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THE TEA PLANTER'S VADE MECUM.

THE

TEA PLANTER'S VADE MECUM:

A VOLUME OF IMPORTANT

ARTICLES, CORRESPONDENCE, AND INFORMATION, OF PERMANENT INTEREST AND VALUE,

REGARDING TEA,

TEA BLIGHT, TEA CULTIVATION AND MANUFACTURE,

TEA MACHINERY, TIMBERS FOR BOXES

AND OTHER PURPOSES,

WITH A PRACTICAL TREATISE ON

THE USE AND CARE OF STEAM ENGINES IN TEA FACTORIES:

The whole Work brought up to the latest date,

AND HAVING

A Classified Synopsis of Contents, and a Copious Index.

COMPILED BY

THE EDITOR OF THE "INDIAN TEA GAZETTE."

Calcutta:

PUBLISHED AT THE OFFICE OF THE TEA GAZETTE,

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PREFACE.

It is hardly necessary to say much as a PREFACE to this WORK. The CONTENTS will speak for themselves.

The Compiler can only say that he has spared no pains to include in this VOLUME everything of value to TEA PLANTERS, and has endeavored, by most careful classification, and a very full INDEX, to render the varied Information and Instruction given, as easy for reference as possible.

CALCUTTA,
September, 1885.

THIS VOLUME

IS RESPECTFULLY DEDICATED TO

THE MEMBERS OF THE INDIAN TEA INDUSTRY,

BY

Their Humble Servant and Fellow Worker,

THE EDITOR.

September 1885.

MEMO.

---:o:---

The Editor of the Tea Planter's Vade Mecum will be glad to receive the opinions of Subscribers as to the present Work, with any suggestions they may be pleased to favour him with, which he might be able to adopt in any Second Edition of the Book that may hereafter be published.

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SYNOPSIS OF CONTENTS.

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REMARKS ON THE SYNOPSIS OF THIS WORK.

THIS VOLUME, for greater convenience of Reference, has been divided into SECTIONS, with separating Half-titles showing the contents of each Section.

The first Section is devoted to a brief Historical and Descriptive Account of TEA, and of the Several Indian Tea-producing Districts, —their speciality as regards suitability of Soil, Climate, &c., for TEA CULTIVATION.

The Second Section treats of FORESTS, and their influence on Climate, Drought, and Rainfall, of which latter a Table is given showing the Latitude, Longitude, and Rainfall, of Principal Tea Localities.

The third division of the WORK is devoted to a Chapter on the Botanical Origin, Chemical Composition, and Analysis of TEA.

Section IV. treats of the various forms of Adulteration known, and especially as practised in Foreign Markets; to which is appended an account of *Substitutes* not seldom passed off as TEA.

Part V. deals with SOILS, their nature and properties, and indicates the essentials of good Soils for TEA.

The important subject of MANURING occupies Section VI. of this WORK, and the best kinds of Manure, and their mode and time of application, are treated of.

Section VII. deals with the important subject of DRAINAGE; and the different sorts of Drainage desirable for different Soils are indicated.

Next comes TEA SEED and TEA SOWING, which Chapter deals with the selection and sowing of Seed, upon due attention to which so much of the success of all Nurseries must depend.

In Section IX. the subject of TRANSPLANTING is discussed. As much of the success or failure of an Estate depends on the way the Tea-bush is planted and cared for when young, too much attention cannot be given to this matter, and if the Instructions copiously given be only followed, there will be little fear of miscarriage.

Section X. discusses the important question of the influence of the SAU-TREE as a *Tea-fertilizer*, regarding which there have been so many different opinions mooted.

The subject of CULTIVATION is dealt with in Section XI., and this Chapter embraces all the best-known Opinions as yet recorded, from which, also, the relative merits of Light *vs.* Deep Hoeing, according to circumstances, will be readily seen.

BLIGHT, that dread enemy of the Tea-planter, occupies a Section, also, by itself, in which the various forms of Blight, and their best-known modes of treatment, will be found detailed.

The question of PRUNING, regarding the mode and extent of which there is so much difference of opinion, will be found fully referred to in Section XIII.

PLUCKING occupies the next Section, and the relative merits of Coarse *vs.* Fine Plucking are discussed. The subject is one of much importance, as affecting the price which our Teas fetch in the London market, and also the yield which it is our object to obtain. It raises the much vexed question of QUALITY *vs.* QUANTITY, regarding which, as in most other matters, a judicious *medium* will be probably found to answer best.

BUILDINGS, their form, material, and arrangement, comprise the contents of Section XV., and although this Chapter will apply more particularly to those entering for the first time upon TEA, it will serve of utility also to those who find, as time goes on, and Estates expand, re-construction of Buildings necessary.

As all large Factories now use Steam power, the knowledge of how to manage it most profitably and safely becomes of essential importance; and instruction on this topic being difficult to obtain, it is believed that the inclusion of the very practical Articles contained in Section XVI. will be read with much profit.

As MACHINERY, also, is now fast superseding hand-manufacture in TEA, and is bound in time wholly to do so, even on small Estates, the particulars given of the different Inventions, and the review of their relative merits, cannot but prove of much interest. Opinions will of course differ as to which is the best form of machine for the different purposes of Tea-manufacture, but the rival claims of the several Inventors who have as yet come forward will be found herein impartially discussed; and those who may be for the first time introducing Machinery into their Factories, or those who may be renewing or adding to their Plant, will find, it is hoped, in this division of the WORK, ample information to guide their choice, according to circumstances surrounding.

As regards the subject of MANUFACTURE, there are, as is well known, diverse opinions and systems; but there remain primary Rules which should govern all; and these will be found fully set forth in Section XVIII. The Discussion contained in this Volume on the relative systems of Withering, Rolling, Fermentation, and Firing, are profitable reading, and much may be learnt, even by the experienced, from the varied opinions herein set forth.

The advantage of correct BULKING, to meet the requirements of the Home Trade, needs hardly to be impressed upon Managers, but as the new Regulations now in force are greatly in favour of owners, if carefully complied with, we commend the remarks in this Section (No. XIX.) to careful notice.

It has long been notorious that our heavy and unsightly PACKAGES meet with much disfavour at home, although the Trade have had, hitherto, to put up with them; but they like them none the better for that, and it should be borne in mind that a reform in this respect is being attempted in Ceylon by the use of a new wood obtained from Japan, of which Tea-Boxes are now being manufactured. *Cryptomeria Japonica* bids fair to supersede all other woods now in use, and we should strongly recommend a trial of it being made in India. The Section on TIMBERS for TEA Boxes, &c., contains evidence of the necessity for more caution being exercised in this country in the selection of our Box-timbers, and we would strongly advise an experiment being made with *Cryptomeria Japonica*, which has already been adopted to some extent in Ceylon, where the Agency for this new introduction is located. A reference to a Colombo House would secure full information on the subject, and may be well worth the making.

Meanwhile, as long as we use Indian Timbers, it is well that we should select the best only, and those most suitable for the purpose; and Mr. Peal's Paper on this subject, in SECTION XX., cannot be too carefully studied.

Turning, now, to FOREIGN MARKETS for our Tea disposal, we may draw attention to the necessity which exists, even more than it does at Home, for adapting the size of our Packages to the wishes of the Trade in the Colonies and Abroad. It has been repeatedly pointed out in the *Tea Gazette* that, for shipment to Australia, whole chests are a mistake, but still they continue to be largely forwarded. Why will people not learn from experience ? The Chinese, finding that there is a prejudice in favour of small packages, in the Colonies, have already adapted themselves to the necessity ; but India still blunders on. and sends the largest proportion of her TEA forward in the unsightly and undesirable heavy packages, as formerly. This may seem a small matter of complaint, as it is the *Tea* which is purchased for its quality, and not for the look of the Box in which it is contained. Never mind : prejudice is a strange thing, and one difficult to overcome ; and as it costs so little to yield to it, in this case why not do so ? We commend, therefore, to the notice of the Reader the remarks on this subject given in Section XXI. of this WORK, as also the new Rules now in force as to TEA WEIGHMENT at the Custom House in London, attention to which will save owners from having the bulk of their Teas turned out (and possibly largely pilfered from) in the Bonded Warehouses at home. It seems strange to have to enforce such advice, but, according to the brokers at home, quite insufficient attention is still paid here to the means of avoiding what is at present a great drawback in respect to the weighment of Indian Teas.

Although TEA in INDIA out of BENGAL does not constitute a Trade of very great importance, it is still such as to require a place in this WORK, and it will be found sufficiently touched upon in Section XXIV.

When we come, however, to Section XXV. (TEA IN CEYLON), it will be seen with how much reason we have to regard the steady advance of that Island. We do not write this with any desire to create jealousy of feeling, but rather with the object of stimulating Planters in this Country to maintain their high position to the fullest; so that, in a spirit of fair and honest rivalry, each may strive its utmost towards perfection in Cultivation and Manufacture; and although India is by a long long way the Elder Brother, still, in these days of Competition, MERIT is bound to carry all before it; and a good name may stand to become weakened if others establish a claim to a still better one. There is, doubtless, room for both Ceylon and India in the World's markets, and there is no reason why they should not advance hand in hand and side by side; but we must not ignore the growing advance of our Younger Brother, or shut our eyes in any way to the progress in TEA which Ceylon is making. Rather let us show a *knowledge* of this fact by strenuous endeavour to hold, still, a leading position, based not only upon maturer years, but upon the fullest exercise of that maturer Knowledge which we should possess, and should seek in every way to improve, further, to the utmost.

Of the concluding Section of this WORK, we need only remark that although not referred to for any exact imitation, it has been thought that something may still be learnt from our old-world neighbours, China and Japan, in respect to their painstaking system of Manufacture; for, with us, the use of Machinery is apt to cause us to become somewhat careless in the matter of perfect manipulation, which even the most scientific Machinery does not enable us to disregard the necessity for. There is manipulation, although of a different kind, required with Machine-manufacture as there is with Hand, and it is to the attention which we pay to this matter that we have to look for equally good results in our machine-made Teas as was able formerly to be so successfully obtained by hand: indeed, it may be said that the use of Machinery in Manufacture entails upon us the need for *increased* attention, so that, while we provide more efficiently for the disposal of our greatly-increased and increasing outturn, we do not neglect in any way that closeness of supervision in manipulation, in its every detail, which rendered our Hand-made Teas the finest in the World.

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Renandin Bollinger & Cie—Very dry, clean: a perfect wine for India ..	60	0	64	0
Perinet et Fils, Vin Brut ...	62	8	66	8
Do Cuvée Resorvée, choice and dry	56	0	60	0
Do. Carte Noire, a nice light wine, dry	52	0	56	0
Fleur de Sillery—a fine light dry wine, selected for India ...	48	0	52	0
Ditto ditto, ½ pints	15	0		
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Ditto ditto, 2 ,, pints, nett	,,	38	0

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CHATEAU LEROC ST. ESTEPHE: a very full and mellow after-dinner wine ...	,,	29	0
CHATEAU BROWN CANTENAC: an exceedingly choice *light* after-dinner wine, of great bouquet and character ...	,,	46	0

INTRODUCTORY.

THE aim of the Compiler and Editor of this WORK has been to place before TEA PLANTERS as exhaustive an Epitome of Information and Instruction on TEA and TEA MATTERS, as possible; and to present to the Reader the latest-known Facts, in regard to CULTIVATION and MANUFACTURE, in a concise and easily-referable form.

MACHINERY, also, now plays such an important part on TEA ESTATES, that it has been felt desirable to give a prominent place to this Subject; and the professional Papers herein contained on MACHINERY, and on STEAM ENGINES IN TEA FACTORIES, will doubtless prove of much practical utility, as the Topic has been specially treated by its author in very clear untechnical language. It is believed, therefore, that these Sections of this Volume will not be found in any sense "dry reading," but will afford a desirable aid in respect to the varied knowledge which the Manager of a Tea Estate now finds it needful to possess.

Another Subject which has been dwelt on, intentionally, at some length, in this Volume, is that of TREES and TIMBERS, and TIMBERS for TEA-BOXES. The Planter is so largely dependent on WOOD for Buildings, Fuel, and Boxes, that full information on this head cannot but prove of much advantage; while the scare which not long ago took place in regard to the use of INJURIOUS WOODS for TEA-BOXES renders a special treatment of this Division of the WORK very opportune.

When the Tea Plant was first introduced into this Country, few could have conceived the extent and importance which the INDIAN TEA INDUSTRY was destined to attain; but that extent and importance is now palpable, and admitted; and the fact that it is found practicable to maintain a SPECIALIST JOURNAL devoted solely to the TEA INTEREST is one proof of this, as is the production of a VOLUME like the present, another.

The tide of progress of TEA IN INDIA has by no means yet reached its flood; for although the golden dreams once indulged in have departed, to be indulged in no more, yet the INDUSTRY has now settled down into a condition of safe permanence, and of probable gradually-advancing Prosperity. To further this, it is, however, necessary that we should "keep all our wits about us," seek to increase and improve our knowledge of CULTIVATION and MANUFACTURE in every way, and meet the danger of over-production by the utmost practice of judicious improvement and economy in all directions and branches. And lastly, not to believe, any of us, that we have no more to learn from our neighbours: for truly, in the matter of TEA, "in the multitude of counsellors will be found wisdom:" for Facts and Information present themselves in so varied a form, yet under circumstances and surroundings apparently so nearly similar, that it requires constant watchfulness to enable us successfully to grapple with difficulties as they arise. Interchange of idea and community of knowledge on the many divisions of TEA CULTIVATION AND MANUFACTURE are, thus, of great importance, and can only tend largely to improve the condition of the INDUSTRY, and of all engaged in it.

It is hoped, therefore, that this WORK may have the effect not only of still further stimulating those who are striving in every direction to increase and maintain the high reputation of INDIAN TEA, but that any who may not hitherto have been so active workers will lend their aid, with increased zeal, towards placing and maintaining in the highest position

THE TEA INDUSTRY OF INDIA.

SECTION I.

HISTORICAL AND DESCRIPTIVE.

Historic Notes on Tea.

The Indian Tea Industry: its past and present.

Indian Tea-producing Districts.

THE

TEA PLANTER'S VADE MECUM.

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HISTORIC NOTES ON TEA.

SOME interesting information on this head is furnished in a newly published Work by the learned Swiss botanist, Professor A. de Candolle. A legend, originally related by the Dutch traveller Kœmpfer, of a Buddhist monk, who came to China from India some time during the fifth century of the Christian era, and, in vexation at having slumbered during a night of vigil and prayer, cut off his eyelids, whence, forthwith, sprang up two tea-plants, has often been repeated in popular Works as not only prefiguring the anti-somnolent properties of the leaf, but as affording traditional evidence of the source and probable period of introduction of the Tea-plant into the Flowery Land. Unfortunately for this view, the legend, it seems, is wholly unknown in China, whilst the plant itself has been known there from ages far more remote. Dr. Bretschneider, physician to the Russian Legation, Pekin, who has made many valuable researches in Chinese literature, states that Tea is mentioned 2700 B. C. in a Chinese compilation known as the *Pent Sao*, and likewise in another, the *Rhya*, which dates from 500 B. C. to 600 B. C.; whilst a native commentator on the latter Work, writing A. D. 400, gives full details of the Plant and of the modes of infusion still in use. Its antiquity in China is therefore very great. In Japan it may be of later introduction; but neither there nor in Cochin China, where it is probably of high antiquity, is there any tradition of its introduction from India. Its name is unknown in Sanscrit, as in the various dialects of modern India. The cultivated Plant spreads its seeds readily, and thus runs wild—*verwildert*, as the German botanists say—so that naturalists are much at variance as to the actual spontaneity of the specimens alleged to have been found growing wild in different parts of China and Japan. A better established fact appears to be, that the plant has been found, in an apparently indigenous state, by English travellers in Upper Assam and Cachar.

INDIA: THE HOME OF THE TEA PLANT.

It is now about 50 years since the indigenous Tea tree was discovered growing wild in the forests of Assam. These forests clothe the hills which form the boundary between India and China, and it is a fair assumption that the plant or its seed was, thousands of years ago, exported from India into China, where it has become an important Industry. Tea has not been cultivated in India for many years, the oldest Company, the Assam Company, having only been founded in 1840. It is now cultivated in a dozen different parts of India, hundreds of miles apart, some being on the north-east or east, others in the north-west or south of India. The chief Tea-producing Countries of India are Assam, Cachar, and Sylhet, Chittagong, Chota Nagpore, Darjeeling, Dehra Doon, Dooars, Kangra, Kumaon, Neilgherries: also, Ceylon. Upwards of 240,000 acres of jungle have been cleared by our countrymen in India, and planted with Tea, employing over a quarter of a million people in the cultivation.

Origin of Tea in India.

The cultivation of Tea in India commenced within the memory of men still living, and the Industry now surpasses even indigo as a field for European capital. Unlike coffee-planting, the Enterprise owes its origin to the initiation of Government, and it has never attracted the attention of the natives. Early travellers reported that the Tea-plant was indigenous to the southern valleys of the Himalayas; but they were mistaken in the identity of the shrub, which was the *Osyris nepelensis.* The real Tea *(Thea viridis)*, a plant akin to the camellia, grows wild in Assam, being commonly found throughout the hill tracts between the valleys of the Bramhaputra and the Barak. It there sometimes attains the dimensions of a large tree, and from this, as well as from other indications, it has been plausibly inferred that Assam is the real home of the plant, which was thence introduced at a prehistoric date into China. The discovery of the Tea-plant growing wild in Assam is generally attributed to two brothers named Bruce, who brought back specimens of the plant and the seed, after the conquest of the Province from the Burmese in 1826. In January 1834, under the Governor-Generalship of Lord William Bentinck, a Committee was appointed "for the purpose of submitting a plan for the introduction of Tea-culture into India." In the following year, plants and seed were brought from China, and widely distributed throughout the country. Government itself undertook the formation of experimental plantations in Upper Assam, and in the sub-Himalayan districts of Kumaon and Garhwal in the North-Western Provinces. A party of skilled manufacturers was brought from China, and the leaf which they prepared was favourably reported upon in the London Market Forthwith private speculation took up the Enterprise. The Assam Tea Company, still by far the largest, was formed in 1839, and received from the Government an extensive grant of land, with the Nurseries which had been already laid out. In Kumaon, retired members of the civil and military services came forward with equal eagerness. Many fundamental mistakes as to site, soil, and methods of manufacture, were made in those early days, and bitter disappointment was the chief result. But while private enterprise languished, Government steadily persevered. It retained a portion of its Assam Gardens in its own hands until 1849, when the Assam Company began to emerge from their difficulties. Government also carried on the business in Kumaon, under the able management of Dr. Jameson, as late as 1855.

THE INDIAN TEA INDUSTRY.

The first plants and seed of Indigenous Tea appear to have been brought down from Upper Assam in 1824 by one of two brothers of the name of Bruce, but Lieut. Charlton's claims to the discovery have also been warmly advocated. No advantage appears to have been taken of the discovery till 1834, when Government became alive to its importance, and appointed a Tea Committee.

