thus acquires the right of priority.

"On trouvera dans mon Mémoire tous les détails nécessaires sur les propriétés et la composition des deux Quinidines. J'ajouterai seulement, afin de les caractériser tout de suite, que l'une d'elles, à laquelle je conserve le nom de *Quinidine*, est hydratée, efflorescente, isomère de la quinine, dévie à droite le plan de polarisation, et possède, à l'égal de son isomère la quinine, le caractère de la coloration verte par addition successive du chlore et de l'ammoniaque. L'autre base, à laquelle je donne le nom de *Cinchonidine*, est anhydre, isomère de la cinchonine, exerce à gauche son pouvoir rotatoire, et ne possède pas le caractère précité de la coloration verte."

Nothing could be more complete and satisfactory, and certainly there has been no addition to our knowledge recently, on the ground of which the original name should be changed.

The "*Quinidine*" of commerce, in England, and I think in France, is the true *Quinidine of Pasteur*, and the "*Cinchonidine*" also as above described.

ON THE COMPARATIVE MERITS OF THE TWO SYSTEMS OF "COPPICING" OR OF
"MOSSING" CINCHONAS.

THESE contrasted plans for harvesting the Cinchona bark form the subject of three Returns published by the Government of Madras, in May, 1873, and in April and September, 1874, the last resolving to "leave it to the Commissioner of the Nilghiris to see that the trial between the two is conducted in a manner that shall leave no room for future question."

In order to arrive at this desired conclusion, it is not necessary to enter into all the subjects of personal controversy between the parties concerned; but it is important to note that on the 30th May, 1873, the operation of what is called "coppicing" was performed on fifty-eight trees of *C. succirubra*, selected by Mr. Broughton and Mr. McIvor in concert. The trees stood in four rows, and were selected on account of their size and vigorous growth. They were the finest trees to be found. The largest measured thirty-seven feet two inches in height. The trees afforded 809 lbs. of wet trunk bark, equal to 286½ lbs. of dry bark, or 4.93 lbs. of dry bark per tree. The trees were all ten years and eight months old. The shoots were left standing on the stool of each tree. The condition of these shoots is described in a detailed table attached to the communication. Fifty-eight trees in the four rows adjoining the block thus coppiced were duly "mossed." This process was completed on the 25th June. The tallest of these mossed trees was found to be thirty feet. Prior to mossing, 301 lbs. of wet trunk bark, equal to 106 lbs. dry bark, were taken from the trees, giving on an average 1.83 lbs. of dry bark per tree. In April or May, 1874, a second harvest of natural bark was expected to be taken from these same trees. In the judgment of Mr. McIvor, a larger area would give a fairer selection of trees, and a result less favourable to the coppicing system. Bark peels best, he tells us, on the first occasion from trees eight years old. In February and March, 1871, he took mossed bark from 1,000 red-bark trees of this age. In May, 1873, he had stripped 3.744 lbs. of dry bark from these trees, giving an average of 3.75 lbs. per tree. In the spring of 1874 these trees were expected to yield 1,200 lbs. of dry bark, and a further harvest of about 1,600 lbs., to be available in the succeeding spring, and so on every year the quantity given on each occasion being larger than in the preceding one.

That operation here called "coppicing" is correctly described as "felling a tree six inches from the ground and leaving the shoots springing from the stool." Mr. Broughton believed, that after a lapse of eight years these shoots would produce as much bark as the original tree. This produce, however, is not great, for "240 trees coppiced by Mr. Broughton, of which 200 trees were eight years old, and 40 trees five and a half years old, only gave 255 lbs. of dry stem bark." "Experience, as far as it has reached, shows that the bark on coppiced trees is less valuable than the bark on the original tree. The Bengal Government is" (was in 1873) "sending home coppiced barks from Darjeeling. They fetch 5d. to 1s. 4d. per lb. in the London market, whereas original and mossed barks" [from Ootacamund] "have never fetched less than 2s. 2½d., and the last parcel in part 2s. 10d. per lb."

Even this return seems to be very uncertain, for Cinchona trees thus cut down are subject to "excessive bleeding," and a certain number die from this cause. Mr. McIvor says that "fairly coppicing, that is to say, taking off the head of a tree completely, as corn would be cut,

is never, I am led to believe, carried out in oak coppices in England, except in the cases where there are no shoots near the bottom of the stem, and where, therefore, there is nothing to leave, and the reason is, that depriving a stem of every shoot is so radical an operation that the life of a tree receives a shock from the operation very difficult for it to recover. Accordingly coppicing, as ordinarily carried out, is the felling of a tree, say six inches from the ground, but leaving the shoots sprouting from the stool."

"One hundred trees were thus fairly coppiced in 1866. I took note," he says, "at Neddiwuttum" (in 1873?) "of the largest of these coppiced trees. The shoots look weak and sickly. Their diameter is about an inch and a quarter at the bottom. I stripped a piece of bark from one of them, and found that when dried it presented a thickness no greater than blotting-paper." Mr. Broughton attributed their weakness to an insufficiency of light and air, but numerous shoots from untouched trees in the neighbourhood, according to Mr. McIvor, "indicated great succulence and vigour." "The coppicing experiments hitherto made have ranged over all seasons. I annex a list of them :

In December, 1866, about 50 trees.				
„	January,	1867	„	50 „
„	May,	1871	„	240 „
„	June,	1873	„	58 „
„	October,	1873	„	57 „

"The trees coppiced in October, 1873, were cut close to the ground, leaving no shoots. Twenty-one of these stools have died. It does not appear that any season of the year prevents the excessive bleeding.* "Trees have been coppiced at all seasons of the year, and the result in every case has been equally unsuccessful." "One advantage of the coppicing system," according to Dr. Bidie, "would be that it would afford an abundant supply of firewood for the factory at Neddiwuttum. A matter of great importance, as *jungle-wood is now getting scarce.*"†

The Commissioner gives us the valuable information "that on the Nilghiri hills the greatest enemy to plantations is wind," and he fears the too rapid thinning of the trees.

The system of "coppicing" seems to be a return to the mode of cutting which is now understood to be adopted by the more careful proprietors of Cinchona forests in New Granada; but these latter have the advantage of beginning with trees which have cost them nothing, individually, in care and attention; which have grown up to maturity, so that each tree may probably be worth twenty times as much as those we have been considering in India; and which, moreover, possess this advantage, from the nature of the Calisaya of Sta. Fé, that every twig which grows successfully from the stump of the felled tree will clothe itself with bark of good Quinine-producing quality.

The finest "coppiced" trees of *C. succirubra* in India have given not quite five pounds of dry bark. It is a liberal estimate to suppose this bark to be worth 2s. per lb. The value of each tree would then be not more than 10s. after ten years and eight months' care and attention. It is extremely problematical whether, after a further period of even eight years had elapsed, there would be any further produce of bark from the twigs worth collecting. The Commissioner of the Nilghiris reports to the Secretary to Government on 19th September, 1874, as follows :—

"The felled trees at Balmadies (the 58 trees before mentioned) have thrown up shoots of an average height of 3½ feet, though some have grown 6 feet. A similar success has not attended the 'coppicing' at Neddiwuttum.

* J. R. Cockerell, Esq., 19th September, 1874.

† The italics are added by J. R. Cockerell, Esq., the Commissioner of the Nilghiris.

This is perhaps attributable to the difference of altitude. Balmadies is 2,000 feet below Neddiwuttum, and the climate is more genial. The *succirubra* grows best in a moderately warm temperature. I have already reported that the shoots of seven years old on coppiced trees at Neddiwuttum are mere wands. The bark on these shoots is too thin to be of any value whatsoever."

It is true that Mr. Broughton obtained from the bark of vigorous shoots of seven or eight years' growth as much as 2.14 pure sulphate of Quinine, and 4.29 pure sulphate of Cinchonidine. The Cinchonidine, however, at the present moment, does not count for much, nor is it likely to do so, unless some great alteration should take place in the demand for this medicament.

In the year 1874 I sent a contribution to the *Gardener's Chronicle*, in which I gave other objections to the "coppicing" system, and expressed my belief that the verdict would not be in favour of this method. I will now turn to the comparative merits of the plan advocated by McIvor, the renewal of the bark under moss, which he terms the "mossing system." This nomenclature leads to confusion. It is the system of "renewal of bark" which is in question, and not the application of moss.

I shall, in the first place, quote Mr. McIvor's description of the process itself.

Mr. McIvor says :—

"I will now turn to the 'mossing' system. That system, as far as I am aware, has never been fully described. The process is as follows: A labourer proceeds to an eight-year-old tree, and reaching up as far as he can, makes a horizontal incision of the required width; from either end of this incision he runs a vertical incision to the ground; and then, carefully raising with his knife the bark at the horizontal incision until he can seize it with his fingers, he strips off the bark to the ground and cuts it off. The strip of bark then presents the appearance of a more or less long piece of ribbon. Supposing the tree to be 28 inches in circumference, the labourer will take nine of the above ribbons each $1\frac{1}{2}$ inches wide. He will leave thus, after the tree has been stripped, other nine ribbons still adhering to the tree, each somewhat broader than the stripped ribbon, and at intervals apart occupied by the spaces to which the stripped ribbons adhered. As soon as he has removed his strips, the labourer will proceed to moss the trunk all round, tying on the moss with some fibre. The decorticated intervals will thus be excluded from light and air, and this point is one of the capital points in the system. The mere exclusion of light and air from a stem partially bared of bark acts in two ways: it enables a healing process to be rapidly set up in the same way as a plaster does in the case of a wound in an animal organism; and it has this further curious effect, it increases the secretion of Quinine in the bark, renewed under its protection. This increase of Quinine is expressly admitted by Mr. Broughton in all his reports. At the end of six or twelve months the bands of bark left untouched at the first stripping are removed, and the intervals they occupied on the trunk are mossed. At the end of twenty-two months on an average, the spaces occupied by the ribbons originally taken are found to be covered with renewed bark, *much thicker* than the natural bark of the same age; and this renewed bark can be removed, and a fresh process of renewal again be fostered by moss. In another six or twelve months, the renewed bark of the natural ribbons left at the first stripping can be taken; and so on, harvests are obtainable from the trunk alternately, from the spaces left at the first stripping and the spaces left by the second stripping. Experience hitherto does not show any limit to the taking of these alternate harvests from a tree. Of course, it is understood that at every stripping the ribbons taken are longer than at the preceding stripping, because the tree has each year increased in height and in bulk, and therefore the top of every ribbon consists of natural bark, and the lower part of renewed bark."*

It is thus that Mr. McIvor has perfected, by his felicitous idea of covering the tree with moss, a plan which at first suggested itself to the *Cascarilleros* of South America, but which in their hands led inevitably to the decay and death of the tree. I have, amongst other specimens received from Mr. McIvor beautifully illustrating the subject, one which shows in a striking manner the injury resulting to the wood if the bark be not renewed.

It could not have been foreseen that *renewed bark* should be always of better quality than *natural bark*, but this is the case to so great an extent as to secure the prevalence of the system.

* Proceedings, 11th April, 1874.

In this respect there are some remarkable points of coincidence between the process above described and that which is followed to obtain the bark of commerce. M. Adolphe de Candolle has been kind enough to send me a work* on this subject by his son, M. Casimir de Candolle, who has had the opportunity of thoroughly examining the trees in Algeria, and presents us with the results of his labours, which offer many subjects for reflection.

The natural bark of the cork-tree is not suited for the purposes of commerce. It is called the *male* bark, and it has to be removed by an operation termed *demasclage*, after which the *female* bark makes its appearance. The male bark does not possess elasticity; it is not susceptible of increase of volume, and it possesses an abundant periderm. On the contrary, the female bark is ('*ramassé sur lui-même*') formed of cells possessing elasticity, and so packed together that when subjected to the action of boiling water they expand permanently; and finally it has but little periderm.

In the natural barks of the *Cinchona* we have also inconveniences. The formation of alkaloids in their case, as in that of the soft elastic bark of the cork-tree, is connected with the cambium development, and in proportion as the bark becomes hardened by the addition of the woody fibre does the amount of alkaloid diminish, whilst, as the formation approaches the periderm and is exposed to unfavourable influences, the alkaloids disappear, and a corky envelope, devoid entirely of these, is the ultimate result. In the *Calisaya* flat barks may be seen the great loss experienced by the exfoliation of large portions of what was once living tissue abounding with alkaloids. Thus are formed the *conchas* or characteristic depressions on the face of these *plancha* barks. This peculiarity of structure is well given in Berg's '*Anatomischer Atlas*,' Taf. XXX. B. At *e, e*, are seen the layers of periderm penetrating the mass and causing exfoliation of the outer and valuable bark—thus the whole of *a* in Fig. A. would be lost. The familiar spectacle of the bark exfoliating from the stems of the plane-trees in London will illustrate this subject to many of my readers. M. C. de Candolle remarks of a similar structure in the cork-tree (p. 4).†

It is very evident that the external layers, though rich in alkaloid, are a very insecure place of deposit for these products, which, continually formed in the internal layers, are as constantly wasted in the external. All this is altered in the renewed bark, as may at once be seen by comparing No. 5 and No. 6 of Plate III., showing the texture of the natural and the renewed bark on *one and the same branch* of Crown Bark.

I entirely accord with the following remarks of Mr. McIvor on this point. He says:‡ "Mr. Broughton admits that on a *succirubra* tree up to eight years old, renewed Red Bark is decidedly better than Natural Bark; that is to say, he allows that bark on a tree up to this age, which has only formed in the course of eighteen or twenty months, is better than bark which has waxed throughout the life of the tree. The conclusion to be drawn from this fact appears to be that bark, *so long as it remains in a loosely aggregated cellular condition*, is in the proper state for receiving and storing alkaloids. As the bark grows older and woody fibre replaces cellular tissue, the alkaloids already in the bark appear to *turn into resin and gum or colouring matter*, and the

* *De la Production naturelle ou artificielle du Liège dans le Chêne Liège.* Par M. Casimir de Candolle. Genève, 1860.

† "Les proportions suivant lesquelles le liège proprement dit et le périclerme sont associés dans les diverses écorces sont une des principales causes des apparences qu'elles présentent. Ainsi le liège du *Fagus sylvatica* est formé presque exclusivement par du périclerme, tandis que celui du chêne liège renferme une grande masse de liège proprement dit *parcouru par de minces zones de périclerme*. On sait que la *décortication naturelle* de certains arbres, tel que la *platane*, le *bouleau*, les *pruniers*, est due à la formation subséquente dans l'intérieur de l'écorce, de zones de périclerme, qui isolent du reste du tronc des plaques, ou des feuillettes, ou des écailles."

‡ 11th April, sec. 21.

bark secretes in that part of it no fresh alkaloids. The result is, the bark [of *C. succirubra*] deteriorates with age."

Mr. Broughton says:* "The first determinations of the value of the process had been made by Mr. J. E. Howard previous to and shortly after my arrival in this country. These were necessarily made on a very small scale, and on very young trees, whose age in no case exceeded five years. The results were very successful, and were corroborated to a certain extent by my own more early analyses."

Afterwards Mr. Broughton examined the bark renewed on twenty trees, and "the amount of Quinine in the renewed bark appeared less than that apparently† ascribed by Mr. Howard in certain instances on younger trees." He, therefore, raises the question "whether on older trees than the experiments dealt with, the mossed or renewed bark will have the remarkable richness found by Mr. Howard in bark renewed under moss on younger trees. It thus appeared very desirable, for several reasons, to attempt a larger experiment with the mossing process."

This was certainly the right course to pursue, and experiments were commenced,‡ but "the programme of their fulfilment was carried out with irregularity;" and, in fact, never brought to a conclusion. "The condition of the trees, the difficulty of applying labour at certain times, the state of the weather, &c. &c., have been the main practical reasons of the lack of precision in the carrying out of the plan determined on at the beginning."§ In the meantime, Mr. Broughton made examinations which led him to the conclusion that the application of moss to the bark of *C. succirubra* does not compensate for the labour and expense of mossing the trees and keeping the bark under moss.

Mr. Broughton appends analyses of his own, which show that the quantity of Sulphate of Quinine obtained crystallised from renewed bark of the oldest trees, compared with that obtained from the natural bark of trees growing close by, is in the proportion of 3 or 5 to 1—a very much more favourable result for the system under discussion than my trials, made with only a few hundred grains of young bark, could possibly have led to expect. He then gives trials showing nearly a threefold increase of Sulphate of Quinine, after three years "mossing," whilst the total of alkaloids remained stationary. "It appears, therefore, that three years' mossing does not improve the renewed bark." This conclusion arises from his not looking at the matter in a *commercial* point of view. The natural bark of ten-year-old trees would have been scarcely saleable at any price, whilst the renewed bark would have brought a price satisfactory to the cultivator.

On the whole, Mr. Broughton was disposed (and with reason) to look sanguinely on the effects of mossing the barks of *C. officinalis*,|| which are, indeed, much improved by the process. But, as regards the *C. succirubra*, he expressed himself "quite of opinion that no more trees should be mossed until the results obtained from the bark of second and third renewal show the actual results they promise from Mr. Howard's reports."

Mr. Broughton has resigned, and his appointment and all experiments are at an end. The prices brought by the respective qualities this year show that my first experimental decision tended in the right direction. My nephew, David Howard, F.C.S., has been kind enough to take out for me the average price realized by the different qualities in this country, as follows:—

* Proceedings, 29th May, 1873.

† Seems to be an error of the press, but I cannot correct it.
§ Sec. 18.

‡ Proceedings, 29th May, 1873.
|| Sec. 36-39.

QUINOLOGY OF THE EAST INDIAN PLANTATIONS.

Average Test of Unmossed Red Bark from Nilghiris in first six months of 1875.

Quinine Sulph.	. . . . .	1.82 per cent.
Cinchonidine do.	. . . . .	4.45 „
Cinchonine do.	. . . . .	1.56 „
		<hr/>
		7.83 „

* Average price obtained one shilling and tenpence per lb.

Mossed Red Bark.

Quinine Sulph.	. . . . .	2.32 per cent.
Cinchonidine do.	. . . . .	4.11 „
Cinchonine do.	. . . . .	2.01 „
		<hr/>
		8.44 „

* Average price obtained two shillings and sevenpence per lb.

Renewed Red Bark.

Quinine Sulph.	. . . . .	4.09 per cent.
Cinchonidine do.	. . . . .	2.92 „
Cinchonine do.	. . . . .	2.06 „
		<hr/>
		9.07 „

* Average price obtained four shillings per lb.

Mr. McIvor says:† “I am *quite satisfied* with the out-turn of last year's crop from our plantations. The prices, on the whole, have been good. We are now beginning to collect the harvest of the present year. It will be considerably more than that of last year.”

I never doubted the superiority of the quality of the renewed bark, but there remained the following questions to be solved before I could quite see the conclusion of the whole matter. In the first place, would the trees be able to bear so frequently renewed a drain on their resources? Next, whether skilled labour could be procured adequate to the operation? It had also to be seen whether labour of this kind, if supplied, would not too greatly enhance the cost?

On the first point, we have much, and, on the whole, satisfactory information in the above Reports from the Government Plantations. J. R. Cockerell, Esq., Commissioner of the Nilghiris, before quoted, says, after personal examination: “The healthiness of the shoots on the uncoppiced trees gave rise further to a suggestion. It indicated that the mossing process could never destroy the trees on a plantation if a shoot was left on each tree. The main stems might be stripped of bark until they died, and a strong shoot be left all the time growing to take the place of the stem on the extinction of the latter. In this manner not a single tree on a plantation would be lost. The inference was, there was no need to run the risk of coppicing because it was apprehended removing the bark from time to time might eventually destroy the trees.”

As to the real effects upon the trees, the accounts are somewhat conflicting. Mr. Broughton‡ says: “Mr. McIvor at first stated that the taking of the bark has no effect on the growth of the tree. No doubt small experiments on a few healthy trees led to this conclusion, but notwithstanding, I have no hesitation in stating it to be erroneous. That so important a seat of the life of the tree as the bark can be taken from it without affecting its growth, appears almost an absurdity. That it is not the case experience has conclusively shown, and I do not think even the Superintendent of the Plantations now holds the contrary. For some months after taking off the bark the growth of the tree ceases; it appears unhealthy; the colour of the leaves changes to yellow or red; and it has generally a more or less sickly aspect. But

* Less about 10 per cent. charges.

† In lit. ad me, 16th August, 1875.

‡ 29th May, 1873, sec. 34.

after a time it recovers its health; the bark that has been taken renews with variable homogeneity, and after a year it resumes its healthy appearance and growth.* "On the other hand, the trees of *C. officinalis* appear to me to renew their bark with far greater certainty, although the growth in thickness is slower than is the case with red bark. The quality of the renewed bark is also far finer, and is well suited for export."