It consisted of eleven Europeans and two natives, and one of its duties was to determine the site for an experimental Garden. In the meantime it had established the fact that the Tea shrub was indigenous from Suddyah to Yunan. Whether the China plant was indigenous to India was not conclusively determined; the bulk of opinion seemed to be in favor of its having been raised from Assam seed, and having become dwarfed by a less genial climate.

An experimental Garden was opened in Seebsaugor in 1835, but the first Tea manufactured does not appear to have given much satisfaction, as it arrived home in so mouldy a state that samples could not be tested. The Court of Directors, however, nothing daunted, persevered with the work, and shortly afterwards forwarded to the London market some consignments, which commanded such high prices that it was hoped "it would place England in an independent position in respect to China." But however desirous the Honorable Company may have been to ruin the China trade, they were not above indenting on that country for supplies of seed, committing at the outset of the Industry the unfortunate mistake of neglecting the fine indigenous seed they had at hand, and importing in its place at great cost an altogether inferior article. This practice of importing seed obtained for several years; in fact, the Government stuck to the China plant up to the moment of abandoning its Gardens. Indigenous seed was subsequently turned to account by planters, and of late years Assam hybrid has been generally used.

The first Public Company was formed in London in 1839, under the title of the Assam Company, and in the following year the Government transferred over to the Concern its Experimental Garden at Seebsaugor. The shares of the Company were eagerly taken up at £20, but, in the dark days of Tea, to be referred to presently, they were hawked about the market at half a crown each. The Government worked another Experimental Garden in Assam, which it sold to a knowing Chinaman in 1849 for Rs. 900, when, after fifteen years' trial, it abandoned the further development of Tea Cultivation to private enterprise.

The pioneers of Tea confined their attention at the commencement to Assam. Colonel Hannax opened the first private Garden near Debrooghur in 1850-51. By 1853 three further Gardens in Seebsaugor and six in Luckimpore had been planted out; while, by the end of 1859, after innumerable difficulties had been overcome, the number had been increased to fifty-one. In the meantime private enterprise had ascertained that Tea could be grown in other and healthier districts than Assam, and during the period 1850-60 several Gardens had been opened out in Sylhet, Cachar, Darjeeling, Chittagong, and a few in the Kumaon and Hazareebagh districts, Assam still continuing, as it has, indeed, to the present day, to engage the bulk of attention. We doubt if any of the Gardens paid their way up to the year 1860, but of this we are convinced that, had the Industry been then left to itself to develop, the good results which it has since attained would have been much earlier declared. It was at this critical time, however, at what we might call its turning-point, that influences were brought to bear upon the Industry which threw it back several years, and all but proved its ruin. Tea was, in fact, brought into a most unenviable notoriety, from which it has not completely recovered up to the present.

To describe rightly how the Tea mania was brought about, it will be necessary to explain the conditions under which planters held their lands. In the earlier days of Tea, Government was anxious to foster its cultivation; it was ready to grant suitable tracts of land on very easy terms, but, as the Industry further developed itself, and applicants for grants came forward more freely, more stringent Rules were introduced, culminating in the Assam Rules of 1854. These Rules were particularly unpopular with cultivators ; nor is it to be wondered at that they were so, considering that they only allowed 99 years' leases, under heavy clearance conditions. Complaints with reference to them were loud and frequent, till, in 1861, they were supplemented by what are generally known as Lord Canning's Rules, which, among other reasonable concessions, permitted the redemption of land in fee simple. Symptoms of the Tea mania had already shown themselves before these Rules were published; but shortly after their promulgation, it broke out in all its force. It was the period of the American War, when rapid fortunes were being made on both sides of India, and when the attention of capitalists in all parts of the world was turned to this country. Speculators saw their opportunity, and made the best of it. From the good results attained by a few private Gardens, exaggerated pictures were drawn of the enormous profits to be made by working with large capital. Companies were hurriedly formed, and land taken up in the most reckless fashion, and there was as eager a rush for shares in the new Concerns as there was a few years later for Port Canning scrip.

Those were greedy days, when men hoped to get rich by strides, and it would have been well for the Tea Industry had the new Rules been framed with a view to check instead of to foster speculation : but unfortunately this was not the case.

What took place in those evil days is thus described in "Papers regarding the Tea Industry in Bengal," printed in 1874 :—

> "The chief object of speculators during the Tea mania was to get possession of one or more lots of waste land, and the suspension of the clauses in the Waste Land Rules providing for demarcation and survey, previous to sale, made it very easy of attainment. The next step taken by the more honest among them was to try and bring portions of their lots under some sort of resemblance to Tea cultivation in as short a time as practicable. Local labour was hired at any rate which the laborers chose to ask for. Tea seed was purchased at extravagant prices. The earth was scratched up, and the seed being laid down, the speculator considered himself free to form a Company, which was started by buying the lands he had scarcely finished clearing and sowing on, as accomplished Tea gardens, and what still remained of undesirable waste at a cost out of all proportion to the amount he had contracted to pay for it to the State, and to what it was worth. But in time even such a pretence of cultivation as has been described in the previous lines was thought too slow, and more enterprising traders found their account in persuading shareholders to invest in Tea gardens that were actually *not in existence at all*. A remarkable instance of this occurred in the Nowgong district, where the Indian Manager of a promoter of Companies in London was advised by his employer to clear and plant a certain area of waste land for delivery to a Company to whom he had just sold it *as a Tea garden.*"

The evils above described were not confined to Assam, but were extended, though certainly to a less degree, to Cachar, Darjeeling, and Chittagong. In the latter district whole tracts of land utterly unfit for Tea cultivation, steep hills and used-up paddy land, were taken up, and resold to others at enormous profits.

The inevitable sequence of the greed and folly of the period 1864-67 was the collapse of several of the mushroom Companies, and a strong reaction against Tea. The mania was succeeded by a panic. In place of the rush to possess Tea property regardless of cost, there was now a still more eager desire to get rid of it at any price. Gardens which had been sold for enormous sums now went a-begging at a few hundred Rupees. Tea shares which had been run up to heavy premiums were pressed on the market for mere nominal values, all that their holders wished being to get their names as quickly as possible off the Registers, and be quit of Tea for ever. Men had become bankrupts through Tea, borrowed money which they had no hope of repaying on account of Tea, ruined their friends through Tea,—till its very name was odious. It took its place for the time among the many commercial Bubbles of the period, and everything connected with it was viewed with suspicion.

So serious was the crisis, that Government considered itself called upon to interfere, and early in 1868 appointed a Commission to enquire into the state of the Industry.

Its report was confined to Assam, Cachar, and Sylhet, the result confirming what every well-wisher of Tea supposed to be the case : that is to say, the old Gardens were found to be generally in a flourishing state where they had not been injured by stock-jobbing influences, but the Commission pretty strongly intimated that the sooner some of the newly-opened Gardens were wound up, the better it would be for all parties concerned. It took some time to re-establish confidence, so heavy was the blow the Industry had received. In fact, there are still people who have such a painful recollection of those times that they refuse to the present day to believe anything good of the Industry, and look upon an investment in Tea as an act of reckless daring. But there were others who were not slow to recognise the fact that Tea properly worked was certain to become valuable property ultimately, and it is a fortunate circumstance that most of the Gardens which changed hands at this period were taken up by men determined to give the Industry another fair trial, while it is gratifying to know that most of them, with a judicious outlay of capital and a moderate display of perseverance and patience, have realized the expectations of their purchasers. There is little probability now of the former mistakes being repeated, Tea having settled down into its place as one of the staple products of India, with a fair future before it.—*From A. F. Dowling's Tea Notes.*

INDIAN TEA PRODUCING DISTRICTS.

In describing the produce of the different districts, it is not proposed to give exhaustive particulars of each production, but rather to point out one or two of the most prominent features respecting them.

Experience teaches, and it should be remembered, that there are often good and indifferent Teas sent from the same district ; and although some districts have never acquired the credit of producing very excellent tea, and others have degenerated, yet the good teas from such districts often surpass the indifferent teas from a good district.

Occasionally, also, a description which will be true of the teas of a district as a whole, may be falsified by some special parcel which has turned out much better or much worse than its fellows. This will, of course, be readily understood when it is considered that each district extends over many miles, and comprises within its limits Gardens in various stages of cultivation, and that the varieties of "hybrids" between the indigenous tree and the China bush exceed one hundred.

There is one remarkable difference between Indian and China teas, and that is, while second, third, and fourth-crop China teas are different in character, and respectively inferior the one to the other, there is nothing in Indian Tea to proclaim its relationship to any particular crop or gathering.

The number of times an Indian bush is plucked varies considerably, according to the position and soil of the Garden and the state of the weather. When all things are favourable, some trees will yield as many as sixteen or seventeen *flushes* (pickings), while occasionally only five or six can be obtained.

The following are the principal districts from which the supply of Indian teas is obtained :—

Assam.	Hazaribagh (Chota Nagpore).
Darjeeling.	Chittagong.
Cachar and Sylhet.	Neilgherries (Madras).
Kangra.	Dooars.
Dehra Dhoon.	Julpigoorie.
Kumaon and	Ramgurh.
Simla.	

Assam.—Indian teas from the district of Assam are nearly always strong and pungent, the brokens, in addition, being thick and rich. The colour of the infused leaf is a ruddy brown, with a tendency to red. The dry leaf is a dull, greyish black. The finer sorts are evenly curled, and abound with Pekoe tips.

Assam is the home of the indigenous plant, and its hot, moist climate and rich soil are nearly perfect for tea-growing.

Darjeeling.—Darjeelings are full and very flavoury, but are not so pungent as Assams. The infusion is, or should be, bright. The dry leaf is blacker, but, taking the average, is scarcely as tightly twisted as that of Assam teas.

Darjeelings from the Terai below Darjeeling are probably the best pure-drinking teas that are brought to England ; for full flavour, smoothness, and rich strength, they are unequalled.

Occasionally Darjeelings are found that do not possess the flavour for which the district is justly famous. The tea, then, is soft and insipid, and is useless for increasing the flavour of a blend. Most of the plants in Darjeeling are from China seed.

Cachar.—Teas from this district are in character between the Assam and the Darjeeling. They are not so pungent as the Assams, nor are they as flavoury as the Darjeeling, but neither their strength nor flavour is to be despised. The leaf is blacker than the Assams. The liquor is rather soft, and occasionally fruity, with a tendency to be slightly burnt. The majority of the Cachar trees are hybrids.

Sylhet.—Sylhet produces teas that are similar to those of Cachar, but are more pungent.

Kangra.—Teas grown in the Kangra Valley are fine, delicate, and aromatic. Their infused leaf is very bright, and the flavour is even considered superior to that of the Darjeelings, but unfortunately they are often thin.

Dehra Dhoon.—Dehra Dhoon teas are mostly thin, high-burnt, and rather sour. Occasionally the flavour is rather earthy. They are not very much sought after.

Kumaon and Simla.—These teas are somewhat similar to Kangras. They are very flavoury, and sometimes rich, but are not unfrequently thin, and occasionally the flavour is not of a very high order.

DEHRA DUN TEAS.

The remark as to Dehra Dun Teas in page 6 requires qualification; for of late years they have considerably improved, and the faults formerly characterizing them have now disappeared.

For years the Dehra Dun Planters found it more advantageous to manufacture their leaf into green tea to supply a local paying demand, and it was only on this local demand becoming extremely uncertain and irregular, owing to troubles on the frontier, that they were forced to change their manufacture to black teas. For a time their buildings and manufacturing space were too limited for the changed system, and the usual appliances were wanting, so that teas were very irregular in quality, and often inferior.

We are glad to say that, with the introduction of improved methods, the teas now being made in the Doon compare favourably with our *finest* hill teas, being described as "well-made, with thick rich liquor," and "well-made leaf, thick good flavor."

Hazaribagh (Chota Nagpore).—The infused leaf of these teas is very bright. The liquors are fresh and flavoury, but also sometimes weak and sickly.

Chittagong.—Chittagong teas are strong, thick, and almost nutty in character. They are good, useful teas, and for their great strength are in considerable demand.

Neilgherry (Madras).—The Neilgherry Hills produce fancy green teas. The black teas from these hills are, perhaps, the most inferior of all Indian teas. When Neilgherry teas were first imported, the flavour was decidedly objectionable. It has now slightly improved, but is still far from perfection. The liquor is thin, and the dry leaf black and tippy. These Neilgherry teas from Madras must not be confused with the Assam Neilgherry teas, which are strong, rough, and pungent.

Dooars.—The teas produced in this district are similar in character to those of Cachar, but, being considerably stronger, are more valuable for blending.

Julpigoorie.—Julpigoorie teas have a very bright infused leaf, and a thick, rich, but rather soft, liquor.

Ramgurh.—The infused leaf of this is also bright. The liquor is fine and fresh, but thin, and inclined to be sickly.

SECTION II.

FORESTS AND CLIMATE, DROUGHT AND RAINFALL.

Trees as a protection to Tea from hot or violent Winds.

Tea Climates in India and Ceylon.

Rainfall of Indian Tea Districts.

DROUGHT.

In India, happily, we do not suffer much from Drought, as far as Tea Cultivation is concerned, although we may not always get the *amount* of rainfall we require. But it will probably be a matter of some surprise to many to learn that *Cultivation* has a marked influence in the sense of utilizing and *re-furnishing* the moisture which falls as rain. The general idea has been that rain once absorbed by the soil does not give much back again to the *atmosphere;* but it will be seen that such *is* the case, to a greater extent than is supposed. A very interesting Paper on this subject, by Dr. B. Puryear, was read some time ago at the Richmond College in America, where the Professor of Chemistry spoke as follows :—

"Have we any remedy against droughts? To no inconsiderable extent we have, and that remedy is deep plowing.

1. Deeply-plowed lands receive, when rains are abundant, into their substance, all or nearly all the water that falls ; none, or little, runs off from the surface. Such lands have therefore a large storehouse of water from which plants may draw their supplies—crops will stand a drought better for this reason. But the farther the water sinks into the substance of soil, the smaller is the amount which the hot sun of summer will evaporate. Twelve inches beneath the surface the soil is many degrees cooler in summer than the surface ; and hence if the soil be once saturated to that depth, much less water is dissipated and lost by solar heat. Deeply-plowed lands, therefore, not only receive into their substance much water, when rains are copious, but hold this water with greater grip and tenacity.

2. A deeply-pulverized soil is permeable by the atmosphere, and the atmosphere, how dry soever, always contains some aqueous vapor. In a perfectly dry atmosphere our bodies would shrivel in a very few hours into mummies ; all plants would wilt and die in a day. When the atmosphere can descend deeply into the soil, the cool soil deprives the aqueous vapor of heat, and so converts it into water, and deposits it just where it is most needed, about the rootlets of plants. In other words, in deeply-plowed lands dew is being deposited in varying quantities all the time about the roots. Here is another reason why crops stand droughts better in deeply-plowed lands.

3. Water is always rising from below by the capillarity of the soil, but it rises slowly through a hard and compact soil—with ease through a deeply-pulverized soil. Hence the more deeply the soil is plowed, the larger will be the amount of water drawn up from below by capillary attraction.

Can philosophy draw comfort from a drought? When the fields are dry and parched, when the water-courses are failing, and our domestic animals are pinched both for food and water, and the farmers' hopes are blasted—are there no compensating advantages? We think there are, and we give them for the comfort of the despairing and despondent. During a drought the soil is collecting its forces, and recuperating its energies for better work in the ensuing season. Let us see :

If from a damp cellar we take a cube of cut sugar, and touch a point to water, the water will strike slowly through the mass of sugar; but if we take a cube of cut sugar made perfectly dry by exposure to the hot sun, and touch it to water, the water in a moment flashes through the lump. The difference with which the two lumps receive water is striking and obvious. The dry lump in a tenth of the time will receive ten times as much water into its substance as the moist lump. It is just so with the earth—the dry lump of sugar represents the earth in drought; the drier the soil, the stronger is the tendency of water to rise from below to the surface, where it is evaporated. But water never comes to the surface simply as water; it must come charged with all the soluble material which it has encountered in its ascent to the surface; it brings with it the nitrates, the alkaline salts and compounds, which have been exposed far below to its solvent action. When a solid is dissolved in water it is no longer solid, but is as liquid as water, and must go wherever water goes. It can part company with the water only at or near the surface, where the water changes its form and becomes vapor. But these salts lately dissolved in water become solid again when the water is lost by evaporation. The more severe and protracted the drought, the greater the depth from which the water will rise, and hence the greater its opportunity of meeting and dissolving solids and bringing them in solution to the surface, where they are deposited for the benefit of the ensuing crop. During a drought, then, that mightiest power in the Universe, that exhaustless source of all power, the great Sun, is drawing up from depths inaccessible to the spade and the plow, the soluble matter of the earth, and putting it where it is most useful to the farmer, *in the surface-soil*. This water as it comes up brings what the farmer needs, and only what he needs: it brings up only soluble matter, and it is only soluble matter in the soil that can feed the growing plant The substances that the plant derives from the soil are solids ordinarily; but they did not get into the plant as solids —all come up into the vegetable circulation *in solution*.

Again, no mechanical reduction could put this material, brought up by water, in so comminuted a condition. It was lately dissolved, more finely divided than could be effected by the boasted machinery of our day. When the water leaves it, it is therefore in the best possible condition for solution again. It is fully and freely available in consequence of its excessive communication, far more so than if the same amount of the same fertilizing material had been ground and bolted by the most perfect machinery at our command.

A year of hard drought is sure to be followed, if the seasons be moderately favorable, by a year of plenty. The crop gets the advantage of all the soluble material drawn up and deposited near the surface during the drought of the preceding year."

The remarks, it will be seen, have more especial reference to agricultural crops, but the principles underlying may be equally applied to TEA, and go to teach us that we should keep the soil between the lines of Tea-bushes as open as possible, because, as is shown, water, if not prevented by hard, caked soil, will always rise from below by the capiliarity of the soil itself. This is a very beautiful and interesting theory, which of course underlies the principle of Cultivation, but which nevertheless we may not always pay sufficient regard to. In fact it is not uncommon to find the lines of soil between TEA resembling rather narrow beaten pathways than anything else, and although they are and must be necessarily to a certain extent used as such, yet the necessity of keeping the soil there as open as possible, from time to time, should not be lost sight of.

TREES AS A PROTECTION TO A TEA GARDEN FROM HOT OR VIOLENT WINDS.

BY THE EDITOR OF THE *Indian Forester*.

IN the correspondence column of the *Indian Tea Gazette* of the 4th April 1881, two letters have appeared, which discuss the practical benefit derived from trees or shrubs as affording protection to a Tea Garden against hot winds.

As all the services which trees are capable of rendering to the community form a subject of study for forest officers, and the power of resistance to the wind possessed by belts of trees is an important consideration in arranging the order of felling (*assiette des coupes*), I hope that the following remarks may prove interesting to the readers of the *Indian Forester*, and, if at the same time they are of any service to the correspondents of the *Indian Tea Gazette*, whose letters have called them forth, my object in writing them will be fully attained.

The effect of forests in tempering and checking the force of the wind is frequently alluded to by writers on forest economy; and if I quote a few of the passages which I have met with, it is because I think that will be the most conclusive manner of testifying to this important *role* of protection which trees and forests perform for the benefit of neighbouring cultivation.

The Americans, who have often been reproached with the wanton destruction of their forests, are now endeavouring to re-establish them. A notice on the subject, by Mr. G. P. Marsh, which occurs in the *Revue des Eaux et Forêts* for October 1880, under the title, *Le reboisement aux Etats-Unis*, begins by pointing out the value of trees to the settler on the prairie as a protection against the wind. The passage, translated from the French, is as follows:—

"None can better appreciate the benefits conferred by forests than the settler on the prairie, whose dwelling is ever exposed, as a ship on the ocean, to the fury of the violent and changeful winds which sweep across the bare and level plains where no obstacle checks their impetuous career.

"Seated by the hearth in the depth of winter, when his dwelling, buried in snow, looks like a mole-hill in the midst of a vast expanse of moorland, he regrets that, when some 20 or 30 years ago he was selecting a site for his dwelling, he did not plant out with trees a few patches of hundreds of acres of which his holding consists. Had he done so, his house would now be snug and quiet, with a fine clump of trees to shelter it from the north-west wind. His garden would not be dried up by the first dry wind of Summer; and he would not see his fruit blown off and destroyed by the wind.

"There are very few among the pioneers of the far West who have had this forethought; but the wisdom of those few is now so manifest, that from one end of the prairie to the other it is felt that the planting of trees is an object of public importance."

As shewing the advantages expected from this planting of trees, the last paragraph of the extract from *The Scientific American*, entitled: "Preservation of Forests," which appeared in the *Indian Forester* for July 1879, may be quoted:—"Any State where these precautions" (planting groves of trees, quickset-hedges, trees on road sides, &c.) "should be generally adopted, would soon be so unmistakeably distinguished by the unfailing humidity and freshness of its fields and the abundance of its crops that the sheer necessity of competition would induce backward neighbours to try the same experiment, and before long the maxim would not only be generally recognized, but generally acted upon, that husbandry and tree-culture are inseparable."

This certainly points to practical benefit to be derived by agriculture or other cultivation from the planting of trees in their vicinity ; and this, too, without its being necessary to establish extensive forests, or even to distribute the trees with the special object of forming a protective belt.

Forests, too, are effectual in tempering the winds, rendering the climate of the place more equable —(*Baudrillart Dictionnaire Forestier.*)

A writer in the "*Independance Belge*" of 18th June 1865 thus describes the effect of forest trees:—

"1*st.*—They prevent the sun's rays from reaching the ground and heating it.

"2*nd.*—By the expanse of branches and leaves they multiply the cooling surfaces affected by nocturnal radiation.

"3*rd.*—The upper layers of the air, cooled in the tree-tops of the forest, sink by their increased density towards the earth, and thus is kept up a degree of cold considerable in its intensity, and thereby a well maintained moisture.

"From what has just been stated it may be clearly deduced by scientific reasoning that forests lower the temperature of their locality and render the climate at once cooler and moister."

I believe that these views are rather one-sided, and that the fact really is that, as forests absorb or part with heat very slowly, and as the air inside the forests is not renewed so freely as it is in the open, forests have an equalizing and regulating effect on the heat of the local climate, and tend to absorb the heat of hot winds, and to give back this heat as the weather becomes colder.

In the "Transactions of the Academy of Science of France" (*Comptes Rendues*) Vol. LX., sitting of the 10th April 1865, a memorandum may be found which establishes the opinion that forests afford shelter from the wind to cultivation in their neighbourhood ; and it is pointed out that this action is more effectual the higher the trees.

It has been noticed in many countries that extensive denudation has caused hot winds in summer and hail-storms in winter. Thus the occurrence of hail-storms has been remarked in the vineyards of many parts of France to have been caused by the destruction of a screen of forest vegetation which previously warded off the winds and their attendant storms.

A well-known instance of the protection afforded by plantations of trees is the great work of fixing the rolling sand-hills in the Departments of the *Gironde* and *Landes*, which was first effected by Bremontier, and is still being carried on. In this case not only had the wind to be combated, but the substance of a moving range of sand-hills to be consolidated, so that the wind should not be able to roll it, piecemeal, inland.

The authority of M. Lorentz and Parade (*Culture des bois*) will, I feel sure, be admitted on this subject to be the best that can be adduced. Speaking of the climate of plains, (p. 21, 5th edition) we are told that "the absence of large surfaces of water by an increased heat and drought in summer and in winter, adds to the intensity of the cold."

As regards the effect of a *belt of trees* in protecting the ground behind it from the wind, the third chapter of the Work just quoted, treating of the laying out compartments of forest for felling, contains much that is instructive. The following passage (pp. 205, 206) is particularly applicable :—"It is an addition to the advantages of the rule we have just been discussing to leave standing on the West and South margins of the forest, when the feelings reach those parts, a belt of trees forming deep forest of a width more or less considerable (100 to 50 feet) according as the place is exposed or sheltered, as the trees are deep-rooted or the reverse, &c. It is well known that near the margins of a wood the trees are generally more branchy and stunted, and more firmly rooted than in the interior, and that having grown up under the constant action of the wind, they naturally withstand its violence better.

Monsieur Bagneris, in his *Manuel de Sylviculture*, concludes his remarks on the admitted climatic effect of forests in these words :— " Lastly, the forests break the force of the winds and check their violence " Again (p. 218) on the subject of laying out compartments for felling : " When the side directly exposed to the wind is reached, it is always necessary to maintain intact on that side a zone to be kept up as deep forest and worked by selection fellings. The width to be given to this belt must vary according to the resistance it has to offer ; but, to be effectual, it is seldom that it can be made less than a hundred yards wide."

On exposed ridges or plateaux, as well as in narrow valleys swept by the wind, it is often necessary to increase the width.

In the "*Independance Belge*" of the 20th June 1865 the use of forests as screens to protect cultivation from the wind is discussed. Their influence—(and Arago is cited in support of this view)—is one of equalization ; and the writer proceeds to say : " It is for man, and particularly for the agriculturist, to know how to constitute such screens as will be free from any drawbacks that might be presented by dense forests of vast extent. Now for this purpose extensive forests are needed not ; screens of trees, quick-set hedges, plantations round the homestead and along the roads, will afford ample shelter, without occasioning, as forests might, late spring frosts, and thereby often endangering the crops."

The circumstances of different localities must necessarily vary so greatly that no rule can be laid down as to the width of the belt of trees ; but as regards shrubs and quick-set hedges affording ample shelter, that, I think, depends on the intensity of the danger to be counteracted and the extent of ground to be protected. The resistance of the belt of trees will be in proportion to its density and the firmness with which the trees in it are rooted ; the extent of ground it will protect will be greater or less as the trees forming it are tall or short.

I believe that the distance behind the belt to which the shelter extends is about twenty times the height of the screen. No doubt there is some mathematical formula, whereby, with certain data, it might be computed ; but the surest and simplest plan will be to rely on actual observation in each case. One may expect that a low wind sweeping over a level plain, and a wind coming in a slanting direction, as from the side of a mountain, would not be counteracted to the same extent by a belt of trees of a given height,—so that I should expect to find the extent of ground sheltered to depend very much on the angle of incidence of the wind.

As to the best kinds of trees to be planted, in the absence of existing timber, they must above all be suitable to the soil and climate—of hardy growth, capable of growing up in the exposed situation where they are to be placed. Such as are gregarious and will form dense thicket are to be preferred, and valuable kinds, if suitable in other respects, should be used in preference to those which are useless as timber. If the winds to be counteracted are constant, evergreen trees which keep their foliage throughout the year are to be preferred to deciduous kinds. According as the winds are hot or cold the kinds should be chosen which are best suited in this respect; thus, in Europe, the Scotch fir (*Pinus Sylvestris*, Linn.) is found to resist cold better than the maritime pine (*Pinus maritima*, Linn.), which, in the winter of 1879, succumbed to the cold extensively in the north and centre of France.

Sissu (*Dalbergia Sissoo*, Roxb.), which is recommended, I see, by two of the *Tea Gazette* correspondents as suitable for planting in amongst the bushes, would be very useful also for the belt of jungle, as it is gregarious and hardy, growing in the stoniest soil of river-beds exposed to the winds which sweep down the valleys. It is also a quick grower, and the wood is valuable for cart-wheels, furniture, gun-carriages, &c.; but it does not, as a rule, form compact or dense forest. It would be useful on the outside of the belt, by its hardy temperament and firm root-hold.

Bamboos have the advantage of growing to their full height very quickly, and when propagated by off-sets they form good-sized clumps in three or four years. A *Tea Gaz.* correspondent remarks that the bamboos in his part of the country are all flowering, and asks if there is no remedy to prevent their dying after running to seed. I believe there is not. In Drury's "Useful plants," 2nd edition, p. 64, we find that "at the age of 15 years the bamboo is said to bear fruit—a whitish seed-like rice, and then to die." I have noticed that the forest bamboo of the Terai, (*Dendrocalamus Hamiltonij*) is flowering pretty generally this year; but the phenomenon does not universally affect all the bamboos. I have also noticed clumps of this bamboo in a languishing condition, which had lately flowered.

The bamboo is very useful to Tea Planters, and is frequently planted on estates in the Darjeeling Terai. It is also very firmly rooted, and the clumps have a good broad base. This is important, at least for the outside of the belt, as they may be used in place of deep-rooted trees should the soil not be deep enough for their growth. But whatever tree or shrub is used on the outside, all the low branches must be kept. Stunted trees with branches feathering down to the ground, will be most useful. At page 68 of the *Indian Forester* for July 1880 this sentence occurs:—

"In exposed situations both the pruning and thinning of trees should be much lighter round those margins of plantations which face the prevailing high winds of the district. By too close packing it often happens that only the face of the very outermost trees are dotted with foliage, so that any injury to one of these admits the destructive winds. This may be guarded against by a judicious early thinning of such margins, so as to secure a belt of low-branched trees.—(A. J. Burrows, in *The Garden*.)"

The India rubber (*Ficus elastica*, Roxb.) would be a good evergreen tree for the outside edge where permanent foliage is desirable. It will grow in most soils provided they are well drained and permeable; and it also requires plenty of sunlight. Its roots take firm hold of the soil. *Cedrela Toona* might also be grown as suggested. It is a shade-loving tree, and its being planted amongst other kinds would draw it up with a fine clean stem, so that the trees would be likely to give good timber. The toon is capable of attaining a height of seventy feet or thereabouts, but requires a moist rich soil and a sheltered situation: otherwise its growth is stunted. The young plants are apt to be broken by deer browsing on the leaves. The new shoots also suffer from the attacks of a grub which eats into the pith.

If the soil is suitable it would be worth while to grow toon, as the timber is greatly esteemed for *tea-boxes* and furniture.

As regards the raising of sissu in a nursery, as recommended by a correspondent of the *Tea Gazette*, in a recent issue of that Journal, I think under the circumstances it would be a waste of time. Sown broadcast, sissu germinates very readily, and the seedlings grow far more rapidly than the plants raised in the nursery and then transplanted. It would be better to sow broadcast over the whole of the proposed belt, and to thin out any plants required for planting in the Tea, replacing them by toon, &c. Sissu seed is very plentifully produced, and is easy of collection, as the pods are indehiscent, and there is no danger in leaving it to get fully ripe upon the trees.

Toon-seed, however, should be collected as soon as the fruit begins to ripen, for if the capsules are left to open, all the seed, which is very light, will be lost. Toon may with advantage be raised in a nursery, as it requires particular care to screen the seed-beds from the sun, and to protect the young seedlings for the first few weeks. To effect this, a rough roof of elephant grass or loosely-woven mats, through which the sunshine can filter as through a cullender, should be erected over the seed-beds. The seed should only be lightly sprinkled over with earth. The best time for sowing is early in the rains, as soon after the seed has been collected as the ground gets damp and warm.

The germination of the seed of *Ficus elastica* is rather difficult. It requires a well-drained soil, yet a warm moist atmosphere like that of a green-house; the seed should be fresh gathered; the beds should be heaped up in little mounds, and the seed sprinkled *on the sides of the mounds.* Pounded brick and charcoal have been tried as soils for the seed-beds. I would recommend a compost more apt to retain moisture,—a mixture of pounded brick, charcoal, decayed leaf-mould, and moss gathered from the branches of trees, and that the mounds be made with this.

Water should be given often enough to keep the seed-beds moist, but they should not be deluged with water, nor should very cold water be given, but having the same temperature as the soil.

The *Ficus elastica* grows readily from cuttings, if struck in soil that has been well hoed up, and the cuttings are put in during rainy weather when the soil is warm, say July or August, in a sunny place.

Wherever possible it would of course be preferable to utilize existing trees ; for, however quick-growing the kinds planted may be, it will take a long time for them to attain their full height, or, in other words, their maximum protective effect. To judge, however, by the opinion of a correspondent of the *Indian Tea Gazette* who writes from the Nilgiris, planters do not always select the site of their plantations with a careful regard to the local conditions affecting climate. He says : "I am inclined to the idea that a want of special knowledge has contributed greatly to the non-success of tea-growing here. In many instances very exposed windy situations have been chosen instead of the low-lying humid valleys ; and sometimes, I think, fixing the site of a bungalow on a nice spot, and having the tea cultivation close by, has had something to do with it." It is interesting to see that tea-planters, who occupy a most important area in many districts, and have a great landed interest in the Country, take interest in forests for the sake of the protection they afford, as well as for the produce they may yield.

Lindley, in his *Theory and Practice of Horticulture*, writes of "the great importance of screens, which break the wind, and keep in gardens of walls the air in repose in their vicinity."

Now, I know of "a garden" which at times is visited by rude Boreas with much too ardent liberties—the warmth of his attentions being sometimes distressing. But can these liberties be effectually stopped? Walls and screens may do, I think, in *narrow* little English gardens ; but our so-called gardens are really *fields* ; and how would you mitigate the evil effects of a too warm wind out in the open fields?

I have an elaborate plan in my mind of thick rose-hedges and of leafy trees in thickly-planted belts all running parallel to each other across the windy field, and of a thick forest border outside ; which would cost labour and time and money, it is true, but none of which would be grudged for *real* benefit ; but to-day it was very windy (a *cold* wind this time), and looking up to the sky the wind seemed to be coming down at an angle of about forty-five degrees, if not actually straight down ; and this made me pause in my mental plans, and think "how high and how close would the walls or screens of trees need to be to resist with any real effect a wind like this." A wind driven by a fan through a pipe one *might* nullify and quench, however hot or powerful ; but how about a wind that, when you turn your face sky-wards, buffets you on the brow? Is it any good to think of planting, watching, and tending rose-hedges and shrubs and thick trees when the wind, after all, may blow over the heads of them all, and mock me for my pains?

Trees planted *about* the garden judiciously might do; but these, being more scattered, would need more expensive nurturing and fostering: and I am afraid that the wind would slip *under* them, and mock one all the same.

I begin to fear that the relief from any system of tree or shrub-planting would be very partial, and limited to the tea-bushes in the *immediate* vicinity of such; and that, apart from the indefinite benefit from the presence of the trees themselves, labour, money, time, and valuable space might be sacrificed for no adequate benefit; but can any one tell me anything from his own practical experience, or give me his theoretical views?

I am writing of a garden, not, like many in Assam, winding by the sinuosities of a well-wooded *ján*, but of one on an open space, as yet too slightly wooded.

F.

SIR,—"F." "special correspondent" for Dehra Doon, wants to know "the practical benefit, if any, of trees or shrubs as a means of stopping the force and effects of the wind?"

I gather from "F.'s" letter that the garden he knows of is visited by hot winds; they cannot, however, have a very long and lasting effect, otherwise the very creditable yield of "426 lbs. of tea per acre over an area of 712 acres" could not surely be obtained. All the same the winds must be very bad for tea, no matter how slight, and I for one can, I think, understand "F.'s" apparent anxiety to overcome the evil caused by them. There is no doubt that trees do to a certain extent break the force and effect of wind, and as the garden "F." alludes to is "on an open space as yet too slightly wooded," it would certainly do no harm to plant more trees all over it. I would recommend his laying down nurseries of Sissoo, (the seed must be easily procurable in the Doon,) and removing the seedlings when they have well grown, and are 3 to 4 feet high. I would plant them all over the garden—in the tea, and by the roads; any ground in, or near the garden not fit for tea might, I think, advantageously be turned into a clump of Sissoo-trees. I suggest the Sissoo, as I know tea grows well under its shade, as it's not a surface feeder, and consequently strikes its roots well down, and not into the tea bush.

If I had ever so little hot wind to contend against, I would be very careful to leave the outside of my bushes well covered, so that my *bushes themselves might offer resistance to such wind*, and I would be very careful how I thinned out. I would cultivate my garden highly, so that my *bushes would be able to stand a little hot wind.* I would see that the bushes are in a good healthy state, and not being over-pruned or over-plucked; but I believe the best advice I can give "F." is to do pretty much the same as is done where they get 426 lbs. of tea per acre over an area of 712 acres, which is certainly *not bad* for a "non-regulation Tea district."

E.

"F." writes to ask if any plan can be devised for protecting a Plantation that suffers from the hot winds. His idea of planting belts of trees, and thick rose-hedges would, in my belief, be not found to answer practically, though in theory it seems good. Not only would it be a very expensive and troublesome operation planting out and tending this belt of trees, but in the end it would not protect the whole of his garden, but simply have effect on those bushes immediately alongside. No belt of trees, unless dense, and all but impenetrable, and from 50 to 100 yards wide, could effectually break the force of the hot winds we have sometimes in April and May. I believe there is no complete remedy for a garden so exposed, so we must look for a partial mitigation of the evil only. It is not only the scorching dry winds, but also the burning vertical rays of the sun, that shrivel up and kill the bush. This last evil can easily be overcome by planting suitable trees in among the tea. It costs comparatively little, and trees can easily be manured, pruned, hoed, etc., at the same time as the surrounding tea. The tree, *facile princeps*, for a tea plantation, is the Sissum or Sissoo (*Dalbergia Sissoo*), for the following reason: it is a fast grower: has deep roots, not surface feeders; it is covered with foliage during the hottest time of the year, giving a light equable shade, and it sheds all its leaves and seed-pods during the cold weather, when shade is not wanted, the leaves, etc., forming valuable leaf-mould; added to this, it is a handsome tree. Next to the Sissum, one might plant the Toon (*Cedrela Toona*), which is also a good tree, but not so good as the former. Both are valuable as timber. Besides these two, I would not plant any other kind of tree in among the tea,—all others seem to have some injurious effect. But above all, never have a mulberry even close to tea: its roots spread out and are almost entirely surface feeders, and the dropping of leaves and berries have a sort of blighting effect on anything growing underneath. There are a number of other trees that do undoubted harm to the tea bush, but they are too many to numerate here, and I believe are fairly well known to those interested in the matter.