Surgeon-Major G. Bidie reports:† "The mossed crown barks, owing to the removal of their lower branches and the faded hue of their foliage, present, on taking a bird's-eye view of an estate, a very inferior appearance compared with trees that have not been barked. I also noticed in both the red and crown barks, which had been mossed, a tendency to produce an unusual amount of flower and seed—a peculiarity very common in plants which may have had their vitality reduced in any way."

. . . "Trees‡ under the mossaing process look much less vigorous and healthy than others which have never been touched. There are several reasons for this, the chief of which are the removal of all the lower branches, and the check or shock communicated by the removal of the bark. The removal of the branches takes place either naturally, owing to the trees being too crowded, or is done purposely to facilitate the mossaing process. In either case the result is that the tree is deprived of a large part of its foliage, and thus becomes less capable of rapid stem-development, and less likely to strengthen its position by the lateral and downward extension of roots. Altogether there can be no doubt that a mossed tree, owing to the various unnatural conditions that it has to endure, is never likely to attain its normal size, or to have a perfectly sound and healthy stem; and it certainly runs a much greater risk of dying prematurely than a tree which has not been subjected to mossaing."

From Ceylon I learn that the thin stems of *C. officinalis* can be compensated for by close planting 4 × 4. This close planting has another advantage in excluding the direct rays of the sun, and so enabling the planter to dispense with the very expensive process of mossaing. In four to five years trees can be cut down where thickest and stems allowed to grow, so as to secure a regular succession.

Commercial experience has then fully shown that Mr. McIvor's plan of renewing the bark is the right one for plantations of *C. succirubra*; whilst for those of *C. officinalis* the plan of planting thick, and cutting down, *not* coppicing, may in some situations be the most feasible, if not the most profitable, arrangement.

If any doubt should remain in the mind of any reader whether the question be permanently settled, I must refer him to the communication from Mr. McIvor in the Appendix.

The Indian Government are sending home for public sale in England in the spring of 1876,

20,000 lbs. Crown Bark,
15,000 „ Renewed Red Bark,
30,000 „ Mossed and unmossed original Red Bark,
1,000 „ Calisaya Bark.

This is the first importation of Calisaya Bark from British India I have noticed. I do not yet know the quality.

* Sec. 36.

† 11th April, 1864, sec. 8.

‡ Sec. 19.

EXPLANATION OF THE PHOTOGRAPHIC PLATES.

No. 1 is a view on the main road of the first plantation of the first *C. succirubra* trees planted by Mr McIvor. These trees are now (1876) from 34 to 40 feet in height. The *mossing* to which they have been subjected is very apparent. From these trees five harvests of bark have been collected—the present from 1,000 trees giving 2,500 lbs. of bark. The trees have produced on an average in these five years upwards of 11 lbs. of good dry stem bark, and are said to be still in fine health and growing vigorously.

No. 2 is a view on the main road of the *C. officinalis* plantations of Mr. McIvor. The trees here are from 24 to 30 feet in height. They were planted in the spring of 1863 and are the finest specimens.



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N° 1.

CINCHONA SUCCIRUBRA, PLANTED IN 1862.

FIRST DENISON PLANTATION NEDDIVUTTUM. VIEW ON THE MAIN ROAD.

Elevation 6200 feet.

BIBLIOTHEQUE
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Nº 2.

CINCHONA OFFICINALIS, PLANTED IN 1863.

DODABETTA PLANTATION OOTACAMUND — VIEW ON THE MAIN ROAD.

Elevation 7,800 feet.

PART II.

BOTANICAL OBSERVATIONS.

Difficulty of Classification.

THOSE who are acquainted with the difficulty of botanical classification will believe that it is not without considerable embarrassment that I undertake this part of my subject. During the last quarter of a century my attention has been unavoidably directed both to the varied facts presented to our view in the inexhaustible variety of Nature, and to the abundant and frequently conflicting theories conceived with the intention of comprehending in a logical manner the wonderful *Kosmos* around us. It is not satisfactory to the mind, nor do we seem fully to comprehend the *being* of objects presented to our view, without tracing the mode of their *becoming* such as they are.

The questions of "Species" and "Varieties" thus tempt us almost irresistibly to some hypothetical solution of the reason of their existence, but it is quite beyond the compass and foreign to the scope of the present work to enter largely upon any such abstruse discussion. It is with the different *forms* of *Cinchona* that present themselves to our notice that I have to deal; and that with the purpose of pointing out to the cultivator those which will be most likely to further his wishes.

I commenced my "Examination of Pavon's Collection of Peruvian Barks in the British Museum" in 1853, by remarking that the botanical classification requires "to be made in several respects more complete, if it is intended ever to become generally used in commerce." I also said that the then "*Cinchona Condaminea*" comprehended so many and so varied kinds of the barks of commerce that it ceased to be the distinctive term of a species, and became that of a *group of trees*.

The idea which I then suggested afterwards bore fruit, and I flatter myself that my friend Dr. Weddell—whose spirit of profound and yet subtle botanical investigation I cannot but admire—has in some respects, and to a certain extent, carried out my views, as may be seen by referring to my "Observations on the Present State of our Knowledge of the Genus *Cinchona*" at the "International Horticultural Exhibition in 1866." In the discussion which followed, Dr. Weddell remarked thus: "I perfectly concur with Mr. Howard as to the great variability of the species of the very natural genus now before us; so much so that, allowing for exaggeration, it might almost be said that all those described are but varieties or races sprung from one typical

form. There is, in fact, no single one of them that can be distinguished from its neighbour by one absolute character; they can only be so by a certain *ensemble*, which the eye may be unable to collect in a herbarium specimen." These views are more fully developed by the author in his "Notes sur les Quinquinas," published in 1870. In this work he even says:—

"Il serait difficile, je pense, de trouver un meilleur exemple que celui des *Cinchona*, pour montrer jusqu'à quel point ce que les botanistes appellent Espèce est une chose peu définissable et combien l'idée qu'on est porté à s'en faire peut varier, selon le point de vue auquel on se place, ou bien souvent encore, selon ce qu'on pourrait appeler les exigences de la situation."

At the above Congress I expressed my desire "that Dr. Weddell should add to those labours for which we are so much indebted to him, as the discoverer of the *C. Calisaya*, by publishing the materials which he has in hand to illustrate the remaining varieties of this species." This wish the Doctor complied with to a certain extent in his "Notes," in which we have a reduced figure of the *Cinchona Calisaya* var. *microcarpa*, Wedd. Through the kindness of this gentleman, I have now the opportunity of presenting the reader with a copy of the original drawing from the pencil of Riocreux.

Concerning this sort, Dr. W. remarks:—

"J'ai rapporté cette variété de Calisaya, en 1851, des montagnes qui s'élèvent au-dessus de la rivière de Coroico, affluent du Mapiri, un des courants les plus importants du département de la Paz. Les Cascarilleros du pays me l'ont signalée comme donnant une écorce supérieure en qualité à celles des autres variétés croissant dans les mêmes lieux; et j'avoue que j'ai été heureux de voir cette appréciation de l'homme des bois confirmée par M. Howard. C'est en effet d'une écorce reconnue par lui identique avec celle dont je viens de faire mention, que mon éminent ami a retiré la plus forte proportion de quinine qu'on eût encore trouvée dans un quinquina, c'est à dire environ le double de la quantité que MM. Delondre et Bouchardat indiquent comme rendement moyen du Calisaya."

I had supposed that this rich variety might very probably be the source of our *Ledgeriana* of Java. On further examination, however, I find this new sort, which contains even more than double the quantity of Quinine possessed by the *microcarpa*, is itself, in botanical language, a well-marked variety, or, as I should say, a separate form of the group constituting the species "Calisaya." The var. *microcarpa* appears to coincide very nearly, if not entirely, with a sort, of which a specimen was given me by Don Pedro Rada, from Eastern Bolivia, and called there also *Calisaya zamba*.

Species, Varieties, and Races.

I find myself thus under the necessity of encountering some of the difficult questions connected with the distinction of species, varieties, and races, if I would fulfil the task of affording practical guidance to the cultivator. It is absolutely necessary to choose the right sort, and to propagate only those trees which will repay the costs of the enterprise. In making this selection we are necessarily thrown back upon the information supplied by botanists, and are compelled to submit to the consequences even of mistaken theories. That such evils have arisen I conclude that I may safely assume, as, with all respect to the acknowledged botanical acquirements of M. Triana, I think I may safely inquire what has become of "the seven species of *Cinchona* called legitimate by Mutis;" and with great admiration for the skill displayed in classification by Dr. Weddell, I may further ask, are there any typical species to be found at all? If nature does not present us with these, we are scarcely entitled to make imaginary entities the basis of our practical distinctions.

M. Triana says: "La première et la plus importante espèce de *Cinchona* de l'ouvrage précité,

est le *Cinchona lancifolia*, *Quinquina orangé* ou *Quinquina primitif* de Mutis. Cette espèce est constituée par quatorze variétés, représentées chacune par deux planches, donnant les analyses de leurs fleurs et de leurs fruits."*

Our supposed cultivator, desirous of commencing a plantation with "the most important species," the primitive bark itself, would be disappointed by finding that the *Quinquina primitif* was a nonentity; that the first discovered *Quina* trees are different sorts to any which grow in New Granada, or which could possibly have come under the observation of Mutis. Further, he would take for the typical species of *Cinchona lancifolia* that sort which is well represented in Icon. II. of the work referred to (of which I possess a specimen given by Mutis himself to Bonpland). This has been again brought into notice by Dr. Karsten, who has obligingly given me a specimen collected by him. I have myself spoken of it as "a centre from which diverge many and abundant varieties,"† and Dr. Weddell has thought it worthy of being distinguished as a *Ramus* in his classification. The bark of this, moreover, has been well known in commerce and abundantly imported, to the extent of many thousand serons; it is also so well figured in Dr. Karsten's "Flor. Columb." Tab. XI., and in Delondre's "Quinologie," Plate 14, that it is impossible to mistake it. Our cultivator would indeed suppose that he possessed a sort more accurately defined botanically than is often the case. He might think himself peculiarly favoured by science, and that her light shone upon his path with peculiar brightness.

Granting all this, the results of his plantation would be failure and disappointment. In order to succeed he would be compelled to turn his attention to the varieties ϵ , ζ , η (of Mutis), and possibly one or two others, and with these, if the climate and the soil favoured, he might perhaps make handsome profits. He would probably feel some astonishment that any botanist had classed these so different trees as one species with the former.

Or he might be much impressed by the *hopeful* opinion which I gave of 'the broad-leaved variety,' seeds of which were sent by Dr. Karsten and sown by M. Hasskarl. I have just received specimens of this plant as cultivated in Java, and find that it is indeed very different from what I expected, but of the actual value of the bark itself I do not find any account. It is probably worthless. See No. 30 of the *Herbarium* from Java.

Of the *Calisaya* of Sta. Fé I am glad to observe that I gave in 1866 a favourable account, and that I then urged its introduction into India. I can only repeat this advice now, having brought under the notice of the Indian Government the importance of employing their previous collector, Mr. R. Cross (who showed his ability in introducing the seeds of Loja bark), to complete the work by the transference of this kind to India. Till this is done, I know not where our cultivator could obtain the plant; but when accomplished, I think that in three years he would secure as good results as in five with the other varieties.

But is this *Calisaya* of Sta. Fé, after all, a variety of the *C. lancifolia* Mutis? To this question I am unable to give a decided reply. I have described it as such for the convenience of classification, having recently published a notice of it in the "Bulletin de la Société Botanique de France." As to the specific place of this kind, I have been glad to shelter myself under the authority of Dr. Weddell, who had previously assigned it this designation.

According to the strict use of language, we *assume* by the terms "typical species" and "variety" community of descent from some ancestral plant, of which the above *Quina primitiva* is

* *Nouvelles Etudes sur les Quinquina.* Par J. Triana. Paris, 1870, p. 19.

† 'Rep. Bot. Congress,' 1866, p. 219.

the normal form, and from which the *Calisaya* of *Sta. Fé* has varied. But when I regard the remarkable difference in the texture, form, and hairy environment of the leaf, and still more that which is related of the rapid growth and general character of the tree, I suspect that even those botanists who believe in this mode of formation of varieties would be rather inclined to consider this a specific type. I must add that in the opinion of R. Cross, it is altogether a distinct species, as yet undescribed, and that it has apparently nothing to do with the *C. lancifolia*.

I could not say the same of the *var. oblonga*, How., which I described in Tome XX. of the "Bulletin de la Société Botanique de France." This latter has more the appearance of a variety of *C. lancifolia*; and probably stands in rather close relationship with the *C. lanceolata* of Pavon.

In the above observations I have certainly not overstated the difficulty which the cultivator would experience in making use of the information afforded by the botanist. Chemical analysis of the bark is needed to supplement and render available such information. The Governments of India have done well in widely circulating botanical information, and in appointing able chemists to investigate the problems presented on the spot by the growing plantations.

Dismissing, then, all considerations as to the actual mode of the *becoming* of species or varieties, in reference to which our knowledge, if indeed we possess any, is in a most rudimentary condition, I must direct the attention of the cultivator to the actual facts which present themselves to our observation. In doing so, I must invite special attention to the observations of M. Jordan, of the Société Botanique de France, in reference to the *allied species* of plants. These views being founded on close observation, rendered more exact through being carried out in experimental cultivation for thirty years, merit peculiar study; and lead to results so similar to those which present themselves to our view in the genus under consideration, that I must request the favour of the careful perusal of some extracts which I have translated, and which will be found in the Appendix, as preliminary to any observations of my own.

I trust it will not be understood that I advocate the notions of unlimited variation or of the transmutation of species. I am in this respect so entirely of the same mind with my *confrère* that I will copy some of his remarks on the subject:—

"Je crois qu'elles doivent être considérées comme des espèces, parceque je crois à l'espèce comme l'humanité entière y a toujours cru, comme les savants de tous les temps et de tous les pays y ont cru jusqu'à Lamarck, inventeur de la théorie du transformisme, qui a été restaurée et réduite en formules de nos jours par Darwin et par ses sectateurs. Partout et toujours jusqu'à ces modernes théoriciens, on a cru à la diversité originelle des types spécifiques, et on a pris pour critérium de la distinction des espèces l'hérédité et l'invariabilité des caractères qui les font reconnaître. Or, nier l'hérédité et la permanence d'une foule d'espèces affines, c'est nier des faits évidents et palpables; rejeter le critérium de la permanence héréditaire, c'est s'ôter complètement la possibilité d'établir des distinctions solides, c'est tout réduire à de simples hypothèses, à l'arbitraire, à la fantaisie des appréciations individuelles, c'est, en un mot, donner pour fondement à la science le scepticisme; ce qui revient à la détruire."*

Allied Forms.

It appears, then, that in common with many other plants, the so-called species of *Cinchona* present themselves to our notice under the aspect of numerous *forms*. I hesitate to call these *varieties*, because, in the first place, I am unable to find in any instance *one single marked typical form* from which the others can be considered divergent. In the next place, it is evident that these allied forms pass by intermediate gradations into other species, so that the whole genus may be looked upon as the successive links of a chain; which again may not be without points of con-

* *Espèces Végétales Affines.* Par A. Jordan, p. 14.

nection with those of other *genera*. I look upon these allied forms as possessed of *equal* permanency and as indefinitely reproducing their likeness. I cannot carry my vision into the past eras of time to see when and how they originated; but whilst here is abundant evidence of their exact identity since first they were studied by botanists, there is none, that I know of, to render probable their divergence from any one extinct type. The supposed *quina primitiva* becomes to me less and less imaginable the more I seek to grasp the possibility of its existence.

To commence with the *C. officinalis* (to which I am glad that Dr. Hooker should so well have restored the primitive appellation), I am inclined to believe that each well-marked mountain district in the vicinity of Loja has its own distinct form. At any rate, the *C. Uritusinga* (Pav.) is one of these, and the *C. Chahuarguera* (Pav.), another. The *C. Bonplandiana* represents not one form but two, namely, those producing the *Cascarilla colorada del Rey* and the *C. amarilla del Rey*, which are both represented in the Indian plantations, the bark being at once recognisable by physical peculiarities, and these most distinctive. The microscopical examination reveals traits that cannot be confounded, nor forgotten when once observed. The chemical constitution is alike distinctive. In describing these as varieties of the *C. Chahuarguera*, I think the Spanish botanists were misled, though probably the *Chahuarguera* exists under more than one form. I shall return to these varieties further on in the description of the figure in Plate XI. The miscalled "*crispa*" form of India seems evidently a form of the *C. officinalis*, not improbably the one existing on the mountains of Cajanuma, where Cross gathered most of his seeds, or Guatisinga, and distinct from the *C. Uritusinga*. But then, as I have proved, the seeds of this "*crispa*" will give rise to the remarkable form or so-called variety *angustifolia*, which perhaps was not collected by the Spanish botanists. This does not appear to result from hybridisation; indeed the "*crispa*" varies in the form of its leaves, occasionally, almost if not quite, into the *angustifolia*. In the hybrids we find in the chemical examination the effects of mixture, but in the *angustifolia* we have the characteristics of the *C. officinalis* in their greatest perfection, marked by an unusually large production of quinine. It might be looked upon as the very type of the species, but this again would not be easily made to agree with the facts.

These kinds are now all cultivated together on the Nilghiris, and, as far as appears, they retain the peculiarities specially belonging to them in America. I except from this remark the hybrid varieties. The "*crispa*" of Tafalla was thought by that botanist to be specifically distinct, and this is also the opinion of M. Triana.

The question arises, how it has come to pass that all these forms are reproduced in the East Indies? The *C. Uritusinga* may be entirely composed of the direct lineal descendants of the plant which I gave to the East Indian Government, and which I raised from seed sent me from the mountains of Uritusinga. I do not trace this exact form amongst the specimens given me by Cross, but there is a fair representation of others. I have great confidence in the diligent exploration of the neighbourhood of Loja by this energetic and successful collector, but I am scarcely able to imagine that under the very peculiar difficulties which beset his expedition he could have met with specimens of all the rest. There has been no other source than these two for the plants of *C. officinalis* now grown in India. Is it possible, then, that the different forms reappear from seed? In such case would they be as stable and permanent as appears to be the case? I am watching with considerable interest the development of some young plants of the pubescent form sent me by Mr. McIvor, but I must confess that I am led to suspect in these the result of mixture of pollen of other plants of Cinchona. They may be *Mischlinge*, if not *Bastarde*, as remarked by

Klotzsch and others, the mingling together of allied forms giving a fertile progeny instead of the sterility and instability which more or less stamp the true hybrids.*

M. Planchon, in his interesting work "Sur les Quinquinas" (to which I have elsewhere alluded) says:†—

"Les cinchona forment un genre très naturel, dont les diverses formes passent souvent de l'une à l'autre par des transitions insensibles. Il en résulte, pour la distinction et le groupement des espèces, des difficultés qu'il n'est guère possible de surmonter par l'examen des échantillons toujours incomplets d'un herbier."

This observation is very correct in the main, and, on this ground, I doubt the determination of certain new species founded by Professor Miquel on botanical specimens of Dr. Hasskarl's Herbarium, to which I have referred at pages 64 to 66. I may further say that nothing has more tended to modify my opinions of the genus than the habit of watching from day to day the development from seed of its different species. I have thus had under my eye several different forms of *C. officinalis* from the original *C. Uritusinga* to the newly-discovered *C. angustifolia*, also of *Calisaya*, both from the seed brought by Mr. Ledger and that from the East Indies. In like manner I have raised the *C. micrantha*, *nitida*, and *Peruviana*, also the varied forms of the Bolivian *micrantha*. I have, moreover, had the *C. Pahudiana* and the *C. Tucujensis* growing in my stoves, with several others of less certain name. A very striking feature is the great variability even of the same plant at different times. Thus I have a plant raised from the seed contained in the capsules of a Herbarium specimen.‡ This is about six to seven feet high, and is now growing near a plant of *C. officinalis*, which it greatly resembles at the present moment, though there are points of difference to be detected by careful examination. But this is the *var. crispa* of the plantations, and has, in the course of its development, greatly resembled at times the *C. angustifolia*. Moreover, the curious part of the matter is, that from the seed from the capsules of the same Herbarium specimen I raised also the veritable *C. angustifolia*, with its characteristic long leaves and pensile foliage. This could not, I think, be the result of hybridisation, for there is no other form possessing these peculiar leaves; and moreover, they appear on the sister plant in very nearly the same proportions. Not much can be made of this state of things, except that it indicates close affinity; but out of it arises this curious fact, that the *C. angustifolia* is one of the richest barks known, having the peculiarity of producing some ten per cent. of Quinine, and this in very pure condition. The Pitayo barks I have also cultivated, but these seem very difficult to preserve. No one could possibly mistake them when living for a variety of *C. officinalis*.

In the course of the year 1873, Mr. Broughton sent me some seeds of the *C. succirubra* from trees grown on the Balliziri Runcan hills in Mysore. It was supposed that in this new locality the trees had acquired some peculiarity in appearance, possibly the result of strong winds. I do not find any such deviation from the normal type in the flourishing young plants, five in number, which remain to me as the produce of these seeds. I notice, however, one amongst the five which, though of luxuriant growth, is of dwarfed stature, and the leaves are somewhat rounder than the rest, besides which they are no longer glabrous like the others, but decidedly harsh to the feel. This cannot result from hybridism, as the loneliness of the situation would forbid this; and, moreover, the form is simply one of several constituting a group of plants in its native regions. The first collection of botanical specimens which I received and described *sub voce* '*C. succirubra*' illustrates this.

* I have since heard from Mr. McIvor that such is actually the case.

† p. 23.

‡ No. 6 at Kew, and in my collection.

That *like* produces *like* is a principle which must evidently be accepted with some modification. When the two sexes, as in animals, are fully developed, the product of their union partakes of the character of both. It is probable that in the Genus we are considering the strongly marked *macho* and *hembra* development tends to the formation of varied products from the seed as fertilised by the pollen of neighbouring plants. Thus hybrid sorts are produced in India, but it is not believed by those conversant with the native forests in South America* that this takes place to any extent there, as the circumstances are far less favourable to such result.

It is probable that the only absolutely certain mode of reproduction of any form of *Cinchona* that may be desired is that of cuttings or layers, as the seeds are almost certain to partake of the nature of the closely surrounding sorts. This is well known and carefully attended to in Java, and I presume that sufficient precautions are taken to keep the seed of the best variety pure; but after all there is nothing so certain as the propagation by cuttings or layers. This is in the vegetable what *parthenogenesis* is in the animal kingdom, the exact reproduction of like from like.

Bonnet† “took a young aphid after it was just hatched, isolated it completely, and saw it in that state of undoubted virginity produce, after twenty-one days, ninety-five young ones. The aphides thus produced were able themselves to produce others. Bonnet placed one apart, and obtained from it five successive generations without the aid of a male. An aphid of the fifth generation produced young under the same conditions, and Bonnet saw this fecundity prolonged over ten generations. This viviparous condition *ceased in the autumn*, when the males began to appear; then the aphid becomes oviparous.”

This looks as though the same reproduction could not indefinitely be continued, and it is possible that in like manner the product of one tree might require to be renewed after a certain lapse of time. The subject requires careful experiment.

In 1818 Chamisso's‡ studies on certain molluscs, called *Biphore* or *Salpæ*, led him to the discovery that these animals are alternately free and aggregated. In the first generation strings of *Biphore* are found, the product of gemmation; in the second, solitary *Biphore* produced from spores; in the third, the strings reappear, so that the young never resemble the parent, but always the grandparent.

1st generation	.	.	aggregated <i>Salpæ</i>	.	.	grandfather.
2nd	„	.	free	.	.	father.
3rd	„	.	aggregated	.	.	son.

The researches of Saars, Steenstrup, Owen, and Van Beneden, show that in some animals the cycle is not limited to three generations, but that often it is more extended; and that the resemblance, instead of passing from the grandfather to the grandson, passes from the great-grandfather to the great-grandson. In those species which propagate by alternate generation the process is this: an ovum produces a simple organism, and this propagates by gemmation; the creatures thus produced resemble neither the parent nor the original organism; next the primitive type reappears, and with it the attributes of the two sexes and propagation by ova. Thus, in the medusa, between two perfect types we find three as follows:—

1st generation	.	.	<i>Medusa</i>	.	.	great-grandfather.
2nd	„	.	<i>Ciliated Larva</i>	.	.	grandfather.
3rd	„	.	<i>Polyp</i>	.	.	father.
4th	„	.	<i>Strobila</i>	.	.	son.
5th	„	.	<i>Medusa</i>	.	.	great-grandson.

* See also Klotzsch (*Bastarde und Mischlinge*), Berlin.

† ‘Hered. Ribot.’ Eng. Trans. p. 175.

‡ Ibid. pp. 177-179.

It is not now, as in cases of metamorphosis, the same individual which passes from the larval to the nymph state, and then becomes a perfect adult. Here we have several individuals totally different from one another.

The conclusion to be drawn from these facts is, that we ordinarily understand heredity in too narrow a sense, looking at it only under its immediate form from one generation to the next. But, as we see, it may embrace a much larger cycle. It is true that these phenomena are met with only in the lower species, and there are no instances of alternate generation among vertebrates; but still they show how strong, tenacious, and, so to speak, unlimited is *heredity*. At the same time it gives us a better understanding of *atavism*. The two facts, indeed, are not identical, and I do not at all mean to say that atavism is a form of alternate generation, yet the mind readily perceives an analogy between them. Reversional heredity in man seems less singular to us when we compare it with these orderly cycles; and on witnessing these indisputable facts, we can better understand how great is the force of heredity.

At a time when alternate generation was yet unknown, Burdach and Giron de Buzareingues were led by their researches to admit that there are stronger resemblances between grandfather and grandson, grandmother and grand-daughter, than between father and son, mother and daughter. This is expressed in the following table (Burdach, "Physiologie," ii. 269):—

	<i>Paternal Line.</i>			<i>Maternal Line.</i>	
First generation	grandfather	grandmother.	Grandfather	grandmother.	
Second generation	|	father.	Mother	|	
Third generation	son.	daughter.	Son	daughter.	

If we compare this table with that given above for the *Salpæ*, it is impossible not to be struck with the resemblance.

It will be seen from what precedes, that when I use the term *species*, it is only as the expression sanctioned by use, which I retain to express a group of *forms* more or less intimately allied, but not passing absolutely one into the other, since, as far as can be seen, every one *form* is as permanent as every other. The word *variety* might conveniently express such alteration as we know to be produced by the influence of surrounding circumstances. *Mixtures* and *hybrids* of an evanescent character are apparently produced in great number where the different forms of the *Cinchona* are allowed freely to mingle, and amongst these some may be permanent enough to claim the character of *races*.

Such is the manner in which I am at present disposed to regard the phenomena before us in this genus. Nature seems spread out like some magnificent poem composed in separate books and in lines not capable of being displaced without injury to the whole. The reader may have very little idea of the art of poetry, but he will at once understand that such a composition is *not prose*. So in studying nature, I am convinced that, notwithstanding the multiplicity of forms, and their apparent blending with each other, there is after all a fixity connected with the very design and purpose of the whole. In other words, that *heredity* or the produce of like from like is the most unchangeable amongst the laws which govern the reproduction of organized beings, and *permanence* rather than insensible variation and the gradual transformation of species is that which meets our view. I have just received from Mr. McIvor a large sample of the bark of the trees resulting from the *C. Uritusinga* plant which I gave the Indian Government. I have thus a *Fourth Generation* to add to those previously described.* The absolute identity of the specimen with

* See page 3, "Chemical and Microscopical Investigations."

that which was sent me with the seed from the mountains of Uritusinga is most striking, extending to the minutest characteristics of a bark which can be distinguished at first sight from the other forms of *C. officinalis*. I may add that it is also the same with my specimens of *C. Uritusinga*, gathered by Pavon a hundred years before.

The analysis of this last specimen of the Fourth Generation is as follows, as examined by my nephew, David Howard, F.C.S. :—

Quinine	5.62
Cinchonidine	1.05
Quinidine	0.20
Cinchonine	0.30
Amorphous Alk.	0.30
Total	<u>7.52</u>

The Quinine resulted in a beautiful crystallisation of seven and a half per cent. of Sulphate of Quinine. This is an improvement beyond my expectations, and if the whole of the 60,000 trees are of this quality they must form a valuable plantation, constantly increasing in the profit to be derived therefrom, and restoring the primitive* and almost extinct *C. officinalis* to its normal position of usefulness in a new abode.

HYBRIDITY OF CINCHONAS.

Mr. McIvor is confident that he has been able to attain important results by hybridising some of the Cinchonæ. He says that these "belong to a tribe of plants highly susceptible of improvement by these means." "So soon as our plants flowered (or early in the spring of 1865), I made a vigorous attempt to attain this object. The result was, that in 1866 a number of hybrid seedlings were produced. Among these, six distinct varieties possessing remarkable vigour of growth were selected, and the weakly growing sorts destroyed. The selected varieties were planted here and there in every soil, exposure, and elevation available. Under all these conditions, our new seedlings maintained that remarkable vigour of growth which at first distinguished them. This raised my hopes still higher. * * Circumstances soon arose which clearly indicated that under certain conditions these seedlings produced a bark of great value. Subsequent investigations shewed that the same variety maintained nearly equal value in the bark in all the conditions under which the plants were placed. Evidence was clear also that in these vigorous-growing hybrids we had secured, in a marked degree, the good qualities of both parents."

I shall not trouble the reader with details of the warm controversy which arose in India on this subject. It was certainly commendable in Mr. McIvor to see what could be done in this direction. He says: "The Commissioners seem to overlook that my experience of the chemical constituents of the bark is co-equal with my experience of the cultivation. For this department of inquiry I had no special training, but by the able assistance of Mr. Howard and Dr. de Vrij, I was enabled to conduct these investigations from the commencement of this undertaking until 1867, and with such conclusive results that seven years' subsequent labour of a specially trained officer has not advanced the inquiry one step beyond the point at which he found it. His labour, in fact, being confined to confirming the results we had previously obtained, or distinctly indicated."

* See the plant figured and described by Dr. Hooker in Curtis's *Bot. Mag.*, Vol. xix. 3rd Series. Tab. 5,364.

It now appears that Mr. McIvor has succeeded in obtaining one or two really useful sorts by the means indicated, and I must in so far modify the opinion elsewhere expressed, that hybridity necessarily tends to degradation in the *Cinchonæ*. Nevertheless, I am afraid that the tendency of indiscriminate mixture will still be unfavourable. It seems difficult now to obtain seed from Ootacamund that is not hybridised. In this case it is to be presumed that the chance variation will be equal, or more or less favourable, in different directions; and who shall decide until after the lapse of at least five years, which are the good and which the bad plants? If, as in Java, the stock plants are kept carefully select, it is a very different matter, and the planter can go to work with something like certainty.

If Mr. McIvor has been successful in the production of a hybrid with power of quick growth, and at the same time adapted to yield a large amount of Quinine, he has been very fortunate; for I do not think these qualities are often combined. Quick growth generally involves rapid alteration in the tissues of the trees, and the cell contents, including the alkaloids, share in the general movement. This, as far as the alkaloids are concerned, is a disadvantage. Mr. McIvor's process of renewal seems to be exactly the reverse of all this, and insures large deposit of that alkaloid (Quinine) which is probably first in formation.

C. CALISAYA VAR. LEDGERIANA (HOW.).

M. Van Gorkom, the able Director of the Cinchona Plantations of the Dutch Government, in Java, observes, in a letter to me, as follows:—

"The *C. Ledgeriana* truly presents many distinct varieties in the form of the leaves, and there are many of our older Calisaya trees (introduced by Dr. Hasskarl) which seem not different from the *Ledgeriana*. Meanwhile the total habit, the typical form of the *Ledgeriana* tree is so characteristic that we can scarcely mistake; though we cannot say what is the true difference in a botanical view until they bear flowers, which *commonly* are white and small—*micrantha*-like as to the flower, as you can see in the specimens here enclosed."

The resemblance of the flowers sent, to those of *C. micrantha*, was indeed striking, and the capsules, in their slightly hirsute character, present another point of agreement. By placing my Plate of the B form of *Ledgeriana* beside that of *C. micrantha* in my 'Nueva Quinologia,' the reader will, I think, be struck with a certain kind of analogy and general resemblance.

I have before noticed the approximation of certain varieties of *C. Calisaya* to the Grey Barks, *C. Peruviana* and *C. micrantha*, and I would now request particular attention to the fact that the young plants of this species are at once to be distinguished from the normal *C. Calisaya*. This I noticed in 1865, and also their resemblance to the young plants of *C. micrantha*.*

On the whole, there can be little doubt that we have here under examination the richest form of Calisaya, distinguished above all others by its great productiveness in pure Quinine. This seems to stamp the character of the *Ledgeriana*, in the midst of many diversities of form and of colour.

I have taken this rich production of Quinine as guiding me in discrimination, especially from the tree of Hasskarl, which though presenting points of resemblance in the form of the leaves, and perhaps in the capsules, is essentially a Quinidine-producing tree; and, though it may have some resemblance, is capable of being distinguished by its habit from the true *Ledgeriana*.

* See my remarks on the young plants raised from Ledger's (*not Lechlers*) seed in 1865. Page 5, note.

This view of the matter may not be according to the rules of botany, but at all events it is so true to nature that the cultivators have been beforehand in distinguishing the sort after the name of Ledger, as I first suggested in the "Pharmaceutical Journal."

I have represented in the Plates three somewhat varying forms of this variety—in Plate IV., the "macho" form, or that in which the male element seems to preponderate—in Plate V., the "hembra," or feminine type (as I conclude from the analysis of the flower), and in Plate VI., another variant form, in which there is not a remarkable prominence of either element. These flowers seem more adapted for self-fertilization than those of the *Josephiana* type, or even the normal *C. Calisaya*. (See Weddell's Hist. Tab. iii.-iv.) I do not perceive that the masculine or feminine type of these plants has any bearing on the production of alkaloid, though it certainly has on the colouring, &c. of the different forms.

I had expected from the small-sized capsules which I saw in the bag containing Mr. Ledger's seeds on their way to India, that the var. *microcarpa*, Wedd., might be the type of these best forms, for the *microcarpa* contains a large portion of Quinine; and in connection with this idea I obtained from Dr. Weddell the valuable present of the original drawing of the *microcarpa*, with the permission to reproduce the form under the eye of the reader in Plate XV.

Being undeceived in this matter, I thought well to have the most typical forms drawn, and to present them under the eye of Dr. Weddell for his opinion, which is entitled to such special consideration in reference to this species above all others of the Genus.

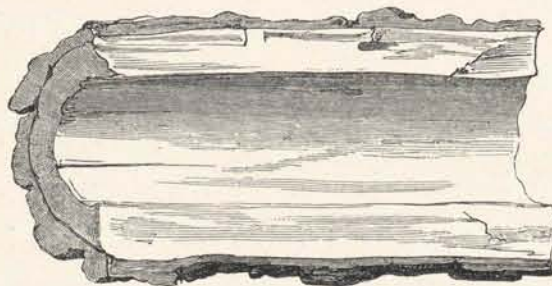
I received from this gentleman the following confirmation of my opinion (2nd November, 1875): "I think you are quite right in considering your two Java plants (Plate IV. and V.) as constituting a distinct variety of *Calisaya*; but whether one of the two forms you have had pictured is worthy or not of being ranked as a sub-variety of the other could hardly be affirmed without comparing a considerable number of specimens. The characters offered by the leaves are not weighty ones, and hardly any stress can be laid, I believe, on those offered here by the seeds."

Dr. Weddell's diagnosis is as follows:—

"*Cinchona Calisaya* var. *Ledgeriana*, How.

"*C. foliis elliptico-oblongis vel fere oblongis, obtusis obtusissimisve, haud raro ante apicem nonnihil angustatis s. constrictis membranaceis, utrinque viridibus vel subtus pallide purpurascensibus nervis simul rubris, axillis vulgo sat distincte scrobiculatis; panicula florifera ovata, corollis albis, antheris subexsertis (saltem in specim. obviis); panicula fructifera subcorymbosa, densa, capsulis ellipticis (9-12 millim. longis), puberulis.*"

This variety was first seen by Mr. Ledger near the Rio Mamore, and the seeds were gathered at a spot distant 120 leagues from Pelechuco. The *Bolivian micrantha* is a wholly different tree, which I have grown to a large size. It differs from the *C. micrantha*, R. and P., only in the purple colour of the under side of the leaf.



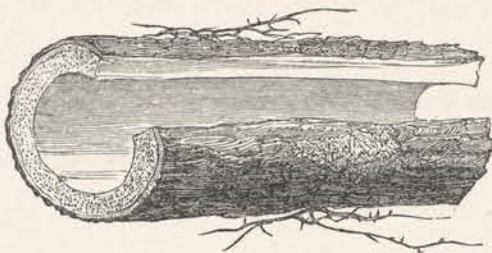
BARK OF *C. Calisaya*, var. *Ledgeriana*, How.

"CALISAYA JAVANICA."

I have represented in Plates VII. and VIII. two forms of this plant (others being noted in the Herbarium) to which I have not attached any distinctive botanical designation. I simply describe them under the name current in the Java plantations, as it appears to me that they form a group of trees very nearly allied to the *C. Josephiana*, Weddell, but distinguished from this frutescent form by their growth as trees apparently of considerable size, and also by their larger production of alkaloids.

The Directors of the Java Plantations have very wisely determined no longer to propagate these inferior kinds of Calisaya, and it remains for the cultivators in British India to beware of the loss they may probably incur by cultivating, under a specious name, plants which will almost certainly disappoint their expectations.

For fuller information on these points I must refer the reader to the correspondence from Java.



BARK OF "CALISAYA JAVANICA."

C. JOSEPHIANA, VAR. GLABRA, WEDD.

The plant from which Mr. Fitch has taken his drawing (Plate IX.) is now growing (with me) under glass, having attained an elevation of 9 to 10 feet. It has not only flowered freely, but also has in the past year perfected seed which, together with the capsules, are represented in the drawing. The flowers are generally of a pure white, but I have noticed an occasional slight tinge of pink. The corolla is long, slender, and often arrested in its falling by the pistil, as shown in the drawing. The *hembra* organization of the plant is very obvious. The flowers are very fragrant.

Dr. Hooker, to whom I am indebted for the plants of this form, has figured (in Tab. 6,052 of his Botanical Magazine) the plant from a specimen flowering in October, 1872, with me, and has appended a full botanical description; he remarks that it is obviously one of the plants brought by Mr. Pearce in 1866, marked as an evergreen shrub, 6 to 10 feet high, gathered in flower at Moro, altitude 5,600 feet, January, 1866, several Ward's cases of which were forwarded from Kew to India in the same and following years.

I think that Dr. Weddell has done well in his "Notes," in separating this plant more distinctly from the normal Calisaya. It is a mere shrub, and its bark probably of no importance therapeutically or in commerce. The glabrous and almost coriaceous leaves contrast strikingly with the normal Calisaya.

Dr. Weddell gives the characteristics of his *C. Josephiana* as follows: "*C. Josephiana*: frutex pratensis, foliis oblongo vel ovato lanceolatis acutiusculis obtusisve utrinque viridibus glaberrimisque rigidulis scrobiculatis aut escrobiculatis; capsula vulgo majore quam in *C. Calisaya* typica et haud raro ut in var. γ et δ ejusdem plus minus attenuata."

To this I should add that in this specimen at least, and also in several of those which I received from Java, it is *foliis ter quaterve scrobiculatis*, a characteristic which may be observed in the drawing.

The plant has flowered very freely with me and the brilliant white of the flowers is sufficiently striking, as also the long and slender tube of the corolla.

"CALISAYA ANGLICA" (HYBRIDA).

Plate X., which is drawn by Mr. Fitch from living specimens in my possession, represents very well the intermediate character of the hybrid plant. The leaves partake largely of the *succirubra* type, and shew in their decadence the bright scarlet tints which distinguish the Red Bark; but the lustrous surface allies them with the Calisaya. The flowers are large, and vary much from the type of the mother plant; which, as I was assured by Mr. Broughton, was of the Calisaya (No. 5) type, with the under side of the leaves purple. The bark, as will be seen by referring to my analysis, was intermediate in its character, and the price obtained for this sort in the recent sale at Amsterdam indicates that it is not one well suited for cultivation, unless, indeed, the rapidity of its growth should be found to outweigh the disadvantage of a comparatively small percentage of Quinine. Even should this prove to be the case, I should hesitate to recommend it for profitable cultivation, as I have no confidence in the stability of these hybrid plants, of which I have variant forms in my conservatory. It is a very handsome sort and might well be increased as an ornamental plant. I know not whether the seeds are fertile.

In the "Pharmaceutical Journal" of 12th July of 1873, and subsequently in a communication to the Linnean Society, "On the Genus *Cinchona*,"* I gave some account of the produce obtained from seed sent me by Mr. Broughton, "from two trees of the same red-under-leaved variety of Calisaya."† In the latter treatise I have discussed the question as to the probability of the variable aspect of the plants having been the result of hybridisation or otherwise. I have since obtained some fresh light on the subject, which it may be well to place on record.