TEA CLIMATES IN INDIA.

The climate required for Tea is a hot damp one. As a rule, a good Tea climate is not a healthy one. The rainfall should not be less than 80 to 100 inches per annum, and the more of this that falls in the early part of the year the better. Any climate which though possessing an abundant rainfall suffers from drought in the early part of the year, is not, *cæteris paribus*, so good as one where the rain is more equally diffused. *All* the Tea districts would yield better with more rain in February, March, and April; and therefore somewhere fogs prevail in the mornings at the early part of the year, are so far benefited.

As any drought is prejudicial to Tea, it stands to reason hot winds must be very bad. These winds argue great aridity, and the Tea plant luxuriates in continual moisture.

The less cold weather experienced where Tea is, the better for the plant. It can stand, and will grow in, great cold (freezing point, and lower in winter, is found in some places where Tea is), but I do not think it will ever be grown to a profit on such sites. That Tea requires a temperate climate was long believed and acted upon by many, to their loss. The climate *cannot* be too hot for Tea if the heat is accompanied with moisture.

Tea grown in temperate climes, such as moderate elevations in the Himalayas, is quite different to the Tea of hot moist climates, such as Eastern Bengal. Some people like it better, and certainly the flavour is more delicate; but it is very much weaker, and the value of Indian Tea (in the present state of the home market, where it is principally used for giving 'body' to the washy stuff from China) consists in its strength. Another all-important point in fixing on a climate for Tea is the fact, that apart from the strength the yield is double in hot, moist climes, what it is in comparatively dry and temperate ones. A really pleasant climate to live in *cannot* be a good one for Tea.

Assam.

The climate in the northern portions is perfect, superior to the southern, as more rain falls in the spring. The climate of the whole of Assam, however, is very good for Tea. The Tea plant yields most abundantly when hot sunshine and showers intervene. For climate, then, I accord the first place to Northern Assam. Southern Assam is, as observed, a little inferior.

The Burhampootra—that vast river which runs from one end of Assam to the other—gives an easy mode of export for the Tea, but still, owing to the distance from the sea-board, it cannot rank in this respect as high as some others.

Cachar.

The indigenous Tea is also found in a part of this province. The climate differs but little from Assam. In one respect it is better; more rain falls in the spring.

Chittagong.

The climate is better than Cachar in the one respect that there is less cold weather, but inferior in the more important fact that much less rain falls in the spring. In this latter respect it is also inferior to Assam, particularly to Northern Assam. There is one part of Chittagong, the Hill Tracts, (Tea has scarcely been much tried there yet), which, in the fact of spring rains, is superior to other parts of the province, as also in soil, for it is much richer there. On the whole, however, Chittagong must yield the palm to both Assam and Cachar on the score of climate.

Terai below Darjeeling.

The climate is a good one, but there is not as much rain in the early part of the year as planters could wish.

The Dehra Doon.

In climate the Dehra Dhoon is far from good. The hot dry weather of the North-west is not at all suited to the Tea plant. Hot winds shrivel it up, and though it recovers when the rains come down, it cannot thrive in such a climate.—[But it *is* grown there profitably.—Ed., *I. T. G.*]

Kangra.

This is a charming valley, with a delightful climate, more favourable to Tea than the Dehra Dhoon : still it is not a perfect Tea climate. It is too dry and too cold.

Kangra is strictly a Himalayan district, but the elevation is moderate,—if I remember right about 3,000 feet, and the land is so slightly sloping that it may almost be called level.

Darjeeling.

The elevation of the Station, 6,900 feet, is far too great ; but plantations lower down do tolerably well (that is, well for hill gardens). The climate, like all hill climates, is too cold. Like elevations in Darjeeling and Kumaon are in favour of the former, *first*, because the latitude is less ; *secondly*, because Darjeeling has much more rain in the spring. I believe, therefore, that the hill plantations of Darjeeling have a better chance of paying than the gardens in Kumaon ; but, as stated before, no elevated gardens, that is, none in the Himalayas, have any chance in the race against plantations in the plains,—always providing the latter are in a good Tea climate.

All the plants in the Darjeeling gardens, with but few exceptions, are China.

The China plant makes by far the best Green Tea, and I believe the Darjeeling gardens would pay much better than they do if they altered their manufacture from black to green. All Himalayan gardens should, in my opinion, make Green Tea (Kumaon has awoke to the fact), for all have China plants, and can therefore make far better Green Tea than can be produced from Hybrid, which is so general in plains gardens.*

Kumaon.

No hill climate *can* be a good one for Tea ; but the inner part of Kumaon, very cold, owing to its elevation, high latitude, and distance from the plains, is a particularly bad one.

An exhilarating and bracing climate for man is not suited to the Tea plant. The district has one solitary advantage—rich soil.

Could any part of Kumaon answer for Tea it would be the lower elevations in the outer ranges of the hills, but these are precisely the sites that have *not* been chosen. Led, as in my own case, partly by the Government example, partly by the wish to be *out* of sight of the 'horrid plains,' and *in* sight of that glorious panorama the Snowy Range, planters have chosen the interior of Kumaon. Some wisely (I was not one of them) selected low sites, valleys sheltered from the cold winds ; but even their choice has not availed much. The frost in winter lingers longest in the valleys, and though doubtless the yield there is larger, owing to the increased heat in summer, the

* When this was written, the demand for Green Teas in Europe was greater than it is now. Still, Kumaon has found a local market for Green Tea over the border—that is, among the Asiatic tribes, and Darjeeling might do the same.

young plants suffer much in the winter. The outer ranges, owing to the heat radiating from the plains, are comparatively free from frost, but there again the soil is not so rich. Still, they would unquestionably be preferable to the interior.

Gurhwal is next to Kumaon, and so similar that I have not thought it necessary to discuss it separately. The climate is the same.

HAZAREEBAUGH.

The climate is too dry, and hot winds are felt there.

NEILGHERRIES.

The climate is superior to the Himalayan, for the frost is very slight. Were, however, more heat there in summer, it would be better.

The temperate climate which holds on these 'blue mountains' is not favourable to a large produce.

WESTERN DOOARS.

As regards climate, soil, and lay of land, it is perfect.—*Col. Money on Tea.*

TEA CLIMATES IN CEYLON.

A contemporary, who *ought* to be an authority on Tea, has been writing in praise of high altitudes for that cultivation, and bases his arguments in their favor on the alleged fact that certain estates in Darjeeling at 3,000 feet have done better than was expected, though we are not told what constitutes "better," and the writer in question goes on to argue that if tea will do well at 3,000 feet in a latitude 270 from the equator, we may safely go to 6,000 feet and over in Ceylon : a theory from which we beg to dissent. In an island like Ceylon, exposed to the full violence of the south-west monsoon, very much depends on position and exposure. Were we writing of the Uva side of the country, we should unhesitatingly adopt the theory, but certainly not on the Kandy side of Newera Eliya, where, as a compensation for the heavy rainfall, there must be heat, if paying flushes are to be had. Will anyone venture to assert that the upper portion of the Rambodde Pass, or the bleak, exposed portion of Upper Lindula, can ever become profitable localities for tea ? To talk of the healthiness of such situations is altogether beside the question. Colonel Money, writing on this subject, says: "A really pleasant climate cannot be a good one for tea,"—by pleasant he intended to convey the idea of a good bracing-climate. Again, speaking of the Kangra District, Colonel Money says : "Kangra is *not* the best place for a man who wants to make money by tea ; but for one who would be content to settle there, and content to make a livelihood by it, a more desirable spot, with a more charming climate, could not be found." Further on he says : "No hill climate can be a good one for tea." "An exhilarating and bracing climate for man is not suited to the tea plant ;" and of Kumaon he adds : "The district has one solitary advantage, rich soil ; but even this cannot, in the case of Tea, counterbalance the climate."

The contemporary who, perhaps not unnaturally, professes such strong faith in an altitude of 6,000 feet for tea in Ceylon, tells how the yield in Sylhet has been brought up to unprecedented amounts ; but then nothing is said as to the altitude of this prolific district, and, singularly enough, Money does not mention it in his Book ; but we find it alluded to in other Works as a flat country, with a few alluvial ridges, and a heavy rainfall from April to November, which keeps the country inundated.

The reason why the low-lying tea districts of this island, so favourable for the yield of tea, unlike those of India are so favourable to health, is the fact of their exposure to healthy sea-breezes, which reach them across an open, well-cultivated country. Yattiantota, Avisawella, Dolosbage, and the Morowa Korle, have none of them exhilarating, bracing climates, yet they cannot be termed unhealthy for the reason above-named.

In the Avisawella District, and those adjacent, Tea flushes very nearly throughout the year,—certainly in nine out of the twelve months, and during those nine months plucking rarely ceases. In the Morowa Korle we believe a similar state of things prevails. After an interregnum of some years since King Coffee was deposed in that part of the Island, it has been ascertained beyond a doubt that no more suitable district for Tea exists in the country. The forcing qualities so detrimental to coffee production, and which were the cause of the abandonment of estates on which much capital had been expended, are precisely those which go to make successful tea plantations. So undoubted has been the success attending the pioneer operations of tea planters in the Morowa Korle, that the proprietor of a number of extensive estates on which coffee has proved a failure, has resolved, after an inspection of the land and under first-rate advice, to proceed with the cultivation of Tea on a large scale, and we have no doubt, from information we have received, that he is acting judiciously. The quality of the produce has been pronounced first class, and we shall be prepared to hear, a few years hence, that this hitherto discredited district has become a favorite locality for investors. A Colombo merchant, who not long ago became the purchaser of the Campden Hill Estate for £3,500, values it to-day, on safe calculation, at £11,000.—*Ceylon Times.*

THE RAINFALL OF INDIAN TEA DISTRICTS.

Though rainfall returns very often convey anything but an exact impression of the climate of a given spot, they are the only means we have of comparing the humidity of one place with another. In the official Report on the Assam district, presented to the Agricultural Department of India, is a statement of rainfall at the head-quarter stations of the following Tea-districts :—

	1880.	1881.	1882.	Average for the previous 5 years.	1883.
Silchar ...	112·46	127·95	113·71	118·51	160·44
Sylhet ...	173·77	166·33	168·11	167·32	148·36
Dhubri ...	113·76	69·13	100·75	107·39	70·37
Gauhati ...	70·07	72·12	66·22	70·69	59·26
Tezpur ...	79·50	96·61	76·39	86·08	72·24
Nowgong...	68·53	79·96	71·05	77·68	72·32
Sibsagar ...	99·06	95·32	80·55	93·33	85·44
Dibrugurh	120·09	116·28	99·85	114·78	104·26

The too rapid denudation of forests has doubtless had much to do with the deficient rainfall which has of late years been complained of in the Darjeeling District, and it is clear that the rules of the Forest Department were not applied a bit too soon. In a very interesting paper on "Forestry in India," published in a late issue of the *Indian Forester*, the writer disputes somewhat the theory that forests tend to *increase* the rainfall. This view may be correct, but it does not alter the fact that forests *concentrate* the rainfall in their immediate vicinity.—Ed., *I. T. G.*

TABLE OF LATITUDE, LONGITUDE, AND RAINFALL, OF PRINCIPAL TEA LOCALITIES.

District	Place	Latitude	Longitude	Detail	January	February	March	April	May	June	July	August	September	October	November	December	Total
Assam	Goalparah ..	26°11′	90°36′	Average rain, several years ..	0·42	0·76	1·84	4·85	11·72	23·72	21·33	12·69	10·93	5·61	0·39	0·20	94·44
				Days rain fell in 1869 .	2	2	4	8	19	24	22	18	15	5	Nil	Nil	119
	Gowhatty ..	26°5′	91°43′	Average rain, several years ..	0·70	1·43	1·48	7·27	10·92	13·29	13·08	11 98	6·82	3·20	0·47	0·12	70·76
				Days rain fell in 1869 ..	2	2	4	8	16	16	9	10	14	2	Nil	1	84
	Seebsaugor ..	27°2′	94°39′	Average rain, several years ..	1,18	2·43	3·77	10·15	11·04	15·56	14·87	13 88	11·13	4·46	1·29	0·69	90·45
				Days rain fell in 1869 ..	11	9	10	13	22	13	19	23	17	8	Nil	2	147
Cachar	Cachar ..	24°48′	92°43′	Average rain, several years ..	0·50	3·53	6·09	12·69	. 16·12	19·55	24·58	16 84	13·90	7·77	7·03	0·79	123·3
				Days rain fell in 1869 ..	2	9	10	16	18	20	18	25	19	8	Nil	Nil	145
Chittagong	Chittagong ..	22°20′	91°44′	Average rain, several years ..	0·37	1·62	1·31	5·46	9·42	22·92	22·54	23·04	13·01	5 93	2·30	0 55	108·47
				Days rain fell in 1869 ..	1	7	3	4	14	15	21	25	17	5	Nil	1	113
Chittagong	Hill Tracts ..	?	?	Rain in 1869 ..	Nil	1·90	1·50	12·55	9·00	12·50	18·20	14·30	12·70	5·70	Nil	0·50	88 85
				Days rain fell in 1869 ..	Nil	4	4	7	13	16	22	19	19	4	Nil	1	109
Darjeeling	Darjeeling ..	27°3′	88°18′	Average rain. several years ..	0·76	1·60	1·65	3·62	7·01	27·50	29·40	29·09	18·06	6·56	0·20	0·14	129·50
				Days rain fell in 1869 ..	2	3	5	9	17	23	26	22	24	7	1	2	148
	Western Dooars [1] ..	?	?	Rain in 1869 ..	0·80	2·00	1·50	6·60	25·30	27·30	46·50	83·50	46·50	9·60	?	2·40	252·00
				Days rain fell in 1869 ..	3	3	5	7	15	19	25	28	22	5	?	?	?
Chota-Nagpore	Hazareebaugh ..	24°0′	85°20′	Average rain. several years ..	0·42	0·52	0·75	0·42	1·37	10·99	14·63	11·44	6·26	3·51	0·19	0·02	50·52
				Days rain fell in 1869 ..	4	Nil	7	Nil	5	11	24	16	21	9	Nil	1	98

The rainfall given for the Western Dooars cannot be relied on. Perhaps more than the average fell in 1869, but anyhow, I should think 83 inches registered for August is an error. I know the yearly fall there is *not* 252 inches.—*Col. Money on Tea.*

THE RAIN-GAUGE.

Object and Principle.—The object of the Rain-Gauge is to show the quantity of rain that falls. This is expressed by inches and decimal parts of an inch; the meaning being that if the rain were to fall on a local surface, which does not absorb it, and from which it cannot run off or evaporate, it would form a sheet of water so many inches or parts of an inch in depth.

Construction.—The instrument consists essentially of a funnel with a square or round mouth, and a receiving vessel. The quantity of rain received is determined by *the area of the mouth of the funnel;* and this area, if the rim of the funnel is round, is equal to the square of half its diameter multiplied by 3·1416. Thus a circular funnel, 4 inches in diameter, has a receiving area $(\frac{4}{2})^2 \times 3{\cdot}1416 = 12{\cdot}5664$ square inches. One six inches in diameter $(\frac{6}{2})^2 \times 3{\cdot}1416 = 28{\cdot}2744$ square inches, &c. Any change in the form of the opening, (such as may be produced by a blow or a squeeze,) diminishes its area, and the gauge will no longer register truly, and must be rejected. To provide against any accident of this kind, the rim of the funnel is generally strengthened by a stout brass ring.

The reservoir is either a large bottle, or a vessel of sheet-zinc or copper, or tin plate; but this last is objectionable, being liable to rust. The water received is measured either in a graduated glass measure, or by means of a dip-stick, or a light graduated rod, carried by a float, which rises as the water accumulates. Some gauges are provided with certain mechanical arrangements for recording the rainfall on a dial; but these need not be described here.

Those with a graduated glass measure are all alike in the essentials of their construction, differing only in shape, dimensions and certain other details; and bear the different names of their inventors, as Symons' gauge, Glaisher's gauge, &c. The float gauge is generally known as Fleming's gauge. It will be necessary to notice those only that are in common use in India.

Symons' gauge.—This is the most convenient and trustworthy form of gauge, and is now used exclusively throughout Bengal and in some other provinces. It is a small cylindrical gauge, five inches in diameter and fourteen inches high. The water is received in a large glass bottle, and it is measured in a cylindrical glass, holding a quantity which represents an inch (or half inch) of rainfall when filled up to certain fixed mark. The space below is graduated in tenths and hundredths of an inch.

The gauge, as made in England, is intended to stand on the ground or to have the bottom buried to the depth of two or three inches. In Bengal it is furnished with a foot, which gives it a firm hold in the ground, and preserves it from the danger of being blown over. It is to be buried in the ground.

To measure the rain, lift the inner receiver and pour the rain cautiously (so as to spill none) into the measuring glass, placed on a large empty dish. The glass will hold one inch. If more than one inch have fallen, the glass must be filled exactly to the one inch mark, then emptied and refilled, until all the rain collected has been measured. The pouring requires some care, and should be done over a large dish to catch any that may accidentally be spilled. The receiver (if of metal) should have a small lip or spout to facilitate pouring. The measure glass belonging to a rain gauge is graduated for a receiving surface of definite dimensions, and cannot be used for a gauge of different diameter without a special calculation. A glass graduated for use with a 5-inch gauge may be used for any gauge of that diameter, but not for a 4-inch nor an 8-inch gauge. On an emergency, rainfall may, of course, be measured in any graduated glass the exact capacity of which is known; but every reading in a register so kept must be reduced by calculation, the data for which are,—the diameter of the gauge funnel, its form whether round or square, and the value of the graduation either in cubic inches or fluid ounces. The latter may be converted into cubic inches by multiplying by 1·733, and this product divided by 3·1416 times the square of half the diameter of the funnel in inches, if the funnel be round, will give the depth of rainfall. This rule may be useful at stations where a broken measure glass is not easily replaced without delay, since an ordinary apothecary's fluid-measure-glass can generally be procured for temporary use.

Glaisher's gauge.—This is similar to Symons' gauge, but is larger, *viz.*, 8-inches diameter. It appears from the comparative experiments made at Calne by a committee of the British Association, that this presents no advantage in point of accuracy over the smaller gauge. The spout at the base of the collecting funnel is bent, whereas that of Symons' gauge is straight; but this is rather a disadvantage, as it is more liable to become choked by the accumulation of dust, &c.

Fleming's gauge.—The receiver of this gauge is long and narrow, and contains a float (nearly as broad as the receiver,) carrying a light brass or wooden rod, which rises as the rain accumulates; passing through a perforated bar across the mouth of the funnel. This bar serves as an index, and shows, by its intersection with the rod, the quantity of rainwater in the receiver. The float requires a certain quantity of water (variable in different gauges) to float it and bring it to the zero mark; and this quantity ought always to be kept in the gauge, a matter requiring some attention during dry weather. Failing this, the quantity required for floatation must be ascertained and added to the quantity read off. Should the rain be too small in quantity to bring the rod to the zero point, it cannot be accurately recorded. This gauge, therefore, in the hands of unskilled and inattentive persons, (and they are many,) is likely to give results always in defect of the truth; and such is found to be the case in practice.

The gauge is open to many other objections. If the float is dented, or otherwise altered in form, or if any part has to be considered, the quantity of water required for its floatation is altered, and this is rarely if ever attended to.

As this gauge, however, is still extensively used, attention is drawn to the following precautions :—

I.—Either enough water must be kept constantly in the receiver to retain the gauge at zero, (a troublesome matter in hot weather) or the gauge must be kept quite empty, and so much added to each reading as is required merely to bring the gauge-rod to zero.*

II.—The gauge, being long, is liable to be blown over. It must therefore be placed in a wooden stand which is firmly bedded in the ground ; or a metal cylinder or long wooden box of such size as to hold the receiver must be buried in the ground, and the receiver placed therein. In this case, the mouth of the funnel should be not less than one foot above the surface of the ground, to prevent dirt being blown or washed into it.

III.—In very heavy rains, as the cylinder will hold no more than six inches, the rain should be measured and the gauge emptied every three hours (or less), according to the quantity of the fall.

IV.—The gauge must be emptied after each observation, with due regard to the provision specified in I.

V.—The funnel which carries the index bar must be truly adjusted and pressed home on the top of the receiver. This should be attended to before the reading is taken.

VI.—Sometimes the float does not rise freely, but either sticks in the receiver or is detained by the friction of the rod against the index bar. Before taking the reading the float-rod should be lifted with the finger and thumb, and then allowed to fall freely, and adjust itself to the point of free floatation.

Site for Rain-gauge.—This is a matter requiring some judgment. First the gauge should always be on the *ground*, and not on a building of any kind ; unless more than one gauge are registered, and it is especially required to know the quantity collected at a certain elevation. This is always less than on the ground, and the variation is especially rapid within a few feet of the ground. In the experiments made at Calne, under the superintendence of a committee of the British Association, in the years 1863 to 1867, with gauges at different elevations, it was found that a gauge with its mouth on the level of the ground gave, on the average of the 4½ years, 6·7 per cent. more than one with the mouth one foot above the ground, and a gauge at the height of 20 feet gave nearly 5·7 per cent. less than the latter. It is, therefore, necessary, in order that the results may be comparable, that the same elevation should be universally adopted. That recommended, and now generally adopted, is that the mouth of the gauge be *one foot above the ground level.* The common practice of setting the gauge on a pillar of brick work is a violation of the rule, and should be abandoned.

2nd.—The gauge must be as far as possible from trees, buildings, and all objects that dominate it ; both that it may receive its full quota of rainfall with the wind from any quarter, and also that it may not receive droppings from trees, &c., when wind accompanies the rain.—*The Indian Meteorologists' Vade mecum.*

* This can be found by a simple experiment : Pour water into the empty receiver till the gauge is brought to zero. Pour it out into an empty glass. Then, having poured a second portion of water into the receiver, and again brought the gauge to zero, return the first quantity into the receiver and the gauge will shew the quantity it contained.

SECTION III.

BOTANICAL ORIGIN AND ANALYSIS OF TEA.

(*From Prof. Bell's "Adulteration of Food, &c."*)

Botanical Origin of Tea.

Description.

Chemical Composition and Analysis.

BOTANICAL ORIGIN OF TEA.

THE Tea of commerce is derived from a plant named *Thea sinensis*, which is an evergreen, and closely allied to the well-known genus *Camellia*. In cultivation, the Tea-plant is generally found from 3 to 6 feet high, but if allowed to attain to its full growth it reaches to a height of between 30 and 40 feet, and possesses a stem more than 1 foot in diameter. It is a native of China, Japan, and the northern parts of Eastern India; but its cultivation has been successfully introduced into many parts of British India, and it has been grown with a fair amount of success in Ceylon, Brazil, and Carolina.

At one time it was thought that black and green teas were prepared from the leaves of two different plants, named respectively *Thea bohea* and *Thea viridis*; but it is now known that one plant, *Thea sinensis*, is the source of both kinds, and that black or green tea can be prepared at pleasure from the same leaves, the difference depending entirely upon the process followed in the manufacture.

DESCRIPTION.*

The Tea of commerce consists of the prepared leaves of the Tea-plant, but in most samples there are present portions of the young branches and flower buds. The leaves are sometimes 2 inches long and 1 inch wide; usually, however, they are much smaller, though the full grown leaf measures from 5 to 6 inches in length.

The leaves are gathered four times during the year; the first gathering being made early in the spring, and the following three at intervals of about six weeks between each. The tea prepared from the first gathering is most delicate in colour and flavour, contains the smallest portion of woody fibre, and is reckoned the best in quality. The quality of the tea depends also upon the age of the tree as well as upon the age of the leaf, the finest teas being produced from the young leaves of young plants; whilst old leaves, and the leaves of old wood, are deficient both in flavour and extract.

In the first stage of the preparation of green tea, the leaves are gently heated for a few minutes to render them soft and flaccid, and after being removed from the pans they are rolled by the hand on a wooden table. They are again placed in the drying-pans, and the leaves are carefully kept in motion until sufficiently dry, the operation being proceeded with as quickly as possible to conserve the green colour and prevent fermentation.

The leaves intended for black tea are thrown into heaps to undergo fermentation, and at the expiration of a few hours are tossed about until they become quite soft, when they are rolled into balls by a peculiar movement and strong pressure of the hands. They are next exposed to the air for some hours, and then alternately dried and rolled two or three times, and finally dried over a charcoal fire.

It would appear that this process is not uniformly followed, as in some instances the leaves are partly withered by exposure to the sun for two hours, and then tossed and beaten by the hands for some time until they become flaccid. This is repeated two or three times at intervals of about half an hour. The fermentative action appears to proceed during this part of the process. The leaves are next heated in an iron pan for a short time, and then rolled into balls, by which operation some of the juice is expressed. Having been half dried over a charcoal fire, they are removed to an open basket and allowed to remain until next day, when the drying is again proceeded with,

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* This "Description" has evidently special reference to China Tea, but will be read with interest.—ED.

and continued with various precautions, until the tea has attained sufficiently crispness to be considered ready for the market. The dried tea is then carefully sorted, by sifting it through sieves of different-size meshes, and by hand-picking. In this way it is divided into parcels of uniformly-sized leaves, and at the same time every unsightly and imperfectly-dried leaf is removed.

Some teas are scented, in order to impart to them an agreeable flavour. The flavour is communicated by placing the leaves in contact with the flowers of plants possessing an aromatic odour, such, for example, as the flowers of *Olea fragrans*, which are used in the preparation of scented Pekoes.*

The two great classes of tea, green and black, are each sub-divided into a variety of kinds, which are known in commerce by particular names. In green teas we have Gunpowder, Hyson, Young Hyson, Imperial, and Twankay ; and in black teas, Congou, Kaisow, Moning, Souchong, Oolong, and Assam. [It would seem as if the author was ignorant of any other Indian Tea than that of Assam.—Ed.]

A Tea is pronounced of good quality when it prossesses delicacy and fulness of flavour with a certain amount of body, and its value in the market is determined by the extent to which it possesses these characters.

CHEMICAL COMPOSITION.

Tea has been the subject of numerous investigations as to the nature and quantity of its several constituents. There has been a certain measure of agreement in the statements which treat of the kind of substances which form the bulk of the tea, but a very great diversity exists in the results stated to have been obtained by different chemists with regard to the quantities in which these are present. This is especially true if we include the earlier investigations on the subject, the results of which, with regard to some of both the organic and mineral constituents, have not been confirmed by the more recent researches. The differences may partly arise from the various meanings which it is possible to attach to some of the terms in which the analyses are stated ; such as, for example, "Extractive," "Gum," "Sugar, "Tannin," and "Albumin." It may be said that the only organic constituent of Tea which has been completely isolated and identified is the alkaloid theine, and this is no doubt due to the facility with which it crystallizes.

The organic substances found to exist in Tea are a volatile oil (to which much of the characteristic odour of Tea is due,) theine, tannin, an albuminous body, gum or dextrin, pectin, cellulose, chlorophyll, and resin.

Oil of Tea.—The essential oil of tea is present in very small quantity. It has a specific gravity less than water, is of a yellowish colour, and readily passes into the form of a resin by exposure to the air. It possesses the peculiar taste and smell of tea, and has very potent stimulating properties. Taken in rather large quantities, the oil is said to produce headache and giddiness.

The peculiar odour of Tea is mostly developed during the process of manufacture. It is more than doubtful whether it arises solely from a definite body pre-existing in the tea, as we have found that the flavour of black tea was produced by heating for some time, to a temperature of 212° F., a portion of an extract of green tea from which the oil or resinous matter had been removed.

* Fortunately, of *Indian* Teas it may be said they require no such adventitious aid—Ed., *I. T. G.*

Theine, $C^8 H^{10} N^4 O^2$.—This is the alkaloid of Tea. The proportion in which it is present was for some time greatly under-estimated by chemists. More recent analyses, however, show a great quantity. Stenhouse has found from 1·05 to 4·1 per cent.; Peligot, from 2·3 to 4·1 per cent.

In some recent analyses made by ourselves we obtained the following amounts of theine from 100 grains of the tea, dried at 212° F. (100° C.):

Congou, low	2·78 grains.
Do. fine	3·12 "
Hyson	2·24 "
Souchong	2·97 "
Moning	2·93 "
Assam	3·42 "
Gunpowder	2·72 "

Theine is very rich in nitrogen, of which it contains nearly 29 per cent. Albumin and similar substances contain only from 15 to 16 per cent.

It is to theine, chiefly, that the beneficial and stimulating properties of Tea are ascribed, aided, no doubt, by the peculiar volatile principle present in the prepared leaf. Theine exists in combination with tannin in Tea, and it is an impure compound of these substances which precipitates on allowing a rather concentrated hot-water solution of tea to cool. Theine crystallizes from water in the form of long needles of a white and silky lustre, containing one atom of water of crystallization. It sublimes at 365° F. (185° C.), and an attempt has been made to take advantage of this property to estimate the amount of theine in Tea, but without any marked success. It dissolves rather freely in hot water, less so in cold water and alcohol, and with still greater difficulty in ether. It is altered by boiling with nitric acid, the produce forming, with vapour of ammonia, a coloured substance which resembles murexide, produced in a similar way from uric acid.

Albumin, or Vegetable Gasein.—This substance exists almost entirely in the insoluble form in Tea. A small quantity is dissolved out with water, but the amount is less than one per cent. Like ordinary casein and coagulated albumin, it is dissolved by alkalis; but its separation by this means from the cellulose of the leaf is unsatisfactory.

The cellulose of Tea is readily acted on by the fixed alkalis, so that the albumin can be only partially recovered in an impure state. The amount of this substance may be more accurately determined by thoroughly exhausting the leaf, first with alcohol and then with water, and estimating the nitrogen in the portion of the leaf remaining insoluble, reckoning the quantity so obtained as being all derived from albumin.

When the nitrogen, associated with the cellulose in the form of vegetable albumin, is deducted from the total amount of nitrogen found in the leaf, a quantity remains which cannot be accounted for by any proportion of theine which has as yet been fairly obtained from Tea. The alcoholic extract, therefore, either contains a large amount of theine than has been recovered from it, or there is present a quantity of another and undetermined nitrogenous compound.

Gum or Dextrin.—Substances under the indefinite term of "gum" are stated by chemists to be present to the extent of from 5 to 9 per cent. We have found, however, in samples of black and green tea, the analyses of which are given above, that dextrin, arabin or similar gum, convertible into sugar by sulphuric acid, was practically absent. It is true that about ½ per cent. of a gum corresponding to dextrin was found in the green tea; but unless the Chinese are exonerated from the suspicion of using such a gum in making up green teas, it is open to question whether even this small proportion is natural to the leaf. [It is well known that the Chinese use facing matter.—Ed., *I. T. G.*]

Pectin, etc.—The characteristic gummy matter of Tea appears to be pectin and pectic acid. It is obtained in considerable purity from the water-extract after the Tea has been well exhausted by alcohol. It is precipitated by alcohol in presence of hydrochloric acid as a transparent jelly, the reactions of which, on subsequent treatment with acids and alkalis, are those of pectin and pectic acids.

Sugar.—Neither of the two descriptions of tea gave any indication of sugar. The tannin of the green tea gave, after boiling with a little dilute mineral acid, 1·33 per cent. of glucose, indicating that a portion of it existed as a glucoside. Under similar conditions the tannin of the black tea gave no sugar.

Tannin.—This is the most abundant substance found in the soluble part of the tea-leaf. Although in some degree it answers to ordinary gallo-tannic acid in its reactions, yet, from its instability and the modifications it undergoes under chemical treatment, we are inclined to the opinion that it differs from that acid in some important respects.

Chlorophyll and Resin.—Tea contains small quantity of certain substances soluble in ether and benzol, and insoluble in water. These chiefly consist of chlorophyll and resinous bodies. It is probable that the amount obtained from Tea is greater than what was originally present in the leaf, as some of the tannin and other constituents are liable to be changed by oxidation into a resinous-like substance.

Cellulose.—The cellulose or woody fibre, which is insoluble in water, forms a considerable proportion of the tea-leaf. After extracting all the soluble constituents of the tea with water, there are left associated with the cellulose nearly all the albumin, part of the ash, and a little of the colouring matter. These cannot be well separated without loss of cellulose, the estimation of which has consequently to be determined by difference.

ANALYSIS OF TEA.

Although, in the analysis of Tea, the more characteristic principles have chiefly engaged the attentionof chemists, a more or less complete analysis of the leaf has been attempted. Various methods appear to have been adopted to arrive at an accurate estimation of the several constituents; but, from the very different results obtained, some of them must obviously be incorrect.

Instead of making a water extract only, we have first exhausted the tea as completely as possible with alcohol of 70 per cent., and then with water, keeping the extract apart and examining them separately. The result of following this process is that a larger total extractive is obtained than by water only, nearly all the tannin and soluble nitrogenous matter being found in the alcoholic extract, while at the same time the constituents soluble in water can be more readily dealt with.

Oil.—This is determined by distilling about 100 grains of the tea in presence of water. The distillate possesses a strong odour of tea, and contains a little chlorophyll and resinous matter mechanically carried over, which should be removed by filtration. The filtrate is saturated with chloride of calcium, and shaken with ether in a separater. The upper layer of liquid is then drawn off into a tared beaker, and the ether evaporated at a temperature of about 80° F. (26·6°C.) The weight of the beaker and oil is then ascertained.

Theine.—One of the two following methods is usually adopted for the estimation of theine in Tea :—

First Method.—One hundred grains of dry and powdered tea are boiled for several minutes with an equal weight of calcined magnesia and 8 ounces of strong alcohol, and filtered. The boiling is repeated with a like amount of alcohol, and subsequently three times with distilled water,—filtering after each operation. The alcohol is recovered by distillation from the united alcoholic filtrates, and the residue, after addition of water, is filtered to remove colouring matter thrown out of solution. A further amount of colouring matter is got rid of by evaporating this filtrate to dryness, and exhausting the residue with boiling water. The resulting solution is added to the aqueous extracts obtained directly from the tea, and the whole evaporated to dryness with the addition of a further small quantity of magnesia, and completely exhausted with pure hot benzol. On distillation, or evaporation of the benzol, the theine is left in a crystalline and almost colourless state.

Second Method.—One hundred grains of dried tea are reduced to a powder, and thoroughly exhausted with boiling water. To the extract, subacetate of lead is added as long as a precipitate appears. The precipitate is then removed by filtration, and the lead in the filtrate got rid of by means of sulphuretted hydrogen. The filtrate from the sulphide of lead is gently evaporated to a small bulk, and left for twenty-four hours, when the theine will be found to crystallize out in an impure state. The crystals are removed from the mother liquor, pressed between bibulous paper, dissolved in a little water, and left to re-crystallize. The mother liquor still contains a little theine, which some chemists have endeavoured to estimate by a standard solution of tannic acid. In the course of our experiments we have found the first of these methods to yield the best results.

Tannin.—The amount of tannin in tea is sometimes roughly estimated by weighing the precipitate occasioned by a solution of gelatine and alum in a given quantity of tea solution, and reckoning 40 per cent. of the dried product as tannin. By a second method 4 grams of gelatine and 2 grams of alum are dissolved in warm water and made up to 1 litre ; then 1 grain of the finest tannic-acid is dissolved in 40 cubic centimetres of water and 10 cubic centimetres of a saturated solution of common salt, added along with a little ground glass. The gelatine solution is introduced into a burette, and run into the solution of tannic acid until no further precipitate forms. The number of cubic centimetres is read off and noted.

Twenty five grains of the powdered tea are next exhausted with boiling water, the solution filtered, and made up to 200 cubic centimetres. 40 cubic centimetres of the solution (= 5 grains of tea) are transferred to a beaker, and solution of salt and some ground glass added as above. The process is now conducted as in the test solution. There appears to be an advantage in making the liquid in the beaker specifically heavier than the gelatine solution, as the latter, when carefully dropped into the beaker, remains for a short time on the surface, and thus allows any formation of precipitate to be more easily discerned.

Suppose that the one grain of tannic acid requires 14 cubic centimetres of gelatine solution, and 40 cubic centimetres of tea solution require 9·8 cubic centimetres of the gelatine, then $14 : 1 : 9{\cdot}8 \times 20 = 14$ per cent. of tannic acid in the sample of tea.

The following method has been proposed by Mr. Allen : A solution of acetate of lead in distilled water is prepared of a strength equal to 5 grams in the litre. 1-10th gram of pure tannic acid is dissolved in 100 cubic centimetres of water, and introduced into a burette ; 10 cubic centimetres of the lead solution are measured into a beaker, and diluted with 90 cubic centimetres of water. This solution is made hot, and the tannic acid solution carefully dropped into it until a little of the filtered liquid gives a pink colouration with a drop of an ammoniacal solution of ferricyanide of potassium.

The tea solution is prepared by exhausting 2 grams of the powdered tea with boiling water, and making up to 250 cubic centimetres. This solution is tested in the same way, and the calculation of the percentage of tannin made from the two results. It is evident that some precautions are necessary in applying the test, as there is no provision made here for the precipitation of the lead by the alkaline phosphates and other substances present in the solution which are thrown down by a salt of lead.

Another method, by Lowenthal, with modifications by Estcourt, has been suggested. For this test various solutions are required :

1. Solution of permanganate of potassium made by dissolving 1·66 grams of the salt in a litre of water.

2. Solution of pure sulphate of indigo : 30 grams dissolved in water, and made up to a litre.

3. Solution of pure tannic acid : 2 grams in 1 litre of distilled water.

4. Dilute sulphuric acid : 200 cubic centimetres of concentrated sulphuric acid diluted to 1 litre, or 1 in 5.

5. Solution of pure gelatine : 25 grams of best glue dissolved in warm water, and made up to 1 litre with a saturated solution of common salt.