Towards the close of the third week in May of 1874, when the plants were just two years old, I cut down five of them, leaving some inches of the stem to sprout again. From the remainder I peeled the bark, which weighed, when fully dried, 880 grains. On subjecting the bark to chemical examination, I found to my surprise, that I had to do with a substance partaking, in something like equal proportions, of the qualities of red bark and of Calisaya bark. I obtained a crystallisation of mixed sulphate of Quinine and sulphate of cinchonine, the latter existing in true Calisaya in very minute proportion, if at all. By recrystallisation (with precautions), the sulphate of quinine was brought into a state of pure and white crystals, justifying the Calisaya character of the parent trees from which the seed was obtained. On the other hand, the residuary alkaloid was, as usual from the *C. succirubra*, largely impure or uncrystallisable.

Certain peculiarities in the products led me to search for quinamine, and, after precipitation‡ of the residuary alkaloids by potassic sulphocyanide, I obtained, by precipitation and resolution in pure ether, a substance which certainly had a close resemblance to the quinamine of Hesse, crystallising by spontaneous evaporation in long needles, forming a peculiar tracery on the sides of the glass vessel.

In my description of the bark of *Cinchona succirubra*, I have said,‡ that "the characteristic peculiarity of red bark is, that it ordinarily contains the alkaloids quinine, cinchonine, cinchonidine, quinicine (?) and aricine (?)." This result of my researches was published in 1862, and some ten years before *Quinamine* had been determined. I have no hesitation in saying that the recent examination of the bark of my five trees has given me again the same results; thus still more strongly indicating the effect of hybridism than even by the large amount of cinchonidine contained.

* Linnean Society's Journal, Botany, Vol. XIV.

† See De Vrij on Quinamine, *Pharm. Journ.* Vol. IV. p. 609.

‡ *Illus. Nueva Quin.* sub voce *C. succirubra*, p. 13.

As nearly as I could ascertain, the bark of these five trees produced :—

Quinine Sulph.	0·170
Cinchonine Sulph.	0·170
Cinchonine	0·170
Quinamine (?)	0·100
Amorphous alkaloids	0·700

The plants themselves partake of the same intermediate character, as I have been able more fully to ascertain since I have had the pleasure of showing them to Mr. Broughton, when in England, who kindly presented me with a collection of eighteen specimens of *Calisaya* from the plantation of Neddiwuttum. Amongst these considerably diverging varieties is a pressed specimen of the No. V., from which sort all of mine spring. Some of mine resemble this parent, others have so much more the character of *C. succirubra* as to be taken at first sight by Mr. B. for that variety; but whilst in form* and general appearance they resemble the *C. succirubra*, they are distinguished by the peculiar gloss or *reflet* which marks the *Calisaya*, and which is entirely absent from the *C. succirubra*.

On the whole, I think that we may safely conclude that there has been an interference, in this case, of the pollen of the *C. succirubra* growing, as Mr. Broughton informs me, in the immediate neighbourhood. I am the more confirmed in this view, since it accords with observations made by Dr. de Vrij on a hybrid sort in Java. But if such be the case, we are led to curious reflections in connection with vegetable physiology. Through the mixture of the two *essentiæ*, brought about by pollen so nearly similar, a change must have been wrought in the chemistry of each cell of the inner bark; if (as I suppose) it is in these that the alkaloids are elaborated. I would bring into relationship with this fact the following observations of the skilful chemist attached to the Dutch Plantations of Cinchona. M. Moens gives me the following information (under date 5th December, 1873):—"Some years ago, M. v. Gorkom had grafted two *Calisayas* upon two *Pahudianas*. The grafts succeeded very well, and I have recently taken the barks for examination. This showed that the *Calisaya* as well as the *Pahudianas* kept their alkaloids as if they had grown separately. The *Calisayas* contained no quinine, or cinchonidine, but quinidine (Pasteur) and amorphous alkaloids. The *Pahudianas* gave quinine, cinchonidine (much), no quinidine, cinchonine, and amorphous alkaloids. I think this is an experiment of considerable interest, and shall repeat it, if possible, with *C. micrantha* and *C. Calisaya* (Ledger). I think the result most agrees with your idea, that the alkaloids are formed in the cellular tissue of the bark."

These careful cultivators take great precautions to propagate only the true *C. Ledgeriana*, and I hope will be successful in guarding against the injury resulting from the pollen of inferior species.

I have since (in 1875) examined the bark of a large and flourishing tree (10 feet in height), having one year's growth in advance of the five mentioned above. It gave

Quinine Sulph.	1·219
Cinchonidine Tart.	0·393
Cinchonine	0·244
Amorphous Alk. and Quinamine	0·670
	2·526

Compare this result with that of the more mature bark in Java. (See Herb. No. 9, p. 59.)

* I have some regularly ovate leaves, measuring fifteen by ten and a half inches.

CINCHONA OFFICINALIS.

γ Bonplandiana, b lutea (How.). "Amarilla del Rey."

Plate XI. represents a flowering branch of this very valuable sort of bark, drawn from nature by Mr. Fitch from a plant in my conservatory. It appears to be easily brought to develop its flowers, as this has been the case with several plants in my possession, but I have not yet succeeded in perfecting the seed.

I have so fully detailed all that I know of this variety in my Illustrations of the Nueva Quinologia of Pavon that I have little to add to the general description. The reader will observe that I there classed it under the head *C. Chahuarguera*, following Pavon in what I now deem to be an erroneous classification. I take the present form from Dr. Weddell's "Notes sur les Quinquinas," page 14, in which place he has adopted and rendered more accurate the designation which I proposed at the International Botanical Congress in 1866. (See Report of Proceedings, page 208.)

I have ascertained that the "amygdaloid appearance" of the inner surface of the bark mentioned in page 8 of my "Quinologia" is owing to a deposition of Kinova-bitter. This can be seen under the microscope by dissolving with a drop of liquor ammoniæ and the subsequent addition of acetic acid, when the characteristic separation of the above substance is apparent.

C. PITAYENSIS, WEDD.

The *C. Pitayensis* is very well described by Dr. Weddell, in his "Notes sur les Quinquinas," 1870, p. 33-37. See especially the notice of the very distinctive botanical characteristic, which the Doctor was the first to observe—the hairs which line the internal face of the tube of the corolla. The same was remarked by Dr. Karsten in reference to his *Trianae* Krst. and *C. Corymbosa* Krst., which are looked upon by Dr. Weddell, and I believe with perfect justice, as forms of his *C. Pitayensis*. The same thing is noted by Pavon in reference to his *C. parabolica*. It is also observed by Dr. Karsten in reference to his *Cinchona macrocarpa*—"Corolla, tubo cylindrico intus pilosulo," as also in his *Cinchona Henleana*, "Corolla intus superne puberulo." Neither of these last, it will be observed, belong to the genus *Cinchona* (according to its strict definition), and the tendency to dehiscence of the capsule from above downwards towards the base, which seems to render their incorporation with this genus uncertain, is not altogether absent from the *C. Pitayensis*. This is remarkably manifest in Dr. Karsten's Plate XXII. of *C. Trianae*, and may also be observed in my specimens.

Plate XII. illustrates my idea of the group of forms constituting the above well characterized species.

The different varieties were drawn and coloured by Mr. Fitch under inspection of Mr. R. Cross the collector, and of M. Triana, in July, 1870.

I have from Cross specimens of the "*Anaranjada fina*" from Pitayo, of the "*amarilla fina*" from the Piñon de Pitayo, of the "*dorado*," which is rare, and of the "*cascarilla roja*" of the Piñon de Pitayo; this was reckoned the finest commercial kind of New Granada. It grows at about 8,000 feet elevation above the sea. A specimen gathered by Cross gave me 5.85 per cent. of Sulphate of Quinine.

AA

I have also the "amarilla del huevo" or "yellow of the egg" from Cross, in 1868. This was accounted one of the finest sorts. It differs but slightly from the others, with the exception of larger and somewhat irregularly obovate leaves, resembling Karsten's *C. Trianae*.

I received, through the same collector, specimens of the "*Quina roja*" (and other sorts) from Taqueyo, two days' journey north of Pitayo. These are of inferior value, as are also those of Almaguer and the "anaranjada" of La Cruz. Of this latter I have a botanical specimen, through the kindness of my late lamented friend Daniel Hanbury. It was gathered in 1869, by a young English engineer, named R. B. White, and presents the extreme of coarse formation of the capsule, striated and tending to open from the apex. The bark from the same tree sent with the leafy and fruit-bearing branches gave me of Sulph. Quinine 1.70, of other alkaloids 2.87. The leaves were regularly ovate and pointed. I also received in 1870 through the same hands and originally from Dr. Largacha, the owner of the *bosque secular*, in which the trees occurred, botanical specimens in a somewhat imperfect state, together with specimens of the bark of the red variety, identical, as far as I can see, with my No. 2, the red of the Piñon; the capsules are long, resembling those of No. 1, and more finely formed than those of the "anaranjada." The bark sent gave me of Sulph. Quinine 3.61 per cent., Quinidine and trace of Cinchonidine 1.00 per cent., of Cinchonidine and Cinchonine 1.70. I could only examine 230 grains, and some doubt about the second alkaloid remained, which I have corrected by subsequent analyses; for which there was full opportunity, as this bark has been largely imported since.

Mr. White wrote me (in 1869), "The La Cruz district lies between Pasto and Almaguer, and is only a few leagues distant from the forests of El Tablon. * * There is really now not one tree of *Cinchona* in all the district of Pitayo; a few trees planted in cottage gardens are all you can meet with."

It would not answer much purpose to refer to specimens which I possess of the wood and bark of other varieties, of which many are doubtless extinct; except as illustrating the variety of *forms* under which this species existed. In reference to this subject, I will give the following opinion of a correspondent who has more practical acquaintance with the trees than any one I know:—

Extract of Letter from R. Cross, Sylvia near Pitayo.

"June 1st, 1869.

"It appears to me that your plan of dealing (botanically) with the Quinine trees of the Andes is essentially *clear, correct, and natural*. If I understand it, I suppose you mean to form those of each district or region into groups, to be afterwards classed as species or varieties according to appearances.

"Thus I would suppose that the Bolivian would form one group, the Loja another, and the Pitayo another. The latter, however, is entirely distinct from the others; nevertheless, the leaves of two of the Pitayo species seem to resemble those of the Quinine trees of Bolivia."

C. GRANDIFLORA (Ruiz and Pavon).

This plant, which I received from Kew, has grown vigorously with me under glass, in a warmer temperature than that which suits the *Cinchona*, and has come into flower in time to be included in this work, Plate XIII. having been drawn by Mr. Fitch from the above.

It is the *Cinchona grandiflora* of Plate CXCVIII., Vol. II., of the Flora Peruviana of Ruiz and Pavon. In Vol. III., page 2, having acquired more perfect information, and also having become aware of allied species, these botanists took it as the type of a new genus—that of COSMIBUENA. I refer the reader to their *character genericus naturalis* in their Vol. III., and also to a full examination of the whole subject by Dr. Hooker, which I hope soon to see published in "Curtis' Botanical Magazine."

In the meantime, this Plate presents the inflorescence of a leading member of the above large family allied to the Genus Cinchona, but destitute of medicinal properties in the bark, the fragrant scent and beautiful appearance of the flowers forming a poor compensation for the absence of these valuable products.

In the *Cinchona oblongifolia*, as described by Mutis, we have not one form only, but several, indeed quite a group of trees. His *Quinologie*, as M. Triana very correctly states,* leaves no doubt on the subject. Indeed the *Cinchona oblongifolia* of this great work is constituted by four varieties, which answer certainly to three distinct and well characterized species of the group Cosmibuena.

Plate XXI. (Triana) corresponds in the shape of the leaf to a specimen given me by Don Pedro Rada, under the name of *Mula Cascarilla*, together with the bark, which is exactly the *Quina nova* of commerce. It also agrees with the specimen in the British Museum labelled "*Cinchona vulgo Azahar, ex Jaen de Loxa, inedita, Pavon*," designated by Lambert "*Cinchona oblongifolia, Mutis*." I doubt M. Triana's identification of this plant with *C. Nitida*, Benth. I have a small specimen, given me by Klotzsch at Berlin, in 1857, with the inscription "*China rubra* of Sta. Fé, collected by Baron Humboldt. *Cinchona magnifolia*, and *C. lutescens* Ruiz, *Cinchona oblongifolia* Mutis." These synonyms are incorrect.

If I understand M. Triana, his Plate XXII. represents two varieties; of which one var. α is the same which Humboldt published under the name *Cinchona oblongifolia*, following the specimens given him by Mutis. (A. Icon. XXII.) This appears to be the same with the *C. caduciflora* of the *Plantes Equinoctielles*, whilst E. Icon. XXII. is the *C. magnifolia*, Pav. (See my *Illust. Nueva Quin. sub. voce*.)

The var. β Icon. XXIII. is like the *Cascarilla carua*, now *Buena carua* of Weddell.

The var. γ Icon. XXIV. resembles somewhat in the form of the leaves, but not in the size of the flowers, the *C. Bogotensis* of Karsten; of which I have a good specimen through Dr. K.'s kindness. The flowers in this specimen are two inches in length; in Mutis' Plate about half an inch; and the form of the leaf is not entirely the same.

I have also a specimen given me by Dr. Karsten (collected by Engel), with the inscription: "*Junge China nova, No. 480 Herbar. Engel. In der Gegend von Ocaña von F. Engel gesammelt; die Mütterpflanze scheint nach den dabei liegenden Blättern die C. Bogotensis zu sein.*"

(Signed) "H. KARSTEN."

This latter, which may not after all be quite the same as the *C. Bogotensis*, appears to me to have the most truly *oblong* leaf of all. I cannot but think that it was on this form (be it *Bogotensis* or *Ocanensis*), that Mutis was induced first to confer the descriptive designation of *oblongifolia*, which being afterwards confounded with "red bark," created so much confusion in the Pharmacopœias.

* *Nouvelles Etudes*, pp. 12 & 13.

The accompanying bark might easily be mistaken by an experienced person for that of *C. succirubra*.

CALISAYA OF STA. FÉ.

The reader will find a description of this valuable sort of bark, and of the tree from which it is taken, in the "Bulletin de la Société botanique de France." Tome xxii. Comtes Rendus No. 1, page 17.

I give the best representation in my power in Plate XIV., and in addition present here some remarks by the intrepid explorer, to whom I am indebted for my specimens.

From Robert Cross.

"August, 1873.

"A very singular thing about the "Soft Columbian" is that it has few roots, and that the root bark is thin, and is therefore not collected. The tree is, in fact, a kind of perennial, rushing up rapidly, and maturing in a short space of time. It is more an annual than anything else, shooting up rapidly, at the same time forming very thick bark, which does not shrink much in drying.

"As we go further north, the species becomes more decimated, until winding through various varieties it at last disappears. Singular enough, too, that unlike the bamboo and many other trees, we do not see any one single variety of quinine tree reappearing in another district.

"I have no doubt that the Calisaya of Sta. Fé is different from some sorts in the astonishing thick, corky layer of the outer bark—its thickness in proportion to the trunk, and, above all, little or no waste. I asked a lad if hail ever fell; the answer was, sometimes it hardly leaves a leaf on a tree; so you see it grows in a rough climate."

C. CALISAYA. B. MICROCARPA (WEDD.).

Plate XV., as before remarked, I owe to the courtesy of Dr. Weddell. It represents one of the best forms of Calisaya, which, as far as my knowledge extends, has not yet been introduced into the East Indian Plantations, where it would doubtless well repay the cultivator.

PART III.

ADDITIONAL MICROSCOPIC OBSERVATIONS.

EXAMINATION OF THE BARK OF *C. LEDGERIANA*.

THE examination of the bark of this extraordinarily rich variety enables me to affirm very distinctly, that the alkaloid in combination is visible not only under the microscope, but even with the naked eye. It must needs be so when we have under consideration a bark containing from one-tenth to one-sixth of its whole weight in Quinine! This cannot be nicely stored away in the interior of the spiculæ, which are indeed few and far between; it must be visible. No one accustomed to observations of this kind can fail to observe the rich appearance which the bark presents when cut. There is, moreover, a peculiar whitish colour of some portions which connects itself probably with a special abundance of cinchotannic acid; for when these portions are left in contact with a surface of iron, they rather rapidly assume an inky tint.

When a section has been made in the usual manner, and boiled for one or two minutes in a solution of caustic potash, it presents very distinctly the Calisaya type of structure, well referred to by Dr. Weddell in his "Histoire." This may be clearly seen, even if the boiling has been continued too long, so as to empty all the cells and leave nothing but the framework of the structure of the bark; but it is very easy so to manage the operation, as to perceive that these cells are to a great extent filled with an aggregation of rounded nodules, in which the Quinine must exist in some state of combination; and the effect of iron shews that the cinchotannic acid must form a leading part in this state.

I have frequently observed this sort of appearance in rich Quinine-producing barks. It may perhaps be looked upon as characteristic of such, and the nodules themselves may be compared with those seen in the "lax cellular tissue full of alkaloid," which I have figured in Plate III., Fig. 2, Microscopical Sections.

It is fortunate that it is not necessary to boil the section in caustic solution, for if cut thin the structure will be at once apparent when placed under the microscope. There is no deposit of oxidized colouring matter to obscure the view, such as I have represented in the section of Red Bark in my "Nueva Quinologia," Plate II, Fig. 13,* and which has to be removed by the action of the potash.

This then is a satisfactory mode of settling the question in so far, as to whether the appearances are produced by the action of the substances employed. The bark may be cut and the section placed at once under the microscope. Of course it cannot be kept in this state, and it is more

satisfactory to boil for two or three minutes in distilled water, then to place it on the glass and add glycerine before covering.

I simply *re-assert* the reality of the crystalline appearances in the microscopic sections which I have described as alkaloids. In reference to Plate I, I wrote to Mr. Broughton, who replied,* "You ask me in your last letter whether the *crystals* are Cinchonidine. Yes, certainly, and unmistakeably. I always examine my crystals under the microscope, and have done for years; among all the thousands of organic substances I have worked with at the Royal Institution, I do not recollect one that could be mistaken for Cinchonidine. The crystals are most characteristic and are the easiest and best test of its presence."

It is then not without some surprise that I read in the excellent "Pharmacographia" of Flückiger and Hanbury as follows:† "As to the contents of tissue of Cinchona barks, crystallized alkaloids are not undoubtedly visible. Howard has published figures representing minute rounded aggregations of crystalline matter in the cells, which he supposes to be kinates of the alkaloids; and also distinct acicular crystals which he holds to be of the same nature. These remarkable appearances are easily observable, yet only after sections of the bark have been boiled for a minute in weak caustic alkali, and then washed with water; it may well be doubted whether they are strictly natural."

It appears then, and I lay great stress on the admission, that the appearances in question are in the opinion of these writers *easily observable*; but then how did it happen that amongst the many observers, who have been occupied in these microscopical researches, no one else thought of alluding to them? If I might venture to answer the question, I should presume that the difference originated in the different mode of preparation of the sections for examination.‡ The description given of my published views is unsatisfactory. Instead of supposing the crystals to be "kinates of the alkaloids," I have said that the "combinations of the alkaloids with kinic acid are extremely soluble, so that in any bark in which these are the prevalent constituents, it is very difficult to ascertain any crystalline appearance." I further said that "I therefore conclude that the crystals seen in the bark section are *Kinovate of Quinine*." This refers to the crystals first noticed, and described in my "Nueva Quinologia," under the head Red Bark.

I may now say further, that I never attempted to have any drawing made of the usual appearance of the *Kinates*, which are nevertheless very abundant and often seen filling the cells of bark. The resemblance|| is tolerably exact to granulated honey and is "easily observable" if only the precaution be taken of not continuing the boiling of the slice of bark in the caustic ley beyond the shortest period that will suffice to remove the colouring matter.

I cannot tell what is meant by the conclusion to which the authors of the Pharmacographia arrive. What are the appearances if "*not strictly natural*"? I have had specimens sent me, in which some flaw or defects in the glass had been mistaken for crystals, but it is not the opinion of the authors that I have fallen into such an error; for they believe the appearances to be "crystalline matter." Moreover, I have very good drawings of the crystals, made by other draughtsmen, confirming the accuracy of those I have published, and shewing that they do not originate in mistake. I suppose these authors mean (as intimated by one of my German correspondents) that they are crystals of potash in some combination, formed "in one minute" in a weak and boiling solution. They must then be either the kinate, the tannate, or the kinova-tannate of this alkali, all extremely soluble. I cannot imagine the *possibility* of crystals being formed under the circumstances. Besides, the crystals

* Under date July 10-12, 1869.

† p. 319.

‡ See "Pharm. Journal" for May, 1865.

|| See page vii, Microscopical Observations, Part I.

of Cinchonidine, have evidently been *slowly* formed, and the surrounding tissues and the resin have been interfered with in the process.