In the application of the test, the tannic acid, indigo, and other matters in the tea solution are oxidised by the permanganate, and the end of the process is shown by the change of the blue colour to green, and then to a pale yellow.

The first point to be ascertained is the number of cubic centimetres of permanganate solution required to decolourise 20 cubic centimetres of the indigo solution. For this purpose 23 cubic centimetres of the solution are diluted with 800 cubic centimetres of distilled water, and 10 cubic centimetres of the sulphuric acid solution added. The permanganate solution is run in from a burette until the blue colour completely disappears—the end of the process being carefully observed. The same quantity of indigo solution is again taken, with the addition of 10 cubic centimetres of the tannin solution, and the permanganate solution added as before. The difference in the two results is due to the tannic acid. It is desirable that the experiments should occupy the same time—about 6 minutes—and the solution should be kept vigorously stirred during the addition of the permanganate.

Two grams of tea are now exhausted with boiling water, and the extract made up to 250 cubic centimetres. 10 or 15 cubic centimetres of the tea solution are tested in the manner just described ; the result represents the total oxidisable matter in the tea. To ascertain how much is due to the tannin, it has been proposed to precipitate the tannic acid in a given quantity of the tea extract with the gelatine solution, filter off a proportionate quantity, and test its oxidisable value by the standard permanganate. This latter indication is deducted from the amount obtained in the first experiment with the solution of tea, and the difference gives the number of cubic centimetres required to oxidise the tannic acid in the tea.

Albumin or Vegetable Casein.—Six grams of finely powdered tea are digested with 3 ounces of alcohol of 70 per cent., at a temperature of 140° F. (60° C.) for fifteen minutes, and filtered, the process being repeated three or four times with successive quantities of alcohol. The residue is next treated with water, and, after having been digested in a similar way as in the first operation, is thrown on a filter, and well washed with hot water.

The insoluble portion which remains on the filter is dried and weighed ; and, in other to determine the amount of nitrogen present, about ·7 gram is submitted to combustion with copper oxide, and the proportion of albumin calculated by multiplying the amount of nitrogen by the factor 6·3—the relation by weight existing between albuminous substances and the nitrogen they contain being as 6·3 : 1.

As already pointed out, a small quantity of albumin is precipitated by boiling the water-extract. This precipitate is weighed, and the nitrogen ascertained in the same way as above.

Pectin and Pectic Acid.—The filtrate from the precipiteted albumin is evaporated to small bulk, and after the addition of a few drops of hydrochloric acid, the pectin and pectic acid are precipitated by the addition of 200 cubic centimetres of alcohol of 90 per cent. The precipitate, which appears as a transparent gelatinous mass, is separated by filtration, re-dissolved in a little water, and again precipitated as before. The precipitate when well washed is dried, and weighed on a tared filter. A portion is then ignited to ascertain the amount of ash present, and the remainder is boiled for four hours with water acidulated with 10 drops of sulphuric acid to convert any dextrin or similar substance into glucose. The weight of ash and dextrin, if any, is deducted from the weight of the alcoholic precipitate previously ascertained, the difference being regarded as the percentage of pectin and pectic acid present.

Dextrin.—The proportion of dextrin or gum is ascertained from the amount of sugar produced by boiling the alcoholic precipitate with dilute sulphuric acid, as in the above process for the estimation of pectin. The quantity of sugar formed is determined by an alkaline copper solution, from which result the dextrin can be readily calculated : 100 parts of glucose or 95 parts of cane-sugar being equal to 90 parts of dextrin.

Cellulose.—The percentage of cellulose cannot be determined by direct analysis, and the process followed is usually an indirect one. The amount of cellulose is represented by the portion insoluble in alcohol and water, less the mineral matter, and insoluble albumin. The ash is obtained by igniting a known weight of the dry residue, and the albumin, as before stated, by combustion with copper oxide. The difference is the percentage of cellulose and insoluble colouring matter present in the tea.

Chlorophyll and Resin.—Fifty grains of the dry and finely powdered tea are left in contact with ether for twenty-four hours. The ether is passed through a filter, and the tea-powder washed with warm ether. The filtrate is evaporated to dryness, and treated with hot water to dissolve out any substances soluble therein. The portion insoluble in water is then dried and weighed.

The powder left after treatment with ether is shaken up with alcohol for some time : the alcoholic extract is filtered, and gently evaporated to dryness. The residue is exhausted with benzol, and, after filtering and evaporating the benzol, the extract is treated with boiling water, as in the former part of the process. After removing the water, the resinous mass is dried and weighed. To this result is added the quantity of extract obtained by ether ; the sum multiplied by 2 gives the percentage shown as "chlorophyll and resin."

SECTION IV.

TEA ADULTERATION AND TEA SUBSTITUTES.

TEA ADULTERANTS AND ADULTERATION.

The adulterants of tea may be classed under three heads:

1st. Those substances which can be detected by their physical properties—such as foreign leaves, quartz, excess of sand, and certain colouring matters.

2nd. Those which can be distinguished by their chemical properties—for example Prussian blue, clay, soapstone, gum, rice-water, etc.

3rd. Partially exhausted leaves.

The quartz and sand are usually made up with the tea when in a soft and flaccid condition, and are ingeniously concealed in the nodules formed of the leaves. Sometimes irregular grains of quartz have been simply coloured with plumbago or other substance, and so made to closely resemble some kinds of genuine caper tea with which they have been mixed.

Magnetic oxide, sometimes referred to in the trade as iron filings, is found associated with quartz and sand in tea.

An attempt at explaining the presence of this compound has been made by attributing it to the ferruginous character of the soil on which, in some localities, the tea plant has been cultivated, but the quantity found is often much too large to be accounted for by the accidental admixture of portions of the soil during the process of gathering the leaves.

The object of adding Prussian blue, china clay, and similar substances intended to impart a greenish tint, appears to be twofold, namely, to improve and give uniformity to the colour of *bonâ fide* green tea, and also—which is very reprehensible—to give to old and inferior black tea the appearance and external character of green.

In adding the colour, the leaves are usually moistened with rice-water, and reheated. Whilst in this condition, the finely powdered colour is shaken on the tea, which is continuously stirred until a uniform tint is obtained. Sometimes a little yellow colour, such as turmeric, is added first, and then the Prussian blue or indigo; in other instances, the Prussian-blue mixture alone appears to have been used.

Some years ago large quantities of exhausted leaves were collected in England, and, after the addition of gum and other matters, were rolled and re-dried so as to resemble genuine tea. *This spurious tea was mixed with tea as imported and sold to the public as genuine*, whereby a serious fraud was perpetrated. By the vigilance of the authorities this practice was suppressed, and we believe that it has never since been successfully resumed. It has occasionally happened that an importation of tea has been submerged in sea-water; in some instances such tea has been re-dried and brought into the market, but perhaps more frequently *re-shipped to another country*. From the present general soundness, however, of the tea trade, the sale of such a description of tea has been reduced to a minimum.

It is well known that the manufacture of spurious tea has been carried on to a considerable extent in China, and that large quantities of the sophisticated article have been imported from time to time *into England*, some of which has been known in the market by the name of the "Mahloo Mixture." Owing, however, to the rigid scrutiny to which tea is now subjected, it is likely that the quantity of such spurious teas passed will become very small.

It has been seen that the adulterants of tea may be conveniently studied under three heads—viz.:

1st. Substances which can be detected by their physical properties.

2nd. Mineral salts, along with some organic substances, all of which have distinctive chemical reactions.

3rd. Partially exhausted leaves.

When tea is treated with hot water, a large proportion of the soluble organic matter of the leaf is extracted, together with some of the mineral compounds, chiefly potash salts. If in a suspected sample the problem to be solved was merely whether it consisted wholly of exhausted leaves, the proof of sophistication would be very easy; but when a portion only of the tea is in that condition, the question presents greater difficulty. This arises from the fact that in vegetable products, tea amongst the rest, nature has provided no hard-and-fast line as to the proportion in which the soluble or characteristic constituents may be present. Where a given test, say that of the total water-extract, is relied upon and applied to a number of teas, great difference exists between the maximum and minimum results. It is obvious, therefore, that a considerable admixture of a spurious tea could be added to one of the better kinds without reducing the amount of extract below that obtained from a genuine though inferior tea.

It will be found difficult in practice to separate individual exhausted leaves. Where this can be done, the results of an analysis of them would no doubt be conclusive. Usually it is necessary to weigh out a given quantity—say 100 grains—of the tea, and after repeated extraction with boiling water, the filtered extract is evaporated down either in whole or in part, and the percentage of dry extract calculated.

Or, 200 grains of tea are finely powdered in a mortar, and introduced into a flask with 2,000 grains of water at 60° F. (15·5° C.), and raised to the boiling-point over an argand burner. After this point has been reached, it is removed from the lamp, allowed to stand for 2 minutes, and filtered hot to prevent deposition of the tannate of theine. The specific gravity of the filtrate is then taken with a gravity-bottle, and the result noted. The best filter for the purpose appears to be one made of flannel, and used double.—*Prof. J. Bell.*

THE ADULTERATION OF TEA IN FOREIGN MARKETS.

We notice in the *English Mechanic and World of Science* for December 22nd, 1882, a most damaging statement as regards Indian tea. As the Organ of the Indian Tea Industry, we are bound either emphatically to contradict this statement from knowledge, and prove it to be wrong, or, by silence, to tacitly admit it. Fortunately we are able to do the former. The paragraph we refer to is as follows :—

> This staple plant [Tea] is at the present time being adulterated to a large extent not only in China and other tea-growing (save the mark) countries, *but also in India*—tea being forwarded from the Assam and Darjeeling districts to Calcutta, *and manipulated there* Those who have been to these places will agree that these observations of mine are correct,—coming as they do from the lips of influential tradesmen, both in Calcutta and Singapore. Having visited Calcutta some few years ago I heard it repeated that a large quantity of Indian herbs, and leaves of trees,—catechu, &c.—are dyed and fabricated to imitate tea leaves, and in that state large quantities *are* forwarded to Europe and other parts of the world, and palmed on to the tea-drinking public as pure Assam and Darjeeling teas.

We do not know which to be most astonished at—the gullibility or the impudence of the writer. We should be glad to know who are the "influential tradesmen" engaged in tea in Calcutta. Unfortunately we have no Dakins, Coopers, Hornimans, or Lewises here. If we had, probably they would see their way to draw in the native community as consumers, and so lead to a very large local and provincial absorption of our crop. Most decidedly, those who have been in Calcutta will agree with us in ridiculing the assertion that " Indian herbs and leaves of trees, catechu, &c.," are doctored up to imitate tea-leaves. Indian tea, though so good, is too cheap and too plentiful to make such an experiment worth the while even of the most "enterprising" Bengali.

The adulteration of *China* teas is a matter of notoriety, because, by reason of the examinations that have at various times been held, at the instance of the English and Australian Governments, consignments have been refused admission to the Custom House, and have, in many cases, been re-shipped to foreign ports, (instead of having been *invariably* destroyed, as should have been the case) ; although, we are glad to say, more particular attention is now being paid to this point—not only in England, but in Australia. But who ever heard of *Indian* teas coming under the denunciation made ? The necessity for analyses of Indian teas in this country or in London has never been felt, because their absolute purity and genuineness has long become an accepted fact, and the demand at home for our growths originally arose, and to a great degree now exists, from the circumstance of their utility in giving point and flavour to the weak Chinas with which the home market is flooded ; but when, the other day, we exploited a new market—Australia—it was deemed desirable to submit our teas to a searching test, because our colonial brethren could not be expected to know, in respect to a quite new importation, what was so fully known in Calcutta and in Mincing Lane. The wise step was therefore resorted to of obtaining the opinion of experts, and this is the Report :—

INDUSTRIAL AND TECHNOLOGICAL MUSEUM.
Laboratory, 7th December, 1882.

REPORT on SAMPLES of INDIAN TEAS received from MESSRS. JAMES HENTY & Co.

THE FOLLOWING RESULTS WERE OBTAINED UPON ANALYSIS :—

Lots.	*Name.*	*Per Centage of Mineral Ash.*	*Per Centage of Extract.*	*Per Centage of Soluble Salt.*
2, 9. 34, 40.	ASSAM PEKOE.	.. 5 69	.. 50 88	.. 3·44
5 13, 23. 27. 41. 44.	ASSAM PEKOE SOUCHONG	.. 5·44	.. 46·32	.. 3 24
6. 15. 22. 30 45.	CACHAR PEKOE ..	.. 5 72	.. 47·08	.. 3 52
3, 7, 16, 20 24, 30, 43, 46.	CACHAR PEKOE SOUCHONG	.. 5 28	.. 44 52	.. 3·08
4, 11 17 21, 38	DARJEELING PEKOE SOUCHONG	5 08	.. 45 92	.. 8·16
1. 8, 14, 25, 26. 32. 37, 42, 47.	INDIAN BROKEN TEAS	.. 5·36	.. 46·38	.. 2·78
10, 28. 28, 31, 33, 35. 36. 48.	INDIAN SOUCHONGS	... 5·12	.. 46·08	.. 2·88

We have carefully examined the above teas, the leads of which were cut under our supervision ; the samples also being taken by us from the bulk. We guarantee these teas to be pure and free from any adulteration.

J. COSMO NEWBERY.
FREDERIC DUNN.

But the writer in the *Mechanic's Magazine* may argue : "This does not prove that fabricated teas may not be sent forward to *London*." No, it does not ; but in the first place the surroundings in Calcutta do not permit of such fabrication, and if they did, Mincing Lane would not take our fabrications : they have more than enough of China adulterations already. It would indeed be a sad thing for the credit of our great Industry if there was a particle of truth in the atrocious statement made by the anonymous writer in the *Mechanic's Magazine.* But there is not. We dare assert that not a pound of Tea leaves this port that does not come from tea-gardens,—there grown and manufactured ; and it is next to impossible, as we have said, that herbs and leaves of trees should be manipulated in Calcutta to resemble Tea.

It seems to us that the writer of the remarks in question, being probably himself interested in China teas, and knowing that adulterations with these teas *are* practised, seeks to drag Indian teas down to the same level, so as to prevent any superior appreciation of Indian teas becoming a potent factor in the minds of the English public. If this be so, it is a most dastardly piece of policy ; for the statement that spurious teas or adulterated teas are sent from India, is absolutely untruthful. We do not need to say this to our subscribers in this country, for they know the fact already, but as people at home will believe almost anything regarding foreign countries, it becomes desirable that we should protest in the strongest manner against a statement made, void of a fraction of foundation or proof.

CHINA "LIE" TEA.

The following is the method, as shown by a Chinese tea-maker, for colouring exhausted black-leaf teas, stalks, &c. :—

"A quantity of the old branches and useless leaves are collected from the bottom of the tea plants, and pounded into a pulp in a rice-pounder or mortar ; then tied up in a cloth, and put into a hole in the ground to ferment for a few hours. When sufficiently fermented, the pulp is placed in a large tea-pan, and boiling water is poured on it. It is then allowed to boil until two-thirds of the water have evaporated. The liquor is strained off, a proportion of gum and coloring mixed, and the exhausted leaves and stalks steeped in it as long as considered necessary. The renewed Tea it then partly dried, lightly rolled, and finished in the sun or on heated plates."

TEA SUBSTITUTES.

Yerba Mate, or Paraguayan Tea.

Mr. L. Couty, after a special visit to South America, contributes to the *Revue Scientifique* an article giving the results of his examination of the food question on that continent, especially with respect to a nutritious beverage known as maté, which he believes is destined to replace coffee and alcohol to a great extent. The leaves are derived from the *Ilex Paraguayensis*, which grows to a height of from three to six metres, and covers acres of ground throughout Paraguay, Rio Grande, Parana, and the province of St. Catherine. This represents an extent of country larger than France and Germany combined. The leaves, which are thick and oblong in shape, are only picked every three or four years. They are dried by artificial means in the woods by the peasants themselves, who send them in a rough state to the factories. Here they undergo a separating process by means of sieves, and are afterward packed ready for sale. In preparing the beverage the leaf is boiled for one or two minutes, the liquid furnished being less limpid than tea, and not so dark as coffee. The aroma is less pronounced than that of good tea, and the maté is sweeter to the taste than coffee, and may be drunk without sugar. Moreover, it may with advantage pass through seven or eight successive boilings, each time in fresh water, and the last infusions will be better than the first, but in this case it must not be allowed to get cold.

This product is now sold at the rate of 5s. 6d. and 6s. 6d. per 15 kilogrammes (33½ lbs.) delivered at Antonine, a shipping port in Parana, and as each kilogramme furnishes 40 litres (about 36 quarts) of a strong infusion, the cost per litre is less than a farthing. But this rate would be still less if there were proper means of traffic from the woods, carriage being three times as expensive as the original article. A great reduction might fairly be anticipated if railways or even good roads were constructed; but at present the transit is made by means of mules, along steep and rugged paths. From a chemical analysis of this plant, it appears that it contains the same properties as coffee, an alkaloid, with oleaginous essences and resinous gums, but as the quantity of the latter present is much greater than in coffee, the nutritive element is superior. This analysis is confirmed by experience. The inhabitants drink nothing else, and with maté and meat they live well, without experiencing any desire for bread or vegetable, although the country is favourable for the cultivation of maize and potatoes if necessary. The cattle-tenders often remain absent for days from all human habitation with their herds, and are content to forego their usual meals if only they have a good supply of maté, which thus appears to be an active element of food, and, unlike coffee, produces neither sleeplessness nor palpitation.

I. Paraguayensis is characterised as a species by its perfectly smooth, ovate, lanceolate, unequally-serrated leaves, and by having much-branched racemes of flowers, the sub-divisions of which are somewhat umbellate, and by its slightly hairy calyx. The leaves of the Maté, the name by which it is known in South America, are from four to five inches long. The Maté occupies the same important position in the domestic economy of South America as the Chinese tea does in this country, and it is calculated that it is consumed in that country to the extent of about 8,000,000 lbs. annually. It has been in use for about a century and a half, the practice having been adopted from the aboriginal people. The leaves are prepared by drying and roasting, not in the manner of Chinese teas, but large branches are cut off the plants and placed on hurdles over a wood fire until sufficiently roasted; the branches are then placed on a hard floor, and beaten with sticks; the dried leaves are thus knocked off and reduced to a powder, which is collected, made into packages, and is ready for use. There are three sorts known in the South American markets: the Caa-Cuys, which is the half-expanded leaf-buds; the Caa-Miri, the leaf torn from its midrib and veins, without roasting; and the Caa-Guaza or Yerva de Palos of the Spaniards, the whole leaf with the petioles and small branches roasted. It is prepared for drinking by putting a small quantity, about a teaspoonful, into a gourd or jug, with a little sugar; the drinking-tube is then inserted, and boiling water poured on the Maté; when sufficiently cool, the infusion is sucked up through the tube. It has an agreeable, slightly aromatic odour, is rather bitter to the taste, and very refreshing and restorative to the human frame after enduring great fatigue. It is almost impossible for those accustomed to it, to leave it off. It acts in some degree as an aperient and diuretic, and, if taken in over-doses, it occasions diseases similar to those produced by strong liquors. It contains the same active principle as tea and coffee, called theine, but not their volatile and empyreumatic oils.

That the *Yerva maté* is to the greater part of South America, Paraguay, La Plata, Peru, and Quito, what the *Thea Bohea* or *Tscha* of the Chinese is to western civilisation, should be sufficient argument in favour of its introduction to Asia. It is just possible, however, that it might have special claims to our attention: that is, it might make an admirable blend with our excellent, though, to some people, peculiar-flavoured Indian teas, and give them a value in the British Colonial markets which they do not now possess.

Maté consists of small pieces of leaf, with stalks an inch long, and parts of the stems, which have been artifically dried. It is of a dirty yellow-gray colour, having a taste peculiar to itself, but resembling the coarser varieties of Chinese tea, and not dissimilar to it in composition. Trommsdorf has found catechuic acid in it, which is probably combined with the *theine* discovered in it by Stenhouse, as is tannic acid in Tea, with the same alkaloid. The quantity of ash very slightly exceeds the maximum found in Chinese or Indian tea, the proportions of soluble salts being in nearly the same ratio, *e. g.*—

	Soluble.	Insoluble.		Total.
Ash of tea	3·55	2·37	=	5·92
Ash of maté	4·22	2·06	=	6·28

Two objections might be taken to the introduction of maté into this country :—*1st*, that it might be used as an adulterant ; *2nd*, that the infusion, unlike that of tea, produces an unpleasant excitement. Regarding the first, although the use might lead to the abuse of it we cannot but believe that in time it would stand in the same relation to tea as chicory to coffee, that is, as an accepted adjuvant. As regards the second objection, the tea with which it was mixed would, in all probability, modify or entirely counteract its excitant properties. Further, were it proved that admixture with maté improved the aroma of tea, the cultivation of the one might enhance the value of the other, in so far that the cultivation and cost of curing maté would be very little: consequently, its admixture with tea, provided it prove pleasant to the consumer, must needs be profitable to the producer. One point which might prove to be of some importance is that opium allays the excitant effects of maté. Might not maté counteract the soporific effects of opium?

We have received from the River Plate a sample of maté. In appearance it is like powdered light snuff-coloured meal, with about 10 per cent. of stick.

The Tea or Maté is made by putting some of the sticks at the bottom of a small gourd, as drainage, and then some of the broken leaf on the top. The gourd is then filled up with boiling water, and the tea or maté is sucked up through a "bombija," *i. e.*, a tube with a rose or strainer at the bottom. This latter is necessary, as otherwise the powder itself would be drunk with the infusion.

The liquor is a dirty straw colour, and the taste slightly bitter, but not very delicate. As we had no bombija through which to drink it, we were perforce compelled to strain the liquor through linen.

Mr. W. S. Cresswell reports to us on the above as follows: "The liquor has a pungent acid flavour very unpleasant to the taste, with none of the properties of the Tea-plant in leaf or liquor, and should the inhabitants of the River Plate have an opportunity of tasting our Indian Tea, they would never go back to their Maté Tea again."

As Mr. Cresswell justly says, Yerba Maté is not tea at all. Still it is drunk, and largely so, and is much appreciated by the Paraguayans. Therefore there seems to be a possible field for our produce in Paraguay.

I frequently use Paraguay tea, or *maté*, and can assure any one wishing to know the truth that it is not tea at all, and is for a certain reason utterly unfit to be used to "blend with Indian teas." Maté parts with its flavour and colouring-matter almost instantaneously by pouring boiling water over the leaves, and this may be repeated several times without exhausting them. Tea, on the contrary, parts *slowly* with its theine and colouring; if mixed with the leaves of the maté ilex, its flavour would be utterly overpowered by that of the latter.

Maté does *not* produce any 'excitement of a very unpleasant kind to Europeans.' On the contrary, I know Europeans who cannot take tea who resort to maté, because it does not produce the excitement to the nervous system caused by tea, including insomnia. Judging from its effect on myself, I consider it to be one of the most harmless of warm infusions, and have always liked it. The South American peoples who use it, certainly do not suffer from its exciting properties, although many of those who imbibe maté in great quantities object to a cup of tea because it affects their nerves.

Maté is an excellent *substitute* for tea : as a *blend* it never can be used. We use it in South America either by pouring boiling water over the pulverized leaves and twigs, with sugar to suit the palate, and then sucking it through a silver tube ; or, by infusing the entire leaf in a teapot or jug, and pouring it out like tea. The latter way of preparation is not very common yet. but will, I think, soon become more general. Undoubtedly it is a good morning or evening beverage for nervous persons who cannot take tea.

This is the plain truth about *maté*. It will never supplant tea in Europe or elsewhere, and will never be employed (at least successfully) to adulterate the latter. It is a beverage *sui generis*, and, although I enjoy a *maté* now and then, I have no inclination to abandon the use of tea. Rich and poor among the natives of the Spanish American Republics use it : but for all that, tea and coffee are yearly being consumed to a greater extent by all classes, whilst the consumption of maté remains about stationary.

Maté, or Paraguayan tea, is known to be extensively used in South America, and almost universally in Brazil, the common practice being to pour boiling water on some of the powder (consisting of ground leaves and twigs of certain species), then to suck the infusion through tubes provided with strainers. M M. d'Arsonval and Conty have recently inquired into the action of this substance, administering it to dogs, either by injecting into the veins, or by introduction into the stomach, and they have observed a remarkable effect of it on the gases of the blood. It diminishes the carbonic acid and oxygen both of the arterial and of the venous blood to a large extent, sometimes a third or even half of nor-normal quantity. This action, which is less intense during digestion, and has no necessary relation to phenomena of excitation of the sympathetic nerve-system, is somewhat obscure as to its "mechanism," but its existence proves directly the importance and nutritive value of the aliment in question, which, consumed in such large quantities in South America, is almost unknown in Europe.

WILD TEA.—EURYA SERRATA.

All who have had experience of tea nurseries must have noticed the curious persistence of the plant so-called "wild tea" (not a true tea although it looks, very like it) in apparently claiming affinity to tea by growing up side by side with tea plants. A planter who found that his pluckers had been taking a flush from some of these plants, got some leaves gathered, and prepared them as tea is prepared. The sample is coarse, and the flavour anything but fine, but certainly the substance might be mistaken for coarse tea.

NOVEL TEAS.

Among the little-known teas are four descriptions which we are not aware of having ever seen or heard of on the brokers' shelves in Mincing Lane. The "powder tea" of Japan is so well spoken of by travellers that probably it may be the sort mentioned by Miss Bird in her interesting book, as selling on the spot for ten shillings a pound; at all times it is said to furnish an exceedingly agreeable and refreshing draught when taken in the orthodox mode. The same plant, that which yields the ordinary familiar teas of commerce, produces this, only the shrubs selected are old, and must for the purpose have been subjected to a system of very copious manuring to the extent of ten applications per annum. The plucked leaves are for a few seconds exposed to a current of steam, dried by spreading out on a mat, and afterwards subjected to a similar round of manipulation as other tea, the finished product being immediately enclosed in airtight metal jars. When required for consumption the necessary quantity for the party is withdrawn, slowly reduced to powder in a handmill, and for every individual a quarter of an ounce is removed on the tip of a feather to the cup, into which boiling water is poured. The mixture is now agitated with a wooden whisk, in the manner adopted with a cup of cocoa, until a drooping head of froth hangs over the vessel, when the fragrant nectar-like fluid is absorbed according to the fancy.

From time immemorial some of the aboriginal tribes of America, and for 230 years the colony founded in North Carolina by Sir Walter Raleigh, have been addicted to the use of what is called "yaupon tea." The leaves, about one inch in length, grow upon the *ilex euponia*, of the same family as our evergreen holly, with chemical properties resembling closely those of the teas and coffee of commerce, and akin to the maté of Paraguay—a desirable and honest character to commence witb. In addition, it is claimed for the infusion that its tonic virtue in invigorating and bracing up the relaxed alumnus, equally with the jaded and toil-worn artisan or labourer, greatly surpasses that of any known fluid. It is described as being at once a sedative, a sudorific, and an anti-febrifuge, the use of which is marked by no subsequent evil effects. By the natives of Carolina it is everywhere enthusiastically invested with the attributes of both meat and drink, so that the sailors and raftsmen, who are often called upon to put forth extra and long-sustained effort, assert that on yaupon tea they can endure more hardship and fatigue than by the aid of any other form of aliment.

A former Consul, Mr. E. Colborne Baber, at Chung Kiug, about three years ago described a few of the wild teas of Szechuen in Western China, which evince peculiarities of considerable interest. During one of his rambles the monks of the Ngomi monasteries refreshed him with a naturally-sweet tea, which tasted like common Congou mingled with brown sugar.

The tea seems to be found only on the slopes of this range, as inquiries a few miles distant failed to produce any recognition of it among the natives. Another kind was met with in the wilderness of the Hwang-mu-chang plateau, overhanging the Tung river at a height of 6,000 feet, which yielded a highly coloured, but somewhat weak infusion, having the taste and flavour of tea and milk mingled together. The plant is described as a leafy shrub 15 feet high, with a stem some four inches thick, every portion of which, except the roots, is used in preparing the beverage.

The so-called 'Puerk,' known also in China as Yunnan tea, but which comes from the Shan States south of Yunnan, is highly prized for its pharmaceutical qualities, being reputedly a certain cure for spleen, bile, and hæmorrhoids. One fact regarding tea may astonish many people not a little, not only in England but in China. Its use among the 300,000,000 of Chinese is by no means so common as supposed. As a fact the poorest classes in Shansi, Honan, Shantung, Yunnan, Twang-is, know it only as a luxury. The peasantry of these provinces, especially the north, sip hot water with the same relish as a Fokien man taking his infusion of Bohea, and try to cheat themselves by giving the innocent beverage the name of Tea.

BATOUM TEA.

There is an interesting account of this product in a recent No. of the *Pharmaceutical Journal*. It is also known as "Trebizond Tea," and has formed the subject of discussion at a recent meeting of the Linnean Society. It is very doubtful, however, whether it can be said to be allied to the true Thea, the leaf being much thinner, and easily distinguishable from the known varieties of the genuine article. It grows all along the Taurus range, and when the leaf is carefully prepared, a palatable beverage is said to be the result. So much, also, can be said for Maté, or Paraguayan Tea, but it is not claimed for the latter, even, that it is of the THEA family. In England an infusion somewhat resembling Tea can be produced from laurel-leaves, but it is absurd to call any of these imitations *Tea*. They may be used as adulterants, but hardly so, we should think, to an extent to make the matter of much consequence. A good deal, however, of this Batoum Tea is said to be sent into Persia, where it passes successfuly for the genuine article. It has a very pronounced odour and possesses an unpleasant acridity. The, leaves are gathered in July and August, and the manufacture is very similar to that of China Tea. It is not uncommon to mix a certain percentage of good China tea with this fictitious article, to pass it off the more easily.

Powder Tea.

Sir,—I have made a little powder tea from old plants kept for seed, and which from the heavy manuring yearly, flush well at this season. A quarter tola worked up with sugar, lemon-juice, and hot water, makes a fair drink; or if cream is used instead of lemon-juice, a good strong flavory cup.

Tea made from other Plants.

The *Pharmaceutical Journal* of March 21st contains a paper from Mr. Thiselton Dyer on Tea used by the Circassians made from a plant (*Vaccinium arctostaphylos*) grown on the hill sides in the province of Roum.

It seems there are several tea substitutes in use in different parts of the world. Another plant (*Ledum palus*) yields Labrador tea.

Bohemian Tea.

For some years past, spurious black and green teas have been manufactured from the leaves of the *Lithospermum officinale* (Gromwell) in Bohemia. These have in some instances been palmed off in the market as "Chinese," but have mostly been used not only in Bohemia but in other countries in Europe, as an adulterant for fine teas. The chemist, A. Vogel, has subjected the plant to a careful botanic chemical analysis, and found that

"Theine or any other alkaloid is not found in the plant, but only cellulose, gluten, gum, glucosides, fat, ethereal oil, resin, tannin, chlorophyl, albumen, acid salts, water, &c. Dextrine also appears to be present in it."

The composition of the teas made from the plant, we are told, "differs greatly and notably from that of Chinese tea."

The genus of plants *Lithospermum* belong to the natural order *Boraginaceæ*. There are several species of the plant, but the most important is the *Lithospermum officinale*.

The *L. officinale* has an erect much-branched stem, lanceolate acute-veined leaves, with tubercles and adpressed bristles above, hairy beneath; the throat of the corolla has minute scales within, and is of pale yellow or greenish colour. The nuts are white, shining, and very hard, two or three ripening in each calyx. They were esteemed in ancient times as an infallible lithonthriptic; their virtues in this respect are, however, entirely imaginary. It is a native of Europe, Asia, and North America. It is found in dry and stony places in Great Britain, but sparingly. All the species of *Lithospermum* are noted for the stony hardness of their pericarps, which have the brittleness and lustre of porcelain. This membrane, when analysed, is found to contain nearly 60 per cent. of earthy matter, which is more than is known in any other organised substance. According to Spenner, *L. officinale* is the only true *Lithospermum*, none of the other species having a crown of scales in the throat of the corolla.

HOW SPURIOUS TEA IS MADE IN CHINA.

Amongst the articles of export enumerated in a recent report from Kung-chow, is one under the name of Kêuch'a. This is described as a preparation for adulterating tea. The name Kêuch'a, meaning root-tea, is an abbreviation of Lê-te-shêug Kêu, or *Bryophyllum Calycinum*, the Chinese term which implies that the leaf when it falls developes a root, being intended seemingly as descriptive of the characteristic manner in which this plant can be propagated. It grows abundantly on roadsides and waste places in the neighbourhood of Kung-chow, and its thick and fleshy leaves are gathered all the year round. These are cut into strips, and the pieces exposed to the sun for several days, when being still slightly moist they are rolled up by hand so as to resemble tea, and after being completely dried are ready for exportation It is satisfactory to know that the export of this spurious tea, which is said to go mostly to Macao, is but a small one, the total in 1880 having been 1,809,39 picus, valued at 1,143 taels.

SECTION V.

SOILS.

Constituents of Soils.

Soils for Tea.

What Constitutes a good Tea Soil.

CONSTITUENTS OF SOILS.

What is silica? It is a substance which occurs in Nature more frequently and abundantly than any of the other earths. All hard stones which give out sparks when struck by steel—the enormous masses of granite, together with the vast accumulations of sand in deserts and in plains, are mainly composed of silica; and there are few stones that do not contain more or less of this substance. There is scarcely a single plant that does not contain it. Grasses, in particular, contain large quantities of it; and it forms the grass-like coating on the straw of wheat.

What is alumina? Alumina is the earth which, next to silica, is found most frequently, and in the greatest abundance, in our soil. Clay, into the composition of which alumina always enters, exists in a greater or less degree in every soil, and is also found in extensive strata beneath the surface of the earth. Moreover, alumina forms a constituent part of most stones, and in some it is the principal ingredient. A small quantity of it is found in the ashes of most vegetables. This earth is of great importance to the agriculturist, in order to enable him duly to appreciate the influence of clay upon his fields, and the improvement or deterioration of the soil which it occasions. Alumina appears to have a greater affinity for water than any of the other elementary earths. It has a very powerful affinity for the other earths, and in certain cases enters readily into combination with them. It has a very great tendency to unite with silica. It is in consequence of this affinity that silica is so often combined with alumina in forming the compound called clay. Lime also has a strong affinity for alumina, which explains the great fusibility of these earths when mixed. Alumina exercises only an indirect influence on vegetation, by its power of attracting and retaining water and ammonia. It is itself very rarely found in the ashes of plants.

What is potash? Potash is procured from the ashes of plants by burning and other processes. The plant which yields the greatest proportion of potash are wormwood and furmitory. Refined potash is called pearl-ash, and is, in that state, an impure carbonate of potash or potash with carbon. Wood-ashes are certainly a valuable manure, and are peculiarly well adapted for gravelly soils and loams. This remark applies to the ashes of almost every description of vegetable land weeds, grasses, peat, and seaweeds.

What is soda? Soda is obtained chiefly from two sources, the burning of marine vegetables, such as common seaweed, which furnishes the alkali called kelp; and the decomposition of salt. A material purpose which these carbonates (carbonate of potash and carbonate of soda) are supposed to serve is that of combining with and rendering soluble the vegetable matter of the soil, so as to bring it into a state in which it may be readily taken up by the roots. They may in this case be said to prepare the food of plants. This mode of action can be exercised in its fullest extent only where vegetable matter abounds in the soil. They are, therefore, most useful where vegetable matter is plentiful, and ought to be employed more sparingly and with some degree of caution where such organic matter is deficient. Another mode in which these substances act, more obscurely perhaps, though not less certainly, is by disposing the organic matters contained in the sap of the plant to form such new combinations as may be required for the production of the several parts of the living vegetable.

What is lime? Lime is one of the most abundant substances in nature; it forms whole mountain chains, and together with other earths and metallic compounds constitutes a great number of minerals. It forms a constituent part of all vegetables; and in animals it forms the principal ingredient of shells and bones. In its chemical constitution, lime is composed of a peculiar metal called calcium and oxygen.

What is magnesia? Magnesia is an earth less abundant than lime. It is never met with pure, but always mixed with other earths, and combined with acids. Several minerals contain proportions of it; springs, rivers, the sea, and salt water, also contain it. The ashes of most vegetables contain it; it sometimes forms a very considerable constituent part of the layer of vegetable mould, and of that marl which is best adapted for the purpose of manure. The bran of flour contains a large quantity of ammoniacal phosphate of magnesia. This salt forms large crystalline concretions, often amounting to several pounds in weight, in the fæcum of horses belonging to millers ; and when ammonia is mixed with beer, the same salt separates as a white precipitate. Liebig makes an important division of plants, according to their propositions of these organic substances. Thus : potash plants he defines to be those the ashes of which contain more than half their weight of soluble alkaline salts. Lime plants and silica plants are those in which lime and silica respectively predominate. The ingredients thus indicated are those which form the distinguishing characteristics of the plants which require an abundant supply of them for their growth. The potash plants include the beet, mangel-wurzel, turnip, maize, &c. The lime plants comprehend clover, beans, peas, tobacco, tea, &c. The silica plants include wheat, oats, rye, and barley. The potato belongs to the lime plants, as far as regards the ingredients of its leaves, but its tubers (which contain only traces of lime) belong to the class of potash plants.