I have the satisfaction to reflect, that the reader who examines my Plates of Sections is furnished with the means of judging for himself about this question; since I have never given instructions to my artist to draw anything from imagination, but have allowed him to preserve the most truthful adherence to nature. The very character of the artist is pledged to the fidelity of his drawings. I would particularly call attention to the representation of the "lax cellular tissue," as favourable to the storing up, and, as I think, to the production of Quinine.

On the whole, I must re-assert my conviction that the remarkable appearances of crystalline matter in the cells are *strictly natural*, though I do not assert that they belong to the *living* structure. I will even go further and say that with a good microscope, a practised eye, and sections prepared with the requisite precaution, any competent observer may satisfy himself of the undoubted visibility of alkaloids, either in their simple or compounded forms.

Dr. Otto Berg, *Professor an der Universität zu Berlin*, says in his Anatomischer Atlas, 1865:

"Die Krystalle, welche Howard (Fig. 12) abbildet, finden sich derartig nicht in der Rinde, sondern sind erst durch chemische Behandlung des Präparates gebildet."

This may be characteristic, but is not *convincing*.

Whilst these pages are passing through the press, I have had under examination a specimen of bark of very peculiar appearance, which, with the leaves and capsules of the same tree, has been sent me by the owner of a plantation in India. When subjected to microscopical examination, I find it full of crystals of the same kind as those represented in Plate I. Fig. 2. The leaves are said to be purple underneath; and the microscopical observations, together with the chemical analysis, lead me to the conclusion that it is probably a hybrid between *C. Succirubra* and *C. Calisaya*.

The analysis of the bark has been carefully completed for me by my son William Dillworth Howard, and proves highly satisfactory to me, as entirely confirming the expectations raised by the microscopical investigation. It will be observed that about one-twentieth of the substance of the bark proves to be CINCHONIDINE, and it is quite to be supposed that this would be visible under the circumstances.

Analysis of the above bark:—

Quinine sulphate	.	.	.	.	.	.	0.21
Quinidine sulphate	.	.	.	.	.	.	0.41
Cinchonine sulphate	.	.	.	.	.	.	0.51
Cinchonidine sulphate	.	.	.	.	.	.	5.16
							<hr/> 6.29

I really think this settles the question, but should be glad to *show* these sections to any investigator in confirmation.

12

1. The first part of the document is a letter from the President of the United States to the Congress, dated January 1, 1861. It is a very important document, as it contains the President's message to the Congress at the beginning of his first term. The letter is written in a formal, dignified style, and it is one of the most important documents in the history of the United States.

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APPENDIX A.

India Office, January, 1870.

SIR,—I am directed by the Secretary of State for India to forward, for your information, the accompanying copies of the Reports of Medical Committees appointed to examine the properties of the Cinchona Alkaloids in the Bengal and Madras Presidencies. I am to add that, as it is very desirable that the value of the febrifuge Alkaloids, other than Quinine, should be generally known both here and in India, the Duke of Argyle will not have any objection to your making any use you may see fit of the information contained in the Reports.

J. E. Howard, Esq.

I am, Sir, your obedient Servant,

(Signed)

HERMAN MERIVALE.

PRELIMINARY REPORTS OF THE MADRAS AND BOMBAY CINCHONA COMMISSIONS

(Appointed to ascertain the Febrifuge Value of Cinchona Alkaloids, other than Quinine).

In a Despatch dated September 30th, 1865, the Secretary of State for India expressed an opinion that it was very important, with reference to the commercial interests of Cinchona cultivation in India, that authoritative medical decisions should be pronounced on the relative value of the Cinchona alkaloids other than quinine, namely, cinchonidine, quinidine, and cinchonine, in the cure of tropical fevers. He, therefore, gave orders that a Cinchona Commission, composed of medical men who have had long experience in the treatment of fevers, should be appointed in each Presidency, with instructions to test the efficacy of these alkaloids on a scale sufficiently extensive to ensure decisive results, and to report the conclusions at which they may arrive.

Supplies of the alkaloids, specially prepared with great care by Messrs. Howard, were sent to Calcutta, Madras, and Bombay, to be distributed to the medical men selected by the Commission.

The following are the preliminary reports of the Madras and Bombay Cinchona Commission.

I.—PRELIMINARY REPORT OF THE MADRAS CINCHONA COMMISSION.

From the PRESIDENT and MEMBERS of the CINCHONA COMMISSION to the SECRETARY to GOVERNMENT, Revenue Department, Fort Saint George.

Madras, 28th February, 1866.

1. With reference to the order of Government, dated March 28th, 1866, we have the honour to report that the printing of the tabulated results of the experimental use of Cinchona alkaloids has occasioned some delay in the submission of a progress report. A considerable number of the tables, however, have now been printed, so as to enable us to estimate, with tolerable precision, the therapeutical effects of the several alkaloids; and, as our President will have no other opportunity of recording his views as to the usefulness of these medicines, the members of the Commission have decided to conclude now a preliminary report of their proceedings, leaving their more detailed observations to follow when the results of the experiments still in progress are more fully known.

2. In the tabular statements, already printed and laid before the Commission, minute particulars in regard to 1,145 cases of paroxysmal fevers, treated either by cinchonine, cinchonidine, or quinidine, have been registered. These fevers have occurred mostly at stations notably malarious, such as at Goodaloor, in the Wynaad; Sumbulpoor and Russelcondah, in the Northern Circars; the Godavery jungles; Mysore, Cochin, and Labuan; and may, therefore, be regarded as fair average types of the forms of paroxysmal fever to be met with in the malarious districts of Southern India.

3. A larger number of cases have been treated up to date, but the returns have not yet been received, or if received, are not out of the printer's hands, so that the results must be considered in detail hereafter.

4. With regard to the 1,145 cases of fever referred to, it will suffice to note that they were treated by the alkaloids, as follows:—

By sulphate of cinchonine	.	.	.	.	.	.	.	.	.	410
Ditto cinchonidine	.	.	.	.	.	.	.	.	.	359
Ditto quinidine	.	.	.	.	.	.	.	.	.	376

C C

The doses and mode of administration varied a good deal. Some medical officers used large doses of from 15 to 20 grains; others, medium doses of from 8 to 10 grains; and some, small doses of from 2 to 5 grains. As a general rule, the members of the Commission are of opinion that the experiments were most successful when medium doses were employed, that is, the cases of fever in which 8 or 10 grains of alkaloid were administered in a single dose daily appeared to recover more expeditiously than where larger or smaller quantities were employed. Large doses of cinchonine, cinchonidine, and quinidine produce effects very similar to those of quinine. Disagreeable noises in the head, singing in the ears, deafness, and giddiness are the more noticeable of the symptoms produced by all of the Cinchona alkaloids. Vomiting, nausea, and purging also are occasionally noted to follow their use. On the other hand, small or moderate doses produce none of these peculiar effects, while they improve the appetite, strengthen the digestion, and, in many cases, appear to have a marked effect in reducing the size of congested spleens.

5. The alkaloids were exhibited successfully, that is, with the result of a rapid cessation of febrile paroxysms, in a very large proportion of the cases. Out of the 1,145 cases recorded, four deaths occurred, and all these took place at Goodaloor, in Wynaad. Dr. Keess observes of them, that the fever was complicated either with pneumonia or diarrhoea, and that a great proportion of his patients were half starved, emaciated persons, completely prostrated by the malarious influences surrounding them.

In addition to the cases ending fatally, it is recorded that the alkaloids failed more or less to arrest febrile paroxysms in twenty-seven persons, a proportion a little in excess of two per cent. of the total cases treated.

6. In regard to these failures, it must be noted that they occurred chiefly in the practice of gentlemen who tried the alkaloids, not in recent attacks of fever, but in patients whose systems were chronically poisoned by malaria. Thus, Mr. Walters, of the 4th Regiment, N.I., Secunderabad, records of many of his cases, that they had been from one to three or four months suffering from fever before he used the alkaloids, and that in some of them quinine failed just as much as quinidine, cinchonine, or cinchonidine had done. Mr. Chipperfield explains the probable cause of failure in his report. In recent attacks of uncomplicated paroxysmal fever, the new alkaloids appeared to most of the medical officers using them, and to the members of the Commission, to be quite as efficacious in the curing of fevers as quinine. On this subject, however, it is impossible to speak with precision, until the results of treatment with the chemically pure di-sulphate of quinine, as supplied by Messrs. Howards, have been tabulated in the form used for recording the treatment by the other alkaloids. Instructions have been issued to the gentlemen engaged in the experiment to do this, and the returns, when received, will afford most valuable data whereby to compare the relative therapeutical effects of the several alkaloids.

7. The evidence, so far as it has come before the Commission, does not go to show any particular superiority of one alkaloid over another.

The sulphate of quinidine is perhaps the one regarding which there is the least difference of opinion as to its merits. All three are undoubtedly anti-periodic, and capable of controlling paroxysmal fevers. The sulphate of cinchonine in *large* doses perhaps causes more unpleasant symptoms than the others, but on this point further evidence is still wanting to enable the Commission to offer a positive opinion. As regards the general and practical question at issue, we agree with Dr. Keess in thinking that all three alkaloids are, equally with quinine, capable of controlling paroxysmal fevers. Dr. Keess's experience led him to conclude that a 10-grain dose of either salt would check or postpone the febrile paroxysm in a considerable number of cases, while very few patients required more than a second 10-grain dose to subdue the disease for the time being.

Other observers have employed larger quantities of the several drugs, but it is by no means clear to the Commission that the quantities exhibited were, in all cases, necessary to check the fever. As regards this part of the inquiry, it is intended to institute a distinct series of experiments for the more accurate comparison of the value of the several alkaloids, when contrasted with quinine or with each other.

8. The main conclusion which the members of the Commission have derived from the data before them is, that the alkaloids hitherto but little valued in medicine are scarcely, if at all, inferior as therapeutical agents to quinine.

What the exact differences may be in their physiological and therapeutical action is a question the answering of which may fitly be deferred until more data have been collected in reference to the new alkaloids. The differences, however, will most likely be found to be of degree rather than of kind, and practically, so far as the wants of India are concerned, it will be just as well that the locally grown barks yield a large proportion of one alkaloid as of another.

9. So impressed are we of the value of these hitherto despised alkaloids, that the members of the Commission are unanimous in considering that, in the public service of this country, they may very advantageously be substituted in part for quinine. If three pounds of cinchonine can be obtained at the price of one pound of quinine, we consider that a great public good would result from the purchase of the larger quantity, as it would enable the Officers of the Medical Department to benefit a much larger number of the population than they can now afford to treat by prescribing quinine. Arrangements will be made by Dr. Mackenzie to include in the next medical indent on the Home Government a requisition for suitable quantities of each alkaloid.

10. We beg to direct attention to the Tables. It gives us much pleasure in testifying that the experiments conducted by Dr. Keess at Goodaloor have been most carefully recorded.

11. Mr. Cornish, Secretary to the Principal Inspector-General, in addition to his other duties, voluntarily undertook those of Secretary to the Commission. For the mode in which these duties have been carried out, the members of the Commission feel that their best acknowledgments are due to that gentleman.

TABLE 1.—SHOWING THE RESULTS OF TREATMENT OF PAROXYSMAL FEVERS BY CINCHONINE.

Name of Medical Officer.	District.	Type of Fever.			Results.		Remarks.
		Quotidian.	Tertian.	Remittent.	Cured.	Failed.	
1. Dr. Keess and Mr. Wade	Goodaloor, Wynaad .	170	19	1	118	2*	Large doses produced disagreeable effects; usual dose from 5 to 10 grains daily. Dr. Keess considers the remedy equal to quinine.
2. „ Foy . . .	Sumbulpore . . .	31	6	1	38	—	Chiefly 5-grain doses from two to three times daily.
3. „ Cleveland . . .	Mysore	38	4	2	43	1†	Dose, grains 10—20, three times a day. Cinchonism resulted, when large doses were given.
4. „ Whitton . . .	Cochin	25	3	—	28	—	Single dose of 10 grains in a few. In most 5 grains before expected paroxysm. Remedy appeared to effect rapid reduction of size of spleen in several cases.
5. „ White, 1st Royals .	Kamptee	6	—	—	6	—	Small doses of 2 or 3 grains used. Had larger doses been given, the cure would have been more rapid.
6. „ Dougall . . .	Northern Circars .	14	2	—	16	—	Given in 5, 10, and 15-grain doses.
7. „ Chipperfield . . .	Madras	8	2	1 contd.	8	3	In unsuccessful cases the remedy was not continued more than two days, small doses only given.
8. „ Heard	Shemogah, Mysore .	2	—	—	2	—	
9. „ Walters	Secunderabad . . .	18	3	—	17	4	Nearly all Dr. Walters' cases had been a long time under other treatment before cinchonine was resorted to. They were obstinate intermittents, and did not yield readily to treatment. Many of the cases had 'burning of the hands and feet.'
10. „ Fitzgerald . . .	Labuan	14	5	—	19	—	Small doses used which rendered treatment protracted.
11. „ Houston	Upper Godavery . .	35	—	—	35	—	Cinchonism resulted, when repeated large doses were used. Dr. Houston notes that, in the majority of cases, the pulse rose soon after taking a dose of the medicine.
		361	44	5	400	10	
	Total	410			410		

* Both died from exhaustion.

† Complicated with pneumonia—the remedy was discontinued.

TABLE 2.—SHOWING THE RESULTS OF TREATMENT OF PAROXYSMAL FEVERS BY CINCHONIDINE.

Name of Medical Officer.	District.	Type of Fever.			Results.		Remarks.
		Quotidian.	Tertian.	Remittent.	Cured.	Failed.	
1. Dr. Keess and Mr. Wade	Goodaloor . . .	137	16	1	154	—	These cases were nearly all cured by from one to two doses of eight or ten grains.
2. „ Foy . . .	Sumbulpore . . .	36	5	—	39	2	In the cases of failure quinine was resorted to, but the result is not stated—generally used in 5-grain doses.
3. „ Cleveland . . .	Mysore . . .	24	10	4	38	—	Doses varied from 5 to 20 grains—small doses in a few cases with less immediate effect.
4. „ Whitton . . .	Cochin . . .	28	4	—	31	1*	
5. „ White, 1st Royals .	Kamptee . . .	—	—	—	—	—	
6. „ Dougall . . .	Northern Circars .	12	3	—	15	—	Given in 5, 10, and 15 grain doses, considered by Dr. Dougall quite equal to quinine.
7. „ Chipperfield . . .	Madras . . .	8	3	1	7	5	Three of the unsuccessful cases were only one day under treatment. See Dr. Chipperfield's remarks in Appendix III.
8. „ Heard . . .	Shemogah, Mysore .	11	—	—	10	1	Grains 8 to 10 before paroxysm.
9. „ Walters . . .	Secunderabad . . .	7	1	—	5	3	As regards three cases the results are so vaguely given that it cannot be said whether the remedy failed or not.
10. „ Fitzgerald . . .	Labuan . . .	18	4	—	22	—	Grains 3, 6, 8, before paroxysm.
11. „ Houston . . .	Upper Godavery . .	25	1	—	25	1†	
		306	47	6	346		
	Total . . .	359			359		Three doubtful.

* Fever became remittent.

† Complicated with neuralgia and paralysis.

TABLE 3.—SHOWING THE RESULTS OF TREATMENT OF PAROXYSMAL FEVERS BY QUINIDINE.

Name of Medical Officer.	District.	Type of Fever.			Results.		Remarks.
		Quoti- dian.	Tertian.	Remit- tent.	Cured.	Failed.	
1. Dr. Keess and Mr. Wade	Goodaloor . . .	140	11	2	151	2	Both died, one from exhaustion, one dysentery.
2. „ Foy . . .	Sumbulpore . . .	37	6	—	42	1	Chiefly five grain doses, three times a day.
3. „ Cleveland . . .	Mysore . . .	28	5	—	33	—	Two cases result not known. From two to twenty grains doses three times daily.
4. „ Whitton . . .	Cochin . . .	26	3	—	29	—	Chiefly five grain doses. In a few cases ten grains.
5. „ White, 1st Royals . . .	Kamptee . . .	9	—	—	9	—	Three and five grain doses, three times daily.
6. „ Dougall . . .	Northern Circars . . .	11	4	—	14	1*	Five, 12, and 15 grain doses.
7. „ Chipperfield . . .	Madras . . .	8	—	—	8	—	Five grain doses, thrice daily.
8. „ Heard . . .	Shemogah, Mysore . . .	12	—	2	12	2†	Doses 2, 4, 5, and 6 grains.
9. „ Walters . . .	Secunderabad . . .	15	1	—	14	2	Some of the cases were successfully treated hypodermically. The two failures cured by quinine.
10. „ Fitzgerald . . .	Labuan . . .	9	1	—	10	—	Six grain doses.
11. „ Houston . . .	Upper Godavery . . .	10	1	1	12	—	Grains 5 to 10, twice a day.
12. „ Henderson . . .	Bangalore . . .	15	—	—	12	3‡	Grains 5 to 10, chiefly in interval of fever.
13. „ Oswald . . .	Ditto . . .	17	2	—	19	—	
		337	34	5	365	11	
	Total . . .	376			376		

* In this case paroxysm only mitigated, not checked.

† These were cases of remittent fever, and remained under treatment though benefited.

‡ Remedy omitted on account of diarrhoea.

APPENDIX TO REPORT II.

REPORT ON THE CINCHONA ALKALOIDS, BY DR. KEESS, ON SPECIAL DUTY IN WYNAAD.

Madras, February 25th, 1867.

1. In obedience to instructions received from the Head of the Medical Department, I proceeded to Goodaloor, South-east Wynaad, and started the alkaloids experiment on the 1st June, 1866.
2. When I arrived at Goodaloor, fever was prevailing to a great extent, both there and in the adjoining coffee estates. Owing to the great rush of fever subjects to the Dispensary, I decided on first observing the effects of large doses of the alkaloids.
3. As there were many persons suffering from fever in June, the administration of a single large dose enabled me to take up a larger number of cases than I would have been able to do had I begun with small and repeated doses.
4. I first tried Cinchonidine, in doses varying from ten to fifteen grains, and in a few days I was pleased to find that it acted as Quinine would have done in similar doses.
5. I next tried Quinidine, with similar results.
6. I left Cinchonine to the last, as it was said to be an irritant of the gastro-intestinal mucous surface. I was, however, agreeably disappointed when I found that it did not cause nausea or vomiting in doses of ten grains, and that it was as good an anti-periodic as the sister alkaloids.
7. Encouraged by the absence of symptoms indicating gastro-intestinal irritation, I used Cinchonine in fever complicated with diarrhoea, and I am satisfied that it is not an irritant of the stomach or bowels any more than quinine is in certain cases.
8. Some of my patients were *out* and *in* patients of the Godaloor Dispensary. Others were visited in the bazar, and in the adjoining coffee estates, from two to six miles distant from Goodaloor.
9. The great majority of my patients were half starved, emaciated persons, with flabby muscles, dry, dirty and shrivelled skins, large spleens, bloodless eyes and tongue, and small atonic pulse. In many of them languor was so marked that they could with difficulty muster up energy enough to reply to questions; and so prostrated were some of them, that they were with difficulty induced to take the medicines offered to them.
10. I have not attempted to reduce to a small compass the results set forth in the tabular reports, as I hear that this work has been undertaken by the Cinchona Commission; but I beg leave to point out that a ten-grain dose of all three alkaloids seems sufficient to check the return of fever in the majority of cases. Where it failed to check the return of fever, the succeeding paroxysms were generally observed to be less severe. When the paroxysms returned with unabated severity, fifteen grains, and then twenty grains were tried. In a few severe cases I administered at the onset fifteen or twenty grains.
11. During the four months that I was employed in the Wynaad, four hundred and sixty-seven cases were treated with the alkaloids. The majority of these were of the quotidian type. Bronchitis, congestion of lungs, pneumonia, diarrhoea, dysentery, and anasarca were occasional complications. I may as well add that these complications did not in the least interfere with the administration of the alkaloids. Where the local affection required special attention, the alkaloids were given with remedies suitable to the complication. I may here add that all three alkaloids appeared to be as efficacious as Quinine.

APPENDIX TO REPORT III.

REPORT ON THE THERAPEUTIC EFFECTS OF THE SALTS OF THE CINCHONA ALKALOIDS, BY
DR. CHIPPERFIELD, ACTING PHYSICIAN OF THE MADRAS GENERAL HOSPITAL.

Madrass, Sept. 18th, 1866.

1. In furnishing the accompanying tabular reports of the therapeutic effects of the Cinchona alkaloids, as tested at the General Hospital, Madras, I have the honour to state, that in order to draw a more accurate comparison between the salts tested and the di-sulphate of Quinine, I exhibited the former in the same way as I am in the habit of using the latter, viz. I gave the first dose upon the decline of the sweating stage, the second and third doses being given at two-hour intervals. The fourth dose was exhibited at the same hour as the first dose, and so on with the fifth, sixth, and any subsequent doses which appeared to be required.

2. I have been led to form a high estimate of the anti-periodic effects of the sulphate of quinidine. This salt was successful in the cure of the eight cases in which it was administered, and it appeared to me to be quite as valuable a remedy as the di-sulphate of quinine itself. In some respects it seemed superior to quinine, as in no instance did it produce any of the disagreeable effects called cinchonism; in fact, two patients who were suffering from severe headache, stated that the medicine completely relieved this symptom. I did not observe any injurious effects upon the digestive organs, but rather a favourable action, as appetite was promoted and digestion apparently assisted. In seven cases the quinidine was given in doses of five grains thrice daily. As these doses were effectual, I continued them. But, as a matter of experiment, in Case 8, I gave, on the 11th of June, one dose of fifteen grains on the decline of the sweating stage, and a second dose of eight grains two hours before the next expected paroxysm. The patient was free from fever for five days, when a relapse occurred. The same plan of administration was followed, and with success, for there was no further paroxysm of ague, although the patient remained under observation for incipient phthisis for a period of more than a month.

3. The sulphate of cinchonine I would place second on the list as an anti-periodic. It was unsuccessful in three out of eleven cases; but two of these were very unfavourable ones. One, a European coffee-planter, was suffering from tænia and general abdominal engorgement, and the remedy could not be pushed in his case, as it produced cinchonism very rapidly. He had taken a large quantity of quinine before the cinchonine was commenced. He was subsequently treated with pernitrate of iron, kuosso, turpentine, and oil of male fern, but he did not pass the head or neck of the tænia, but only a few proglottides. I saw him on September 17th, very much improved in health, getting strong and stout, and quite free from fever. The second case, a European (surgeon of the ship "Blackwall"), was a relapse. Three weeks previously he had been cured of an intermittent by quinidine (Case 7 in the Table). He was then suffering from chronic hepatitis, and had threatenings of hemiplegia. These symptoms quite disappeared before his first discharge from hospital, on the 19th June. On his second admission, it was ascertained that he had been much exposed to the sun, going forwards and backwards among the shipping in the roads. The cinchonine* failed to arrest the paroxysms of ague, which was subsequently effected by quinine.

4. The third unsuccessful case was that of a Eurasian lad, whose stomach would not tolerate the remedy. He was subsequently cured by a combination of diaphoretics with quinine.

5. Gastric disturbance was produced by the cinchonine in most of the successful cases.

6. The sulphate of cinchonidine appears to me a much inferior anti-periodic to quinine. It was unsuccessful in five out of twelve cases in which it was employed. I allowed myself to be somewhat prejudiced against the salt when I commenced its use as it almost always produced nausea.

7. In Cases 1, 8, and 9, it was decidedly successful. Case 2 might be removed from the Table; the man was saturated with malaria, and had previously been treated by quinine and by cinchonine.

8. Case 3 was a complicated one: the woman was the subject of hysteria, and each cold stage was accompanied by violent hysterical fits. Her spleen was much enlarged, and, altogether, it was a most unfavourable case for even quinine. Deobstruents were freely used, even whilst taking the cinchonidine. She is entered as having been successfully treated by the cinchonine (Case No. 10 in the Table). The fact is, there had been no paroxysm for two or three days whilst taking the cinchonine, and as that salt was exhausted, she simply passed to the cinchonidine. She has since had relapses, and has been treated by quinine and deobstruents. She was discharged at her own request on the 31st August, but since then has had a relapse, and has again come under treatment.

* Only drams given.

9. Case 4 might be removed from the Table: he had only one dose of cinchonidine, which increased mental delusions as quinine had done before. He is still under treatment, occasionally getting a paroxysm of ague with very profuse sweating. He is improving under mineral acids, and his distressing mental delusions have disappeared.

10. In Case 5, the remedy produced violent vomiting, and it was discontinued at the patient's request. The same remark may be made as to Case 6, subsequently cured by quinine. Cases 7 and 12 were very mild cases, which would probably have been easily cured without any Cinchona preparation. In Case 10, nine grains of cinchonidine appeared to prevent the recurrence of a paroxysm. The patient, a very anæmic female, was subsequently cured by ferruginous remedies.

II.—PRELIMINARY REPORT OF THE BOMBAY CINCHONA COMMISSION.

From Dr. F. S. ARNOTT, President of the Bombay Cinchona Commission, to the Chief Secretary to Government, General Department, Bombay.

SIR,

March 26th, 1867.

I do myself the honour to report that, as required by Government Resolution dated 26th May last, the Medical Commission, as therein appointed, consisting of myself as President, and Drs. Nicolson, Hunter, and Joynt, as members, has had under investigation the Cinchona alkaloids, and now begs to submit to the Government of Bombay the results of that investigation.

2. To give full effect to the instructions conveyed in the Secretary of State's letter, the Committee deemed it advisable at once to forward to medical officers, both in civil and military employ, at various stations of this Presidency, and particularly those situated in malarious districts, small quantities of each alkaloid for the most careful experiment and report. The Committee at the same time requested the co-operation of the Principal Medical Officer, British troops, in allowing experiments to be made in the hospitals of Her Majesty's regiments, which he most kindly acceded to, so that the Committee is able to judge of the effects of the alkaloids both on the European and Native constitution.

3. In forwarding the alkaloids, the Committee at the same time sent certain instructions which it had drawn up, and which it was directed each medical officer should observe as much as possible in making his observations and in framing his report. These instructions were as follows, and the Committee have to record its high sense of the care with which the greater number of the reports have been framed, and the valuable and conclusive information they furnish:—

“Her Majesty's Government being desirous to have tested the febrifuge and other therapeutical effects of certain alkaloids procured from the bark of the Cinchona trees, the Commission, of which I am President, has the honour to inform you that small quantities of them, as noted below, have been forwarded to you, and requests that you will subject each to the most careful experiment in your hospital.

“2. The Commission is anxious to ascertain,—

- I. What medicinal virtues these alkaloids possess.
- II. Their general effects on the human system in health and disease.
- III. To what extent they possess the anti-periodic effects of quinine.
- IV. Their efficacy in the treatment of the common fever of the country, as well as in other diseases for which quinine is held in repute.
- V. Their relative values as remedial agents; and
- VI. Their proper doses.

“3. On the completion of your experiments, which it is hoped may be not later than the 1st of January, 1867, you are requested to report to me the opinions you have arrived at on the various points mentioned in paragraph 2 of this letter, stating generally the circumstances under which you have prescribed the different alkaloids, that is, showing the nature of the case with its most prominent symptoms, and anything else that may occur to you in the elucidation of the investigation.

“4. Two ounces of each of the following alkaloids have been despatched to you, for which you are requested to send a receipt on their safe arrival:—

Sulphate of quinine.
Sulphate of cinchonine.
Sulphate of quinidine.
Sulphate of cinchonidine.”

4. In analysing the various reports that have been received, the Committee begs briefly to observe that the results of the experiments that have been made are most favourable. There is no difference of opinion as to the highly valuable effects of these alkaloids, though, as was to be expected, there is some difference of opinion as to the exact order of importance in which their medicinal virtues should be arranged. All concur in assigning to them most valuable therapeutic effects as febrifuges, anti-periodics, stomachics and tonics, and they have been most successfully tried in fevers, in neuralgic affections, and rheumatism, in debility, and want of appetite. All give a preference to the sulphate of quinine, after which most, though not all, rank quinidine, though others prefer cinchonine, which again is by many placed at the bottom of the list. In the treatment of disease one of their most important properties seems to be in their effects when given alternately with other remedies, and with each other, as, for instance, both quinidine and cinchonine proved effectual in cases of fever where quinine and arsenic had failed. One medical officer, in recording his want of confidence in cinchonine as an anti-periodic, states that he found it most useful in diarrhoea, and as a restorer of appetite.

5. The Committee having thus tested the efficiency of these alkaloids on a scale sufficiently extensive to ensure decisive results, has unanimously come to the conclusion that they form a very valuable class of therapeutic agents, and taking the order of the instructions sent to medical officers they consider them to be,—

- 1st. Febrifuges, anti-periodics, and tonics.
- 2nd. Their general effects are similar to those of quinine, though perhaps in an inferior degree.
- 3rd. As variously estimated, they possess the same effects as quinine, to the extent of one-half or two-thirds.
- 4th. They are very efficacious in treating the common fever of the country, hemicrania, and disordered digestion, &c. &c.
- 5th. Their relative value seems to be,—
 - 1st. Quinine.
 - 2nd. Quinidine.
 - 3rd. { Cinchonidine } about equal.
 { Cinchonine }
- 6th. Their proper doses are,—
 - Quinine, from 3 to 20 grains.
 - Quinidine, from 5 to 20 grains.
 - Cinchonidine, from 7 to 20 grains.
 - Cinchonine, from 7 to 20 grains.

I have, &c.

F. S. ARNOTT, M.D. & C.B.,
President of Commission.

The subsequent report of the Committee was not issued till 29 Oct., 1868 (when 25 copies were printed and circulated). It contains an account of the causes of delay, and states that "the difficulty of collecting materials has fallen short of the truth, and even at this late period we are, to our regret, compelled to draw conclusions from evidence which is much less copious than we had hoped to obtain; and are entirely without information from sources to which we had looked for much assistance."

Such admissions disarm criticism, but must also be felt to detract greatly from the value of the conclusions. I do not think it necessary to extract anything except the supplementary report from the Calcutta Medical College.

GENERAL CONCLUSIONS.—SUPPLEMENTARY REPORTS.

From DR. EWART, of the Calcutta Medical College.

Since our Report, we have received from Dr. Ewart, of the Calcutta Medical College, an account of some experiments with the alkaloids carried out during the month of October, 1866. The period was limited and the cases not numerous; but their character was strongly marked in every instance, and the result of treatment well pronounced. Dr. Ewart states his opinion in the following "General Conclusions," which are fully sustained by the facts he adduces.

Sulphate of Quinidine is an excellent anti-periodic in doses of 5 to 20 grains. It is probably not inferior to quinine, and is easily tolerated by the stomach. It is a good bitter tonic in smaller doses, and may be combined with ferruginous medicines. It is less disagreeable to the taste and stomach than quinine, and its use is not accompanied by the unpleasant effects known as cinchonism.

Sulphate of Cinchonidine stands next in anti-periodic power in 10 to 20 grains doses, and as a tonic in smaller quantities; it is "agreeable to the stomach," and is not accompanied by symptoms analogous to cinchonism.

Sulphate of Cinchonine is doubtless a powerful anti-periodic in doses of from 10 to 20 grains. "The irritability of stomach caused by it is the great objection to its ever taking rank as a substitute for either of the other alkaloids," but it may be obviated by injecting the medicine in solution hypodermically. It is a good tonic in small doses."

APPENDIX B.

*Extracts from a Letter from W. G. McIVOR, Esq., F.R.G.S., C.M.B.S.E., Superintendent of Government Cinchona Plantations, to
J. R. COCKERILL, Esq., Commissioner of the Nilghiris, Ootacamund.*

Ootacamund, August 2nd, 1875.

I.—Outturn of Coppicing.

	lbs.
58 fine selected red bark trees, coppiced in May, 1873, yielded of dry stem bark	286.50
57 " " " " in Oct. " " " "	264.25
115 inferior unselected bark trees " in May, 1875 " " " "	87.75
The above trees were all coppiced in one block, and were the planting of 1862-63, and about twelve years of age when coppiced. This gives the average yield of red bark trees of twelve years of age per tree	
240 fine selected red bark trees, coppiced in May, 1871, when eight years of age, yielded of dry stem bark	255.00
Or an average per tree of	1.06
This result, corrected by the yield of inferior trees as above, gives the average yield at eight years of age per tree	
	0.75

Careful observation indicates that mossing will, under fair management, yield at least from thirty to forty times the quantity of bark that can be obtained by coppicing. This may not be admitted until such a trial be given to coppicing, as I have from the first recommended. I have said that mossing will produce from thirty to forty times the quantity of bark that can be obtained by coppicing. We find the yield of trees eight years old when the first harvest of mossed bark was taken to be in four-years crops 8.72 lbs. per tree, against 1.06 lbs. in fine selected coppiced trees, and 0.75 in average coppiced trees of the same age. It will be ten years more before the coppiced trees can yield another crop, while the mossed trees will yield every year an increasing crop. True, we cannot see into the future, but we are justified in believing that what has existed for years will continue. On this data the estimate at foot is based, and will be, I believe, with certainty realised.

II.—Outturn of Mossed Trees.

One thousand red bark trees were subjected to the mossaing process in May, 1871. The actual outturn is 8·727, or 8·72 per tree up to date. In ten years more the coppiced trees will yield another crop. During this time the mossed trees will yield on an average 3 lbs. dry bark annually, or in all 38·72 lbs. In the second period of coppicing the advantages will be still greater, as then the mossed trees will yield from 4 to 6 lbs. annually.

7. Not only does mossing produce a much greater quantity of bark, but yields bark over three times the market value of natural red bark. As it costs more to collect inferior bark, and more for freight because it is light, the renewed bark produced under moss becomes to the cultivator fully eight times the value of natural red bark. A bark realising 1s. 3d. to 1s. 6d. per lb. costs 1s. per lb. to place it in the market, including all charges. The profit on this bark is only 3d. and 6d. per lb. On a bark realizing 5s. the profit is 4s. per lb. The discovery of mossing is, therefore, one of the most important I have made in this cultivation.

III.—Results of the Sales of Nilghiri Bark in 1874. Deva Shola.

- | | | |
|--------|---|----------------|
| No. 1. | First strips of natural bark removed from the trees immediately before mossing realised per lb. | 1s. to 2s. |
| „ 2. | Second strips of old bark left on the trees when the first strips were removed, and being subjected to the influence of mossing and renewing bark on each side, from eight to twelve months, realised | 1s. 6d. to 3s. |

Kartary Bark.

- | | | |
|------|---|--------------------|
| „ 3. | First strips taken as at No. 1 realised | 1s. 1d. to 1s. 6d. |
| „ 4. | Second strips „ „ 2 „ | 2s. 6d. |

Sales of Crop of 1875. Deva Shola.

No. 5.	First strips taken as at No. 1 realised	1s. 3d. to 1s. 7d.
„ 6.	Second strips „ „ 2 „	2s. 6d.
„ 7.	Bark renewed under moss	3s. 5d.

Ossington Red Bark.

„ 8.	First strips taken as at No. 1 realised	9d. to 1s. 6d.
„ 9.	Second strips „ „ 2 „	2s. 3d.
„ 10.	Bark renewed under moss	3s. 3d.

Neddiwuttum Red Bark.

„ 11.	First strips taken as at No. 1 realised	1s. 6d.
„ 12.	Second strips „ „ 2 „	2s. 3d.
„ 13.	Bark removed under moss, second crop	4s. 3d. to 4s. 5d.

There is no mystery as to *why* renewed bark is rich in alkaloids. *As is well known, renewed bark is composed of cellular tissue, and all recent investigations, including those of the Quinologist, show "cellular tissue to be the seat of the alkaloids."* Mr. Broughton's investigations do more than this, and show that the "*very cells which contain*" the alkaloid also "*formed them.*"*

Mr. Broughton's contributions to the "Philosophical Transactions," dated June, 1870, page 7, state: "Furthermore, the very local character of these peculiar changes seems to render it highly probable that the alkaloids are really formed *in situ* in the very tissues in which they are found; that is, the very cells which contain them also have formed them."

See also paragraphs 37 and 38 of Mr. Broughton's letter recorded in General Order, 2nd September, 1868, No. 2453.

12. I shall now draw attention to the circumstance, that the transference of material once formed and deposited in one part of a vegetable tissue to that of another part is unknown. A notable example of this is found in the graft. Here two plants differing in their nature are placed in the closest combination; yet in the experience of over 2,000 years, and with almost every species of plant, the stock has not been found to communicate to the graft, or the graft to the stock, in the *minutest degree* any of those subtle influences on which depend the size and flavour of a fruit, or the colour of a flower; both the stock and graft retaining throughout their existence, their separate qualities; though the stock is built up by the sap, elaborated by the leaves of the graft, and the graft supplied with its sap by the roots of the stock. Prior to the promulgation of this theory of the transference of alkaloids, or on the 2nd October, 1873, I had removed from a tree of a hybrid variety of *Cinchona* (var. *pubescens*, Howard) the first strips, or one-half of all the matured natural bark; after these strips of bark were taken, the tree, as usual, was immediately covered with moss. This bark was forwarded to J. E. Howard, Esq., and the result of that gentleman's analysis is given in detail at foot. *It shows the exact condition in which this bark was prior to being subjected to the mossaing process and the influence of renewed bark.* On the 25th June, 1874, I removed from the same tree, and forwarded to Mr. Howard, the other strips of bark, or all the old bark left upon the tree when the first strips were removed on the 2nd October, 1873. Thus the various strips of old bark had at that time been subjected for nearly nine months to the so-called "deteriorating influence" of renewing bark on each side, yet the analysis at foot shows this bark had not deteriorated; on the contrary, it had improved. We find the natural bark taken from this tree for the first time, or before it was subject to the mossaing process at all, gave 12·207 per cent. of total alkaloids. That the old bark of the same tree, after being subjected to the mossaing process, and the effects of renewing bark from 2nd October, 1873, to the 25th June, 1874, gave 12·907 per cent. of total alkaloids.

Letter from J. E. HOWARD, Esq., Tottenham, London, dated 20th February, 1874.

"We make the contents of the bark of the individual tree growing at N. E. exposure to be a little better than that examined by Dr. de Vrij at N. W. exposure, but it is possible that if tried by the same person the difference would be not much.

That sent me gives the following astonishing result:—

Sulph. Quinine	6·00
„ Cinchonidine	5·00
„ Cinchonine	0·60
„ Amorphous	0·60 = 12·20.

"Very accurate testing would doubtless diminish a little the Quinine and increase the Cinchonidine, so that it might be safer to divide the 11 per cent. between them, but even with this deduction, it is clear that you have an extraordinary bark, and one which with its other good qualities throws the '*C. mirabilis*' (*angustifolia*) quite into the shade."

Letter from J. E. HOWARD, Esq., Tottenham, London, dated 4th September, 1874.

"I have delayed replying to your letter of the 27th June, till I could send a full answer to your questions. Having since received by post your parcel containing narrow strips of bark of *C. officinalis* var. *pubescens*, I have devoted my attention to resolve

* See my "Microscopical Observations"—(J.E.H.).

the interesting problem, whether the renewed bark draws the alkaloids away from the old; and have secured the assistance of my nephew (who examined the bark) in addition to my own experiments. You may rely on the conclusion arrived at, viz., that *the sum total of the alkaloids in the two barks is the same*, consequently there has been no such action on the part of the tree as supposed.

The bark now sent, Sulphate of Quinine	6.94
„ Cinchonidine	6.49
„ Cinchonine	0.20
„ Quinidine	0.16
„ Amorphous	1.16 = 12.90.

“The difference, such as it is, is slightly in favour of the bark last sent, thus not differing from some previous trials, which generally seem to show the proportion of Quinine increased by the process.

“3. This is a considerable improvement, especially when the greatly increased quantity of Quinine is taken into account, the market value of this bark being enhanced at least 1s. 4d. per lb. Thus we see by the most distinct evidence that the renewed bark *does not* draw its alkaloids from the old bark. Here also we have the improvement effected by the mossing process, apart from the renewal of the bark.”

13. Even Commerce, in impartial might, arises to crush this theory. From all the large private plantations on these hills bark has been systematically collected by the mossing process, and these plantations have already sent into the market bark from upwards of two hundred thousand trees. The whole of this bark was collected in the same way as the bark analysed by Mr. Howard, *i.e.* the first strips of natural bark were taken and the trees immediately covered with moss; the remaining or second strips of *old* bark being removed at from eight to twelve months after. These second strips of old bark were thus subjected to the influence of renewing bark on each side for from eight to twelve months; yet we find that this bark has in every instance realised in the open market from 9d. to 1s. 3d. per lb. more than the first strips of natural unmossed bark from the *same tree*; while renewed bark also from the same tree has realised fully three times the price of natural unmossed bark.

APPENDIX C.

IMPORTATIONS OF CINCHONA BARK.

The following particulars of Bark imported during the last three years are taken from official returns. I cannot otherwise vouch for their correctness:—

	Columbian, Pitayo &c.	Calisaya.	E. I. Cinchona.
1873	43,398 pkgs.	6,997 Serons	— pkgs.
1874	31,218 „	7,451 „	1,065 „
1875	26,865 „	6,803 „	1,206 „

CINCHONA BARK FROM SANTA MARTHA.

Her Majesty's Vice-Consul at Santa Martha reports a considerable decrease in the shipments of cinchona bark which hitherto has formed a prominent article of export from that place. The quantity has fallen from 14,829 serons in 1873 to 3,213 serons in 1874. This appears to be principally due to the diversion of the general export trade to Savanilla, in consequence of the construction of a railway that has placed that port in connection with the inland districts. The bark shipped from Savanilla during 1873 (the latest date given) amounted to about 2,200 tons, and was valued at more than a million dollars.—*Pharmaceutical Journal*, October 9, 1875.

SALE OF BARK AT AMSTERDAM, June, 1875.

The Sale resulted in the following prices, as reduced to English money, being obtained.

	No.	1	from	s. d.	s. d.
49. C. Succirubra	1	from	1 0	to	1 4
16. „ „	2	„	1 2	„	1 3
18. „ „	3	„	1 4	„	1 5
26. „ Pahudiana	4	„	2 0	„	2 2
3. „ Caloptera	5	„	2 2		
6. „ Officinalis	6	„	3 4		
5. „ Hasskarliana	7	„	2 9		
10. „ Calisaya Ledgeriana	8	„	6 8	to	7 3
6. „ Anglica	9	„	2 6		
13. „ Javanica	10	„	2 6	to	2 9
16. „ „	11	„	2 9	„	3 1
20. „ „	12	„	2 8		
7. „ „	13	„	2 4	to	2 6

Also sundry additional packages of the last description, sold at similar prices.

ON COPPING CINCHONAS.

As all information connected with the cultivation of the Cinchona is important for those engaged in this branch of industry, I will here add a few remarks in reference to the plan of coppicing advocated in an extract from the *Agricultural Gazette of India* and copied in a recent number.

It is well that the owners of the Sikkim plantations find the results of their cuttings "most satisfactory," but it is important to observe that this satisfaction does not extend to those who would desire from thence a supply of material for the extraction of quinine, and, consequently, that it would be a mistake to recommend this plan for general adoption.

The bark of coppiced Oak is, I believe, very abundant in tanning material. Certainly, I know that the corresponding bark of the Cinchona, and especially of the C. succirubra, abounds in the astringent principles which are an annoyance to the chemist in the above manufacture. It is equally a matter of notoriety that the bark of small branches, such as would be supplied by this plan, is comparatively barren in quinine. In my *Quinologia* (*sub voce* C. magnifolia, p. 8) will be found a table from the researches of Dr. de Vrij, showing that kinovic acid abounds in the inverse proportion to quinine, so that the bark of small branches (called *canutillos* in South America) may be very useful as a tonic, and very bitter, but useless for the extraction of quinine.

It is certain that the latter is never found in quantity till the bark has attained a certain thickness. The reason for this is, probably, that the alkaloids are not formed in the leaves and carried downward by the descending sap. A theory that such was the case used to be entertained, but is negatived by the examination of the leaves, such as I have communicated to the *Pharmaceutical Journal*, and by Mr. Broughton's researches in India. On the other hand, I have sought to show that the alkaloids are formed in the cellular tissue of the bark, commencing more especially with the cambium (see *Quinology of the East Indian Plantations*, p. 28). When the bark is renewed, after being stripped from the tree, the new portion presents a very unique appearance; such as I have represented in the last work, and which I call lax cellular tissue. This is specially rich in alkaloid (see Plate III.), and I have found the singularly radial appearance of this structure exactly reproduced in some renewed *succirubra* bark of good quality which I have recently examined.

I compare this in my own mind to the peculiar cellular tissue of the gall-nut, produced through the puncture of the cynips, and therefore in a similar abnormal manner. This tissue, as every one knows, is very rich in the (chemically) characteristic product of the tree.

I am indebted to M. Moens, of Java, for the following confirmation of my opinion (which will not be without interest to your Ticehurst correspondent on grafting Vines, p. 311). M. Moens says:—"Some years ago Mr. V. Gorkom had grafted two *C. Calisaya* upon two *C. Pahudiana*. The grafts succeeded very well, and I now took the barks for examination. This showed that the *Calisaya*, as well as the *Pahudiana*, kept their alkaloids as if they had grown separately. I think this is an experiment of considerable interest, and we shall repeat it, if possible, with (*C.*) *micrantha* and *Calisaya Ledgeriana*. I think the result most agrees with your idea that the alkaloids are formed in the cellular tissue of the bark."

I wished it to be understood that I do not pledge myself to any particular mode of cultivation. I have grave doubts of the possibility of carrying out the plan of renewing the bark with commercial success. Let every plan have a fair trial and time will decide; but, as I think, the verdict will not be in favour of the coppicing system.

It may interest your readers to learn that the introduction of a new sort of *Calisaya* (called *Ledgeriana*) into Java, has greatly added to the value of the plantations, and the prospects of success are of a marked character.

In India, also, Mr. McIvor has found a new variety of great promise—the sample of its bark sent me having yielded not less than 11 per cent. of crystallised sulphates of the two alkaloids, quinine and cinchonidine. These kinds I have referred to in an article, now publishing by the Linnean Society, on the genus *Cinchona*.

This week has seen a large consignment of bark of *C. officinalis* from the Nilgherries, of excellent quality for the extraction of quinine, of course fetching a high price.—*John Eliot Howard, F.R.S.*—From the "*Gardener's Chronicle*," pp. 408, 409: 1874.

EXTRACTS OF LETTERS FROM MR. BROUGHTON.*

Ootacamund, April 26th, 1867.

I have now been located here for three months and like the country very much. The *Cinchonæ* are looking wonderfully well on the plantations and appear to grow almost everywhere they have been tried. Their nomenclature (here at any rate) is most confused. I hope the specimens Mr. McIvor is taking home may enable you to throw some light on the matter. The *Red* barks afford as marked differences as *officinalis*, but have only been allowed to possess one variety by botanists, while here the latter has three, often quite undistinguishable. I noticed at my first visit that the *macho* and the *hembra* distinctions obtain in all the kinds.

There appears to be a considerable difference in the yield of individual trees of *Red Bark*, partly, I think, corresponding to difference of habit. It is very remarkable how *Cinchonidine* replaces *Quinine* in some trees. This circumstance (which you have also remarked, I believe) must, I think, indicate some natural relationship connected with their original formation.

The bark of *Micrantha* here is wonderfully rich—7 per cent. in nearly pure cinchonine.

I have been quite unsuccessful in obtaining any *crystalline* alkaloid from the green leaves. Dr. Anderson, you will notice, has declared he obtained Sulphate of Quinine in crystals from *succirubra* leaves, but his method appears very suspicious.

July 28th, 1867.

I have made repeated analyses (of *crispa* bark) and in no case have I found it deficient in yield of alkaloid.

I find *C. Peruviana* a most interesting bark and that (as you say in your 'Nueva Quin.') the cinchonidine is somewhat different to the ordinary one. It has a less rotatory power on the plane of polarization of a ray of polarized light.

I quite believe in Pasteur's statements respecting the modifying influence of sunlight on the alkaloids. Some crown barks grown under partial shade which I examined yielded but little cinchonidine, whereas those in full sunshine yielded 1½ per cent.

I am very anxious you should have some true *typical* specimens of our leading varieties accompanied with a piece of their bark. I have begun to collect them for you, but I have since seen them so admirably dried by Mr. Batcock, that I have begged him to at once complete a set for you, which, as his botanical knowledge is far more accurate than mine, will be a great gain. You will, I am sure, forgive my expressing the opinion that many kinds which you seem disposed to allot separate names to are *not specifically distinct*. It is true the specimens you receive shew great divergence in appearance and structure, but were you to see the plantations and observe how (among the crown barks for instance) every kind passes by imperceptible gradations in the individuals into another, I think you would allow that these distinctions are not absolute. A tree which for six months has the habit of your *Uritusinga*, will all of a sudden begin to have shorter leaf stalks and leathery leaves, and begin to look like *crispa*. The typical individuals of each variety are very distinct, but there are trees which would, I think, puzzle even you to assign them their places. Of course I am not competent to speak with any authority on this subject, but as it has in the course of work so frequently struck me, I here mention it.

* These extracts convey much useful information. I have not the opportunity of consulting Mr. B. in reference to their publication, as he is, I understand, now travelling in New Zealand; but I presume that he would be pleased they should be given to the world.

Your three analyses of *Uritusinga* bark interested me extremely. It is certainly remarkable how greatly the tree whose bark I analysed resembled its grandfather—moreover, the cinchonine is 0.08 per cent.

The most interesting point I have ascertained lately is the presence of alkaloid in the older heartwood of the Red Bark trees. This amounts to 0.10 per cent. of the weight of the wood. I have obtained it as a crystalline sulphate. The most remarkable instance is that of a tree which, though rich in alkaloid, contained *no* quinine (but quinidine). To my great surprise, the whole of the wood alkaloid was *quinine*!

I have made a series of analyses on the influence of elevation. The statement of the richness of the Red Barks increasing with the altitude is inaccurate. Above 7,500 feet it yields little more than about 2 per cent., and that nearly destitute of Quinine and Quinidine. Below 5,000 feet the bark is thinner and it appears to contain quinidine in larger amounts, and a large quantity of that vexatious resin which you wrote about. But as low as 3,000 feet I have analysed bark which, although thinner, still yielded 4.10 per cent. of alkaloid, of which 0.60 was quinine. In the crown barks the highest elevations yield bark of about even quality down to 6,500 feet. Below that, the amount of alkaloid becomes somewhat less, and instead of quinine, cinchonidine and quinidine [are produced].

At low elevations the trees do not thrive, and the resin in the bark becomes as troublesome as in the Red Bark. The lowest elevation which yields the crown barks which I have examined, gave of total alkaloids 2.68 per cent. Of this I obtained 0.30 as crystalline sulphate of quinine, and 1.40 of other sulphates—altitude about 5,000 feet.

I have quite come to your conclusion that the woody part of the liber is *adverse* to the existence of much alkaloid. Indeed I believe I even extend your opinion. That interesting passage in your "Quinologia" about renewed bark has given me some valuable hints, concerning which I will shortly communicate.

December 27th, 1867.

There are a few other trees in the plantations which possess marked peculiarities. The great difficulty in ascertaining their true value is the uncertainty whether other accidental circumstances are not at the same time modifying the quality. As I obtain further insight into the matter, I find this an increasing difficulty. To give an instance. Near a hill-side, where some fine young Bonplandiana trees grow, whose bark gave me 3.70 per cent. of alkaloids (at twenty yards' distance), grew some of precisely the same appearance and age which only gave me 1.90 per cent. This struck me as so strange that I repeated both analyses by other methods, and obtained nearly similar results.

At the present time I am unable to find out the reason, and can only speculate. Nevertheless, I do not yet despair of making out the cause. For comparative estimate I am obliged to select with the greatest care the trees grown under similar conditions.

That most interesting passage in your book is quite accurate. I mean that concerning renewing of bark. If the *cambium* be not injured, fresh bark always seems rapidly to grow. I have found also the quality improved, almost as if by mossing; but I have yet only found this in one instance—the only one yet fit for analysis.

March 16th, 1868.

I start a parcel of specimens to you—they are *typical* specimens of the crown barks, and have been carefully selected by Mr. Batcock. The *Uritusinga* is a son (by cutting) of your original plant. I took advantage of Mr. B.'s skill, knowing that he, besides being a sound, unpretending botanist, has paid great attention to the *differentia variae* of the genus, and has repeatedly compared the living specimens with your work. You will observe that the latter differs somewhat from the *Uritusinga* as in nature. The difference is also augmented by a little over-colouring.

I have just repeated a capital experiment of yours, that of separating the *liber* from the *external cortical portion* deprived of periderm of the bark. The yield in *Quinine* in the former and latter was nearly as 3 to 5. As the '*bastzellen*' increase with age, the already marked difference will doubtless be augmented. The above has been made with great care, and checked by crystallisation and a stoichiometrical trial.

I have long remarked that the bark, when carefully removed without injury to the cambium, quickly renews itself from below, *not from edge*. The analyses made of bark so renewed of six months' growth have, at present, corroborated your statement respecting the old practice of the cascarilleros as being richer in alkaloids than the original. A microscopic examination shows no difference in structure between it and the mossed bark; the latter, however, gives the greatest yield of alkaloids, as far as my present experience extends.

August 24th, 1868.

Among our crown barks are some trees which have a narrow lanceolate leaf, which grow so closely as almost to appear whirled. The trees are few in number. To my surprise, when I analysed the bark, it gave me 8 per cent. of alkaloids, and actually 7.30 of pure Sulphate of Quinine!! Mr. Batcock is taking home a collection of all our varieties, and I shall mark this one; I am exceedingly anxious to know what you think it. You will, of course, see from its analysis above that it is the finest kind in our possession. Just now the trees of which I speak are putting forth afresh, in which the shape of the leaves is less marked, appearing very like *lanceifolia*; but the older leaves are, as I have described above, much narrower. Indeed, before the new growth appeared, the majority of the leaves were, in shape, very much like those of a peach-tree.

June 28th, 1868.

Mr. Batcock and I went up to the plantations to-day and saw plenty of trees of the *amarilla*. They are singularly like *crispa*, but differ in the bark, and also in having a flatter (not wavy) leaf. There are many trees possessing characters of every gradation between the above and *crispa*. We found many twigs on the tree of *amarilla*, having leaves quite undistinguishable from *crispa*. Indeed, the number of subvarieties is considerable among the crown barks; of the trees which possess all the distinguishing marks of *Bonplandiana*, there are great diversities of habit, foliage, and appearance. I observe, too, among young seedling *Calisayas*,

very considerable differences. If all varieties be ultimately catalogued, I do not think I am wrong in saying that their number will be double those already known.

The crown barks have always been my favourites, from the ease with which the sulphates crystallised and the beauty of even the very first crystallisation of Quinine sulphate.

I observe very considerable differences in the colouring matter of the barks of *C. officinalis* and also in the nature of the tannin constituent. As you have already pointed out, the tannin of the red bark has some distinct properties from that of most crown barks. Indeed, the decomposition of Cincho-tannic acid, as lately described by Rembold, while quite accurate for the tannin of *C. succirubra*, is only with great difficulty accomplished with that of the crown barks, and then but imperfectly.

October 31st, 1868.

I easily, as you, found alkaloid in the heart-wood of the Cinchona you so kindly sent me, but it differs in many respects from that which I obtained from the Neilgherry wood of *C. succirubra*. I obtained of moderately pure total alkaloid 0.24 per cent., and after careful purification, in which a certain loss was suffered, 0.18 per cent. Of this only 0.014 per cent. was quinine.

The wood alkaloid of our *C. succirubra* yields a far larger proportion of alkaloid soluble in ether, and I have not hitherto distinctly detected cinchonine in it, though I have cinchonidine.

I send you by this post a report of mine which contains many results of my work. I propose to embody the more scientific part of my results in a memoir either to the Linnean or Royal Society. *Pray make any use, however, of the matter if it should illustrate any of your own remarks in your forthcoming work.* My results, you will observe, on most points corroborate your own.

January 16th, 1869.

I am extremely anxious to have your opinion concerning the lance-leaved kind, from which I have lately obtained the unprecedented amount of 10 per cent. of real Sulph. Quinine.

I am particularly pleased to find that our examinations of the wood agree so closely. It is the more gratifying as in the specimen [from S. America] you sent, the separation of the alkaloid was more difficult than in the fresh woods I have here.

The leaf you sent of *crispa* is markedly different from ours. Our *crispa* has a leathery leaf and strongly marked scrobicules; but it merges into the other varieties, so that only the more typical plants can be positively identified.

There appear to be very numerous varieties of *Calisaya*, even more than of the *crown barks*, just as you mention with your seedlings—trees have leaves from velvety to quite glabrous, and every tint from purple to pale green. You seem convinced of the permanence of the varieties; my own observation is, as you know from previous letters, against it—but the fact of the accurate representation of the old specimens among our trees is, I must own, a strong point.

October 17th, 1869.

I have a set of *crispa* specimens just ready to send you. They will go on Tuesday next through Government. Those marked *a, b, c, d, e*, are all from *crispa* seed. You will, I think, see a gradation in all characters between the marked types. I want your opinion on these. The small specimen is that of the flowers of the "*lanceolata*," which is an imported specimen.

The other specimens, *f* and *g*, are most remarkable; *f* is one I have spoken to you before about, and I have taken pains in respect to it. It is, I believe, a hybrid between *succirubra* and *Peruviana*; *g* is still more remarkable, and I believe it to be a hybrid between *officinalis* and *Pahudiana*. I would not say this, but I have strong grounds. I believe the tendency to hybridism in dimorphic plants is a solution to the enormous variety of differences which you thoroughly perceive, but which you cannot imagine the extent of without seeing the trees growing.

Our *Calisayas* seem likely to become important: they are very beautiful. The velvety surface and colour are exquisite.

April 9th, 1870.

Scrobicules are a most treacherous mark of distinction, and I think should be excluded from the botanical descriptions. The other day I could not succeed in finding a single scrobiculate leaf on any of the crown bark trees growing at Neddiwuttum. The warm climate or some other reason had made the axils of the veins quite smooth.

The varieties among the *Calisayas* are most numerous, exceeding those of the crown barks. The total number of distinct kinds must be indefinite, according to what is considered the limiting distinctions of a kind.

May 24th, 1870.

The few trees that were coppiced have now stood as long almost as the former trees, and these shoots yield bark of good quality. I think this will be the way of treating the plantations hereafter.

July 27th, 1870.

The only fact I have come across of interest lately is that the difference of 1,500 feet quite converts the *Quinine* in certain crown barks into *Cinchonidine*. *Indeed lower than 6,000 feet the officinalis is not a quinine-producing kind, though eminently so at 7,500—8,400 feet.* I cannot find stated anywhere the fact that laticiferous vessels are rarely formed in trunk bark, though common enough in branch bark. This is my experience obtained by the examination of many hundred sections of Indian barks.

Dr. Moens sends me some papers on the Java plantations which show satisfactory results, though obtained from plants originally obtained from our Government. Mr. C. B. Clarke, who came here four months since, spoke very highly of the *Calisaya* of the Bengal plantations which they obtained originally from Java, and which is the same you mention. It is a curious thing, but cinchonas do not like much sunshine, and suffer from drought.

Cinchonas, as you are aware, alter their appearance greatly when planted out. Thus *Calisayas* lose, in a great degree, the lovely velvety aspect of their leaves, though they retain it under glass.

September 19th, 1870.

I analysed some bark of *C. Peruviana*, which, grown at an elevation of 6,000 feet, contains no crystallisable quinine. The tree I examined grew at 7,800 feet, and yielded much beautifully crystalline quinine sulphate, crystallising as readily as the best from *officinalis* or *Calisaya*.

I am perfectly convinced, as I have told you, that your conclusions as to the seat of alkaloid are quite correct.

January 24th, 1871.

I was especially gratified to find that a strong conviction of mine is also shared by you, viz., that it is the quino-tannic acid to which we must look for the origin of the alkaloids. It is, next to the alkaloids themselves, the peculiar product of the *Cinchonæ*; other plants contain quinovic and quinic acid, but nowhere is the peculiar tannin met with.

The crown barks here are getting admirable; 6.50 per cent. of alkaloids and 4.00 per cent. of pure quinine sulphate is a common yield. It is a pity they grow so slowly.

I find as I expected that mossing for a year and a half but slightly improves the bark of the elder trees. The thicker the bark gets, the less influence has the deteriorating effect of sunshine, &c. over it, and the larger part of the bark takes less share in the activities of the plant. There is no doubt a maximum of yield to which the bark tends to approximate with age, and which no artificial treatment will make it surpass.

To return to the tannin. I dare say you find, like me, certain differences in the tannin from the various kinds of *cinchonæ*. As they are such indefinite substances they are very difficult to deal with, for one is never certain that one has them quite pure.

May 28th, 1871.

I believe myself that the extended cultivation of Red Bark will be found a mistake. Our Crown Bark is of much finer quality, though containing somewhat less total alkaloids.

January 15th, 1872.

I have lately made examinations of two sides of a trunk, and find that the sunny side had 0.80 per cent. less alkaloid than the shady. The difference, moreover, was mainly Quinine. I have made two sets of examinations with similar results.

Among all seedling plants, it is remarkable to observe the number of hybrids that are appearing. I have made numerous analyses of their bark, but have not discovered any special excellence—generally the reverse.

July 29th, 1872.

There is a good deal of disease (canker) showing on many of the Indian plantations, besides Darjeeling. I am glad to say there is none on our Government plantations. The tree, strange to say, seems exceedingly impatient of too wet a climate, in which it at first grows with great rapidity and lankness, until canker stops it.

November 7th, 1872.

The *officinalis* bark, of whose difficulty of purification from alkaloids you complain, is grown at too low an elevation. The *officinalis* barks grown above 7,000 feet, are free from that serious objection, and moreover contain more Quinine.

I have examined some root bark, lately, of *officinalis*, grown at 7,400 feet. It contained no less than 7.65 of alkaloids; but only 0.40 was Quinine. In fact it was nearly all Cinchonidine or Cinchonine. This is a singular fact.

February 13th, 1873.

Respecting the hybrids, I think no one can doubt their formation. Exactly intermediate plants between *officinalis* and *succirubra* appearing in great numbers only among seedlings (there being none among the original trees), seems to leave scarcely room for doubt. Java and Darjeeling have them equally plentifully.

I am getting prejudiced against the Red Bark, in which the amount of alkaloid is beginning to diminish somewhat, and the Cinchonidine to be somewhat replaced by Cinchonine. It is passing thus through the changes you foretold.

November 21st, 1873.

I am very glad to learn that you have an example of the extreme variability of *Cinchona* from seed. What I sent you was gathered from two trees of the same red-underleaved variety of *Calisaya*. Around them were growing the many other varieties of this species, which are quite as diverse in appearance as the seedlings you describe.

If Cinchonidine were more used it would be of enormous benefit to the Indian plantations. I have recommended that more attention be paid to *Calisaya*, in which, I see you agree with me. Some Java bark I received, I found extremely fine, the seed being the same as ours.

July 20th, 1873.

I have lately come to the conclusion that our eldest Red Bark has slightly passed its maximum of yield, and I fear your predictions of its deterioration are already somewhat realized. Many years will elapse before it affects the total bark of the trunk, but I have stated it to Government, though I may be mistaken in the present slight diminution. Further more, *Cinchonine* is increasing at the expense of *Quinine* and *Cinchonidine*. *Officinalis*, on the contrary, is still improving.

Some root bark of *officinalis* yielded me 11.17 per cent. of alkaloids mostly Cinchonine; but I obtained 3.54 per cent. of pure Sulphate of Quinine, and 4.40 of Sulph. Cinchonidine. I consider this a remarkable result, and that it quite corroborates Dr. de Vrij's examination of *Pahudiana* roots. I cannot but consider the darkness in which it is grown as the main reason of its richness.

APPENDIX D.

ON ALLIED VEGETABLE SPECIES. BY ALEXIS JORDAN. 1873.

Remarks on the fact of the existence, in association in a wild state, of Allied Vegetable Species; and on other facts relative to the question of Species. By ALEXIS JORDAN. Read at the Congress of the French Association for the Advancement of Science, at Lyons, 28th August, 1873.

The study which I have made of the plants of France during a long course of years, in the special point of view of the exact limitation of species, has enabled me to certify the existence of very numerous species—that is to say, of distinct and permanent vegetable forms, which until then had not been observed by botanists, or had been misunderstood or neglected by them. I have been able to gather them together, for the most part under my cultivation, in order to observe the distinctions in a living state and to assure myself of their permanence.

* * * * *

It must be admitted that if the species of our Floras, known under the name of Linnean types, are truly the actual specific types, giving us the exact measure of what a species ought to be, the new vegetable forms, presented with the title of species, as a dismembering of the Linnean types, are far from offering a value equal to those of these last, and cannot be placed in the same rank. But there remains the question, whether these secondary forms being distinct, permanent, hereditary, and irreducible amongst themselves, are not on the contrary the only true and legitimate species; whilst the types arbitrarily established by Linnæus, or his followers, are nothing else than purely ideal or factitious species, having no real existence anywhere; and which ought to be considered as an assemblage of specific forms, and which may be considered eventually as genera, or sub-genera in a new and more scientific classification.

The fact of which I wish to speak, is the existence in society of the sociability (if I may be allowed the expression) of similar vegetable forms established at the expense of the ancient types of our Floras, of those which we call Linnean types.

Having observed in their different stations, during more than thirty years, a crowd of vegetables of all families and of all descriptions, of annual or vivacious plants, bulbous or aquatic, trees or shrubs, I have been able to ascertain almost everywhere that when a Linnean type, truly indigenous in a country, was common there to such an extent that it could be cited among the characteristic plants of the vegetation of a certain extent of territory, this type was almost always represented by different forms growing in society and *pêle-mêle*. The superficial observer, who examines the country, is only struck with the resemblance of the different forms; he does not perceive their differences; or attaching no importance to them he does not stay to consider them attentively; he thinks that he has only to do with one only type, susceptible of some modifications accidental and without value. Whilst he who observes with attention may easily convince himself on the spot, that these apparent modifications are found again in many individuals, which are all perfectly alike amongst themselves. If in order to continue and complete his observation, he takes up living examples of each of the forms which he has been able to distinguish, and plants them again in one place, in order to follow them in all their developments, he will soon convince himself that they present appreciable differences in all their organs. If he sows the seed, he will see them reproduce their characters with a perfect identity.

In the same way that the different vegetable families, as well as the greater part of the most considerable genera, have, as it were, a centre of vegetation on certain points of the globe, when they offer representatives more numerous than elsewhere, the Linnean types, which are in some sort genera of an inferior order, have also centres of vegetation in which the similar forms which constitute them are more numerous than elsewhere and grow in society. As they recede from their centre, their forms present themselves with notable specific differences; but their number appears to go on diminishing. In a word, we may say that the groups of similar forms are submitted in relation to their distribution to a law quite analogous to that of which we remark the effects in the study of families and of the great genera.

Independently of the fact of the existence in society of similar species, there is another which it is important to notice here; it is that these species have no tendency to create hybrids spontaneously amongst themselves. It is known from the observations of many observers, that spontaneous hybridizations take place almost always between types relatively markedly distinct, rather than between species offering much affinity.

* * * * *

Although hybridity operates almost always between very distinct types, I am far from affirming that there are not cases, particularly in certain families, in which it has not a more general action on the numerous plants reunited in a garden. One only species may besides fecundate many others, and throw disorder into a whole collection. For practical florists, there is here sometimes a precious advantage; but for the botanist who seeks to assign limits to species, it is a veritable plague; for hybridity introduces confusion, and chaos reigns wherever it plays a part and gives fertile products. That which is best to be done, in this case, is to destroy the hybrid subjects and to throw away their seeds. In order to recommence the study, it is necessary to have new seeds and new subjects.

The products of hybridity, when they are fertile, being characterized by an indefinite variability, it becomes easy to effect in cultivation the trial of specimens which are the issues of hybridity. It suffices, for this purpose, to sow the seeds of different sorts of plants or trees, taking care always to collect the seeds to be sown from one stock only, after having assured oneself that these seeds cannot be the product of a new accidental hybridization. If the seeds offer a mixture of forms, we may conclude infallibly that the seeds proceed from a hybridized subject; whilst, in the contrary case, the seed shewing itself perfectly pure, we shall be sure to have obtained a true species.

Those who are accustomed to seed cultivation, know that it is very easy to see whether a young seedling is pure, or whether it contains a mixture.

The allied or similar species established at the expense of the Linnean types are not only social, they are further hereditary, and this second fact, which is not less of capital importance than the former, is equally certain, equally easy to prove.

I have said that the allied species are very numerous. According to the details which I have been enabled to collect, and which are still very incomplete, in relation to the vegetation of France, I do not think that I make an exaggerated computation, in admitting that the number of species actually described in our Floras may in the end be multiplied tenfold. I have already been enabled to show, that there exists in France a considerable number of centres of vegetation, in which each Linnean type is represented by one or many similar forms, distinct from those of other centres. I have been able to compare some hundreds of species received in a living state from the environs of Paris, and I have found, in cultivating them, that they were for the most part different from those of the environs of Lyons, which bear the same Linnean name. The comparison of the plants of the West, of those of the Vosges, of Cantal, of the Pyrenees has afforded me analogous results. Even at Lyons the plants of the Lyonnais, properly so called, are almost all specifically distinct from those of the region of the Jura, which borders upon Lyons. I will say more: I am almost certain, according to the results of my researches, that there is not, I will not say a province or a department, but even a little territory of more or less original character, which cannot offer a certain number of species, which are special to it, which are found only there and not elsewhere.

In like manner R. Cross remarks in one of his letters about the barks of Loja:—

“There was another species, apparently new and very scarce, growing on the sides of such tremendous ravines, that to collect it would require a balloon. It was quite local, for a few miles to the southward begin the *arenales* of the deserts of Peru.”

LATEST FROM INDIA.

An unexpected delay in the completion of this volume enables me to give my readers the advantage of the most recent facts bearing on the questions discussed.

From the *Ceylon Observer* of May 2, obligingly sent by Mr. Ferguson, I learn a statement copied from the *Darjeeling News*, “that in the case of the large plantation of Poomong, owned by General Angus and Mr. Lloyd, over 2,000 acres of which Cinchonas are scattered, the trees are to be rooted up and the land divided and sold in blocks for the more successful culture of tea.” I have no doubt that this is a wise measure, but cannot quite reconcile the previous reports (see page 109) with such a result. This is no doubt a step in the right direction, which will probably be followed by other proprietors of unproductive plantations, especially of *C. succirubra*.

The Editor gives as one of “the main conclusions which seem inevitably to follow from the experiments made and the information obtained” by Dr. King, that “in the far south to Mongpoo and Rungbee, in the far north on the slopes of the Himalayas, *C. succirubra* has been the most successful and the most largely propagated.” But if the greatest success issues in the above result, it would seem more economical not to begin at all those plantations which must be rooted up in the end.

Dr. King hopes much from the introduction of the preparation of the mixed alkaloids, for which there is, no doubt, room in India; at least in the way of gratuitous distribution.

My chief interest is in reference to the Calisaya. I have mentioned at page 73, that the Indian Government were sending home for public sale in England a quantity of Cinchona bark, which proved to amount to 642 packages sold in London by auction, May 9, 1876.

This included 5 bales of *Calisaya bark*, called by the misleading designation “*natural yellow*”! These I have examined with much interest, as I have failed hitherto to find any proof that the Ledgeriana is cultivated at all in British India. I meet with a confirmation of my suspicions in this parcel, which, though of very good quality, has not at all the appearance of the Java Ledgeriana, and is little more than half as rich. It quite reproduces a fine sort of Bolivian Calisaya which I have taken for Dr. Weddell’s (unpublished) *Naranjada*; of which I have specimens from the Doctor. The contents in alkaloid are just the same as the *C. officinalis* of my introducing; but the Calisaya is reported to assume a spindly character of growth at Ootacamund and, perhaps, is less suited to the climate.

In this sale the “renewed crown” sold for 6s. per pound; the “mossed crown” from 4s. to 5s. 10d.; the “natural crown,” 4s. 8d. to 6s.; the “natural red,” 1s. 6d. to 2s. 5d.; the “renewed red,” 3s. 4d. to 4s.; the “mossed red,” 1s. 11d.; the “broken branch crown,” 1s. 8d. to 1s. 10d.; the “natural yellow,” 4s.

APPENDIX E.

LATEST INTELLIGENCE FROM THE PLANTATIONS IN JAVA.

FOURTH QUARTER, 1875.

ANALYSES.

Number	Sort of Bark	Place of Growth	Water	Neutral Tartrate of Alkaloid dried at 100° Cent.	Quinine	Cinchonidine	Quinidine	Cinchonine	Amorph. Alkaloid	Total Alkaloid	Sulphate of Quinine as computed
28	Cinchona succirubra	Tjiniroean	10.70	9.32	0.35	7.15	—	2.31	0.49	10.30	0.47
29	" "	" "	12.72	11.30	1.60	7.46	—	1.66	1.70	12.42	2.15*
30	" "	" "	13.24	11.17	0.67	8.27	—	2.06	0.60	11.60	0.90
31	" "	" "	13.48	9.59	1.64	6.05	—	1.36	1.06	10.11	2.20*
32	" "	" "	14.74	9.66	0.30	7.45	—	2.46	0.76	10.97	0.41
33	" "	" "	13.27	8.33	1.46	5.23	—	1.75	1.39	9.83	1.97*
34	" "	" "	13.76	8.89	0.72	6.40	—	2.43	0.72	10.27	0.96
35	" "	" "	13.39	8.90	3.00	4.16	—	1.60	1.61	10.37	4.05*
36	" "	" "	13.38	11.89	0.60	8.92	—	2.12	1.03	12.67	0.80
37	" "	Rioeng-Goenoeng	12.54	8.11	1.00	5.50	—	1.82	0.52	8.84	1.34
38	" "	Nagrak	11.38	6.25	0.60	4.42	—	1.81	0.49	7.32	0.80
39	" "	Tji-Bitoeng	11.52	5.77	0.85	3.80	—	2.35	0.73	7.73	1.14
40	" "	Tjiniroean	11.90	7.78	1.14	5.13	—	2.11	0.91	9.29	1.52
41	" "	" "	10.85	4.82	0.91	2.97	—	1.89	0.81	6.58	1.23
42	" "	" "	10.00	5.04	0.97	3.85	—	3.00	0.93	8.75	1.30
43	Calisaya Ledgeriana powder	" "	15.56	4.54	3.62	—	—	0.39	0.58	4.59	4.89
44	" "	Tjiberem	16.65	4.04	3.30	—	—	0.42	0.42	4.14	4.43
45	" "	" "	17.02	4.56	3.68	—	—	0.24	0.55	4.47	4.95
46	" "	" "	12.67	8.29	6.73	—	—	0.45	1.13	8.31	9.05
47	" "	" "	12.10	4.82	3.91	—	—	0.15	1.46	5.52	5.26
48	" "	Rioeng-Goenoeng	12.00	9.00	7.20	—	—	0.41	0.55	8.16	9.69
49	" "	" "	12.64	6.31	5.00	—	—	0.70	0.32	6.02	6.73
50	" "	" "	14.44	10.31	8.24	—	—	0.78	0.75	9.87	11.09
51	" "	" "	13.57	9.87	7.81	—	—	0.59	0.37	8.77	10.52
52	" "	" "	12.37	14.00	10.72	—	—	0.27	1.29	12.28	14.42
53	" "	" "	12.00	10.02	7.70	—	—	0.17	0.62	8.49	10.36
54	" "	Tjiberem	14.85	9.36	7.40	—	—	0.28	0.72	8.40	9.96
55	" "	" "	13.00	9.24	7.50	—	—	0.58	0.55	8.63	10.09†
56	" "	" "	13.24	11.10	9.00	—	—	0.16	1.40	10.56	12.11
57	" "	" "	11.81	5.40	4.39	—	2.00	0.38	1.14	7.91	5.91
58	" "	" "	13.00	12.27	9.85	—	—	0.61	1.40	11.85	13.26
59	" "	" "	10.00	9.15	7.43	—	—	0.30	1.10	8.83	10.00
60	" "	Nagrak	11.94	12.00	9.20	—	—	0.13	1.19	10.52	12.38
61	" "	Schuhkraft	13.42	—	—	—	0.80	2.59	0.36	3.75	—
62	" "	root-bark	13.69	0.41	traces	0.30	1.28	3.94	0.57	6.09	—
63	" "	Bolang	12.86	1.29	0.81	0.23	—	1.61	0.88	3.53	1.07
64	" "	Loeboe-Radja	13.14	1.45	1.18	—	0.16	2.02	0.61	3.97	1.59
65	" "	Tjiniroean	13.57	0.96	0.76	—	1.10	1.79	0.68	4.33	1.02
66	" "	" "	11.59	1.86	1.41	0.10	0.27	1.28	0.33	3.39	2.01
67	" "	" "	12.28	0.60	0.49	—	1.51	0.98	0.64	3.62	0.66
68	" "	Tji-Bitoeng	11.70	1.87	0.88	0.63	0.15	0.85	0.78	3.29	1.18
69	" "	Rioeng-Goenoeng	11.51	1.11	0.60	0.30	0.46	1.43	1.14	3.93	0.80
70	" "	Tjiberem	11.82	1.23	0.73	0.26	0.27	1.50	1.05	3.81	0.98
71	" "	" "	11.01	1.13	0.66	0.26	—	0.84	0.52	2.28	0.89
72	" "	Tjiniroean	12.06	2.78	1.56	0.70	—	0.65	0.27	3.18	2.10
73	" "	" "	12.44	0.40	0.32	—	1.07	0.81	0.61	2.81	0.43
74	" "	Rioeng-Goenoeng	12.81	1.04	0.56	0.28	0.20	1.05	0.75	2.84	0.75
75	" "	Tji-Bitoeng	12.18	1.16	0.63	0.31	—	0.86	0.53	2.33	0.85
76	" "	Tjiniroean	12.27	3.24	1.53	1.09	traces	1.25	0.44	4.31	2.06
77	" "	" "	12.31	0.81	0.44	0.22	1.33	1.51	0.60	4.10	0.60
78	" "	Tji-Bitoeng	10.86	2.77	1.01	1.22	0.32	2.34	0.64	5.53	1.35
79	" "	Tjiberem	10.65	2.95	1.09	1.29	0.27	1.42	0.79	4.86	1.47
80	Pahudiana	Tjiniroean	13.75	3.91	0.24	2.90	—	0.61	0.43	4.18	0.32
81	" "	" "	14.00	2.27	1.84	—	—	1.65	0.24	3.73	2.47
82	Officinalis	" "	13.85	5.74	3.51	1.14	—	0.18	0.77	5.60	4.72
83	" "	" "	13.22	9.61	5.01	2.78	—	0.22	0.91	8.92	6.74
84	" "	harvest	12.58	6.37	4.24	0.92	—	0.15	0.72	6.03	5.70
85	" "	Kawah-Tjiwedei	13.57	7.61	1.37	4.82	—	0.79	2.00	8.98	1.84†
86	Hasskarliana, harvest, 1st sort	Tjiniroean	12.23	2.42	1.55	0.40	0.10	0.59	0.61	3.25	2.08
87	" "	Tjiberem	10.06	2.66	1.50	0.66	0.27	1.42	0.30	4.15	2.01
88	" "	" "	11.82	1.63	0.94	0.38	—	0.60	0.67	2.59	1.25
89	" "	Tjiniroean	12.04	1.22	0.53	0.45	0.28	0.48	0.26	2.00	0.71
90	" "	" "	11.82	5.10	2.63	1.49	—	0.71	0.88	5.71	3.54
91	" "	Tjiberem	11.44	2.87	1.61	0.71	0.29	2.13	0.92	5.66	2.17
92	Ledgeriana (?)	Rioeng-Goenoeng	14.81	1.92	0.97	0.76	—	0.22	0.21	2.16	1.30‡

* Renewed bark. † From fifty to sixty all blossoming and seed-yielding trees (average of S. Quinine in the bark, 10.91 per cent.)

‡ Hybrid between succirubra and officinalis.

|| Apparently a hybrid.

The weather seems to have been, on the whole, favourable, though some damage had been done by rough winds from the north and north-west. The Ledgeriana trees began (in December) to blossom freely, and give hope of a rich harvest of excellent seeds. The total number of trees of all kinds amounted to 1,998,369, (by the still later accounts over two millions.)





W. H. Fitch, del. et lith.

J. N. Fitch, imp.

CINCHONA CALISAYA, var. LEDGERIANA, (How)
'Macho' form (A)



W. H. Fitch, del. et lith.

J. N. Fitch, imp.

CINCHONA CALISAYA, var. LEDGERIANA, (How.)
"Hembra" form (B.)



W. H. Fitch, del et lith.

J. N. Fitch, imp.

CINCHONA CALISAYA, var. LEDGERIANA, (How)
form (C)

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J. N. Fitch imp.

"Calisaya Javanica."
(Hasskarl's)



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"Calisaya Javanica,"
(Schubkraft's)



BIBLIOTHEQUE
D'HERBARIUM
DE LYON

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J. N. Fitch lith. et imp.

CINCHONA JOSEPHIANA,
var. *a glabra*, (Wedd.)



W.H. Fitch, del.

J.N. Fitch, lith et imp.

"Calisaya Anglica,"
(hybrid)



W.H. Fitch, del.

J.N. Fitch, lith. et imp.

CINCHONA OFFICINALIS,
var. *γ* Bonplandiana, b. lutea, How.
"Amarilla del Rey."



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W. H. Fitch, del.

J. N. Fitch, lith. et imp.

CINCHONA PITAYENSIS, Wedd.
1 Anaranjada fina.
2 Roja del Pñon de Pitayo.
3 Quina anaranjada from La Cruz
4 Amarilla del huevo



W.H. Fitch, del. et lith.

C. GRANDIFLORA (Ruiz & Pavon.)

J. N. Fitch, imp.



W. H. Fitch, del.

J. N. Fitch, imp.

CINCHONA LANCIFOLIA,
δ. Calisaya (Sta Fé,) Wedd.



Ricreux, del.

J.N. Fitch, lith. et imp.

CINCHONA CALISAYA,
β. microcarpa, (Wedd.)