What are alkalis? Alkali is a general term. It includes all those substances which have an action like the ley of wood ashes, which is used for soap-making. If this ley is boiled down dry, it forms potash, as all know. Now lime, fresh slacked, has the alkaline properties of potash, but weaker, and so has the calcined magnesia of the shops, but in a less degree than lime. Here we have two substances, earthy in their look, having alkaline properties. They are called, therefore, alkaline earths. But what we understand chiefly by the term alkalis means potash, soda and ammonia. Potash is the alkali of land plants ; soda is the alkali of sea plants ; and ammonia is the alkali of animal substances. Potash and soda are fixed ; that is, not easily raised in vapour by fire. Ammonia always exists as vapour, unless fixed by something else. Hence there is a distinction among alkalis which is easily remembered. This distinction is founded on the source from which they are procured, and upon their nature when heated. Potash is a vegetable alkali, derived from land plants ; soda is a vegetable alkali derived from sea plants : ammonia is an animal alkali, derived from animal substances. Potash and soda are fixed alkalis ; ammonia is a volatile alkali. Potash makes soft soap, with grease, and soda forms hard soap. Ammonia forms neither hard nor soft ; it makes, with oil, a kind of ointment, used to rub a sore-throat with, under the name of volatile liniment. But though there be three alkalis, and two alkaline earths, it should on no account be forgotten that they all have common properties, called alkaline, and which will enable a person to understand their action without anything being said about their chemistry. The property of alkalis to be especially borne in mind in connection with agriculture is their great tendency to combine with acids, and form by that combination what are called neutral salts.

What are acids? Acids constitute a numerous class of chemical bodies. They occur in all the kingdoms of nature. Phosphoric acid, found in bones, is of animal origin ; citric (lemon) acid and oxalic (sorrel) acid are of vegetable origin ; carbonic acid and sulphuric acid are very common in mineral bodies, and are produced by breathing, burning, decomposition, &c. As the word acid is, in common language, almost synonymous with sour, it might be supposed that the taste of a substance would determine whether it was included among the acids. The term has, however, been much extended by chemists beyond its original meaning, and includes bodies which are nearly, or quite, devoid of sourness, but are classed as acids because they agree with them in some other qualities. The acids are generally sour, but not universally. We have said that acids, as well as being found in the bodies of animals and plants, by living processes, are produced by burning, &c. Let us illustrate their production by burning, because this will, to a great extent, assist the explanation of the other operations. Take a lucifer-match, and ignite it by friction ; this sets the sulphur burning. Now, the gas arising from the burning consist of the sulphur and phosphorous united to the oxygen of the air This compound forms two acids, sulphuric and phosphoric. Then the wood burns, and its carbon, uniting also with oxygen from he air, forms carbonic acid. Thus no less than three acids, of peculiar, distinct and important properties, are formed while burning a lucifer-match. The fact to be especially remembered with regard to acids is the converse of that with regard to alkalis. All acids unite or combine with the alkalis and alkaline earths, forming neutral salt; and acids also combine with the metals. Thus they are actively and constantly engaged in the vegetative processes, and possess great powers of combination.

SOILS FOR TEA.

We have to consider first, what *soils* consist of; second, what the plant takes out of the soil; third, what are the constituents of Tea-leaves, manufactured tea, tea extract, spent leaves, and tea ashes.

All soils consist of organic and inorganic bodies: the latter, the earthy and stony substances; the former, animal and vegetable matter.

As a rule, soils contain but a small percentage of vegetable or other organic matter, from three to ten per cent. only,—the proportion being easily ascertained by placing a sample of soil over a strong fire, when the organic portion will be more or less readily burnt away, while the residue will represent the inorganic percentage, which remains fixed and permanent in the fire.

The best soil for Tea is a strong humus soil, full of organic matter, provided it be friable, that is to say, contain thirty per cent. or so of sand. Such soils, however, are scarce, and the bulk of land taken up now-a-days for tea is a light loam, containing plenty of sand, with more or less of clay, carbonate of lime, potash, magnesia, and oxide of iron; while the richer it is in organic matter the better for the growth of the plant. Clayey soils, containing little or no lime, and marly or calcareous soils, containing lime in excess, are unsuitable for tea. Clay can with difficulty, and only at heavy expense, be brought to grow Tea. Sand, on the other hand, without moderate manuring can be made a fair yielding soil. Animal Manure, however, is now very scarce; in fact it can hardly be obtained.

The following rough analysis of Soils can be undertaken by any one, as the tests employed are of the simplest. The information appeared originally in a work published in Madras some years ago. They are not scientifically exact, but do well enough for all practical purposes; and any planter can tell by their use whether the ingredients referred to are in his soil. A more accurate analysis would have to be made by an experienced chemist.

1st.—Weigh a given portion of soil; heat it, and dry it. The loss is water.

2nd.—Burn whatever remains. The loss is chiefly vegetable matter.

3rd.—Add hydrochloric acid to the residue. Thus the quantity of lime may be determined, its presence being indicated by effervescence; and the longer it continues, the richer the soil in lime.

4th.—Wash a fresh portion of soil to determine the quantity of insoluble silicious sand.

5th.—To determine the presence of humic acid, dissolve a little common soda in water, add some of the soil thereto (previously reduced to a pulvurent form) and give it a good boil, pour the solution into a glass and let it settle, and then pour off the colored solution without any sediment into another glass. If vinegar, or diluted hydrochloric acid be added to the clear brown or brownish coloured liquid, brown flecks will fall, which are humic acid, 39 lbs. of carbon and 27 lbs. of water form 63 lbs. of humic acid. All black and dark coloured soils are rich in this fertilizing substance; poor soils contain little, and sandy soil absolutely none.

6th.—To determine the presence of phosphate of lime or bone earth, weigh out 200 grains of soil and place it in a glass, pouring half an ounce of diluted hydrochloric acid over it. Stir and mix with a glass rod, and allow it to stand for thirty hours, after which add half an ounce of distilled water. Stir as before, and run through filtering paper. If to this clear solution liquid ammonia be added, a pale amber-coloured liquid will float, like oil on water on its surface. This is phosphate of lime in solution, and it may be precipitated by further additions of liquor ammonia.

7th.—For Iron treat the soil as before with the acid, and to the filtered solution add a grain or two of prussiate of potash. Stir as before, and in a few minutes the solution will become of a beautiful blue colour, owing to the presence of iron in the soil.

8th.—To ascertain the presence of nitrate of potash, or saltpetre, boil 500 grains of soil in two ounces of distilled water. When cold, run through filtering-paper. Evaporate this cleared solution over sand, or water, as most convenient, till reduced to a teaspoonful. In it dip a slip of unglazed paper (the margin of a newspaper will supply the material needed) and dry it in the sun. If nitre be present, this slip of paper on being fired will behave exactly like touch-paper.

With the use, then, of one or two wine-glasses, a little blotting or filtering-paper, and a few simple tests to be found in his medicine-chest, a planter should be able to form a pretty fair estimate of his soil without troubling an analyst. Where distilled water is not procurable, good clear water, boiled and passed through a filter, will answer the purpose nearly as well.

It is mentioned above that soils contain but a small percentage of organic matter ; plants on the other hand contain much organic and little inorganic or mineral matter. This organic or combustible matter in plants is composed almost exclusively of carbon, hydrogen, oxygen, and minute portions of sulphur and phosphorus, being in the proportion of about 50 per cent. of carbon, 38 per cent. oxygen, 5 per cent. of hydrogen, 4 per cent. of nitrogen, 2 per cent. of sulphur, with traces of iron, phosphorus, and manganese, which elements are supplied in the way of food by the atmosphere through the leaves, and to a less extent by soil through the roots. Thus, carbon is supplied to the plant from the air in the shape of carbonic acid, and in a small proportion only from soluble compounds, such as humic and ulmic acids, existing in the soil ; its hydrogen and oxygen are derived from water ; its nitrogen from ammonia, nitric acid, and other soluble nitrogenous substances partly washed down by rain from the air, and partly natural to the soil ; and its sulphur and phosphorus from sulphuric and phosphoric acids. The green leaves of the plant are constantly absorbing carbonic acid and rejecting exygen by day : they absorb oxygen and reject carbonic aoid by night, retaining a considerable part of the latter as food. Decaying vegetable matter on the other hand rejecting all its carbonic acid day and night, and food for the living plant is thus thrown off by the dead plant. Soils containing much vegetable matter are thus full of carbonic acid : those containing animal substances abound in ammonia.—*A. F. Dowling.*

WHAT CONSTITUTES A GOOD TEA SOIL.

In order to select and judge different soils we must regard in the first instance the requirements of the tea plant, both *physical* and *chemical*. Now it has been found that mature tea-trees in most favourable situations spread their roots far below into the subsoil to a depth of six and even seven feet ; the rootlets are very tender and delicate, and as their extension and the force with which they have to work their way into the lower layers may well be compared with the force with which a nail is driven into a plank, an essential feature of a good tea soil will be porosity and friability down to a depth of at least five feet.

If a heavy and impermeable clay stratum intervenes above that depth, the rootlets of the tea plant will be unable to overcome the resistance offered, and will spread horizontally ; the plant will become more or less a surface feeder, and will be easily affected by droughts or extreme cold. If such a soil is situated on a level, the evil will be increased by the presence of stagnant water—an invariable result of a clayey stratum in the subsoil ; and it is well known to planters that nothing injures the tea plant so such as stagnant water around its rootlets.

The most desirable qualities a good tea soil should possess are therefore that it should be loose and friable to a certain depth, and be on a gentle slope.

A soil which, when wetted, crumbles away between the fingers, will generally be found sufficiently friable and porous for the requirements of the Tea-plant.

Regarding the *chemical* constitution of a tea soil, many opinions of most contradictory character have been expressed. It has been stated that tea will grow on almost any soil ; and the fact has been made use of, that in China only such soils are selected for tea as are unfit for other crops. But it has been omitted to mention that Chinese restrict their cultivation rigidly to the amount of manure available ; their principle is—" without continuous manuring there can be no continuous harvest. "

Some of the *best tea soils* we have found to agree in the following particulars : —A layer of porous loam six to twelve inches deep, containing not less than 50 per cent. of sand, about 5 per cent. lime, and 5 per cent of organic matter, the remainder being clay of a light colour when dry, yellow or reddish yellow in the lower layers, with a porous sandy or ferruginous sandy subsoil extending to not less than 5 feet, with about 10 to 20 per cent. of clay and free from too great an admixture of stones or boulders.

These particulars will suffice to guide the planter in the general selection of a soil for his tea garden ; and the closer he can come to it, the surer will be his success. —*Tea Gazette.*

The Tea plant will grow on almost any soil, and will flourish on many. Still, there are broad general rules to be laid down in the selection of soils for Tea, which no one can ignore with impunity.

A light sandy loam is perhaps as good a soil as any *out* of the Himalayas. It ought to be deep, and the more decayed vegetable matter there is lying on its surface the better. If deep enough for the descent of the tap-root, say 3 feet, it matters not much what the subsoil is, otherwise a yellowish red subsoil is an advantage. This subsoil is generally a mixture of clay and sand. Much of Assam, Cachar, and Chittagong is as the above, but as a rule it is richest in Assam, poorest in Chittagong.

Tea loves soils friable, that is, easily divided into all their atoms. This argues a fair proportion of sand, but this should not been in excess, or the soil will be poor. The soil should be porous—imbibing and parting with water freely. The more decayed vegetable matter on its surface the better.

To be avoided are stiff soils of every kind, as also those which when they dry, after rain, cake together and split Avoid black coloured, or even dark coloured earths. All soils good for the Tea plant are light coloured. If, however, the dark colour arises from decayed vegetation that is not the colour of the soil, and, as observed, vegetable matter is a great advantage. Judge of colour when soil is dry—for even light-coloured soil looks dark when wet. Soil which will make bricks will not grow tea, and though I have sometimes seen young plants thrive on stiff soil, I do not believe in any stiff soil as a permanence.

Stones, if not in excess, are advantageous in all soils inclined to be stiff, for they help to keep them open. But then they must not be large, as if so they act as badly as a rocky substratum, preventing the descent of the tap-root.—*Col. Money.*

SECTION VI.

MANURES AND MANURING.

MANURES AS APPLIED TO TEA.

LIMESTONE A MANURE FOR TEA.

INFORMATION ANENT MANURES FOR TEA.

MANURE AS APPLIED TO TEA.

The amount of manure beneficial to a plant, and the age at which it should first receive it, are questions on which doctors differ. One pound of properly preserved cattle manure to a plant in its second year, from seedling, is about all that a plant of that age could conveniently assimilate, if indeed it could assimilate so much, in one year. Of course the amount beneficial to a plant would go on increasing as the plant approached nearer to maturity : indeed for a very large plant over eight years old, a whole basket (about fifteen seers) has been known to have been applied with advantage, though we cannot think that a plant of this age, even planted six feet by six feet, could anything like absorb, in one year, this enormous quantity, but it may tend to fertilize the soil for future years. An allowance of seven pounds (say a basket to four bushes) is probably enough for mature plants of any age.

It is, as we remarked in a previous issue of the *Tea Gazette*, that a garden which had been years in existence would benefit but little from a surface application of manure, but we say without hesitation that a high state of cultivation is at all times necessary, that is, if one is to look for anything like appreciative results in the future. Take, for instance, the case of a tea-garden of say twenty years' standing, and calculate the amount of valuable mineral matter which has been removed from the soil in the leaf which has been plucked during this period. Let us suppose that the soil was originally one of great natural fertility, and let us estimate the yield per annum at five maunds per acre : the total amount of tea made will thus be $5 \times 20 = 100$ maunds per acre in the twenty years. Now, since the amount of ash in Black Tea (as found by Professors Wolff and Knop) reaches 6 per cent., we can easily see that for every 100 maunds of tea the soil is impoverished to the extent of 6 maunds for the mineral portion alone of the leaf removed.

The soil we must regard as a complex mixture of a very large amount of mineral matter, which can never be of any use to plants (further than it affords them an anchorage,) together with a small amount of actual plant-food, some of which is at once available for absorption by the roots of vegetation, while by far the greater part exists in an insoluble condition, requiring time, and the various operations of Nature, to render it of any service to the tea-plant : and when we consider that, after all, the real amount of plant-food in the soil is so very limited that some very fertile sands contain when dry 85 per cent. of silica, which is utterly useless both now and for ever as a plant-food, and that much of the real and manurial matter, such as lime and soda, exists in larger proportions than are absolutely essential to plant nutrition, while the most useful constituents which we are so constantly removing in large quantities from the plant by "plucking," &c., exist but in very small proportion in the soil, our readers will, we feel assured, be compelled to admit the necessity of Manuring, in the sense of a "higher cultivation."

LIMESTONE A MANURE FOR TEA.

It seems now to be tolerably well accepted that the future of Indian tea depends, first, on better communications, to enable planters to place labour on their estates at but a tithe of the ruinous cost at present ruling ; and secondly, on the throwing up of all unprofitable patches, and the concentration of all energy on the high cultivation of those portions of the gardens which, from jât of plants and suitability of lay and site, promise remunerative returns. By the term "high cultivation," we do not mean the ceaseless hoeing of steep inclines or even of flat lands liable to submergence during the rains, but the application to tea-planting of those principles of agricultural science that have proved so successful in Europe, America, and the Colonies. The planter of the future must combine within himself not only the qualifications that have hitherto been considered those of a good manager, tea-maker, and accountant, but he must also be a skilled agri-horticulturist, versed in the treatment of diseases incidental to the tea-plant, the proper drainage of low land, and the application of manures, in the blending or proper admixture of which he will have to become an adept. Some time ago the *Indian Agriculturist* drew attention to the value of crude limestone as the basis of most of those fertilizing agents which have now become recognized as necessary stimulants to all lands that have been under cultivation for more than five years,—by which period the average of our tea plantations attain their maximum yield That there are exceptions we know, but we are here concerned only with tea-gardens as a whole.

In selecting sites for tea planting, no one who could get flat land would select *teelahs*. But though a large area of desirable plots exists, they are mostly in the hands of native or other proprietors, and thus many people in opening out fresh lands to supplement their present area are compelled to make use of *teelahs* more or less steep, and to counteract the drawbacks of such lands by a system of 'terracing.' Now, though this system is imperatively demanded to keep the plants in proper position on the hillsides, almost all the surface soil is so much disturbed in the primary operation, that at the end of the rains but a very small proportion remains *in situ*. Theoretically, the only portion of the terraced land thoroughly deprived of the original vegetable deposit is the apex of the *teelah* so treated, the argument being that what surface soil is disturbed from above is retained on the lower terraces. But if we will but watch the effects of heavy rain on newly terraced land, it will be apparent that the surface soil, from the light nature of its composition, is carried so rapidly over the edges, as the terraces become soaked with water, that it is almost all washed down to the foot of the hill by the end of the first rainy season ; and although the loss of it has no material effect on the tea-plant for the first year or two, a few minutes' reflection will tend to show that manuring by means of renovating-pits upon terraced *teelahs* is absolutely necessary from the time the plant commences to yield, because the very process adopted for the benefit of the plant at the outset is such as, by depriving the soil of its most valuable constituents, to ensure the rapid deterioration of its yielding powers. Much indeed might be done were the surface soil from the upper terrace scraped together, and buried either in a trench running right round the inside of the terrace, or in pits dug behind the place subsequently to be occupied by the plant. But although this might eke out the yield, possibly for a couple of seasons, it must now be apparent to all who have had experience of *teelah* gardens that, without renovating aid artificially supplied, the yield must gradually fall off until it becomes no longer remunerative. To any one knowing the Sylhet and Cachar districts tolerably well, this can be ascertained beyond all question by referring to the statistical accounts of the annual yield of the numerous gardens in the agency of the firm publishing the quarterly reports alluded to. In the instance of one garden, the falling off has been so' marked as to lead the shareholders to look upon the existence of the Company to be ensured only by large extensions yearly : whereas, had the money already sunk in such extensions been employed in the scientific application of manure to the older portion of the property, the average outturn would have been maintained and the garden kept within the original area. Moreover, these extensions necessitate a much greater expense in the way of additional labour and supervision than the careful nursing of the old garden would require. We think therefore that the efforts of our tea planters should be directed to the utilization of all such material for forming manures as can be collected within a reasonable distance of the factory, such for instance as cowdung, stable refuse, and *bheel* soil. But it is evident that these manures alone do not possess the requisite strength to compensate the plant for the severe strain put upon it, and so long as this demand is exacted, it appears to us quite evident that something more stimulating and nourishing is required. A close investigation into the merits of limestone has confirmed us in the opinion that the present yield of our *teelah* gardens would be largely increased were a regular system of manuring resorted to, and we trust soon to hear that the collection of a compost of all animal refuse, mixed with one-third its bulk of crushed limestone, is being carried out on all gardens where renovating pits can be dug without endangering the stability of the plant. That this would be a work of time we admit, but in the present state of the Tea Industry an increased yield as soon as possible is absolutely necessary, and the effects of manure such as we recommend, would increase the outturn far quicker than large extensions even of the best *jât*, which latter must always remain, for two or three years at least, a dead weight on the finances of the factory. Some doubts have been expressed as to the safety of applying limestone to Tea, but as that matter can at once be set at rest by a visit to easily-accessibl places, we need do no more than refer to it here. Terriah Ghât at the foot of the ascent to Shillong *viâ* Cherra Poonji, is well worth a visit, if merely for the purpose of proving our arguments in favour of limestone; for here may be seen its effects on jack, areca, sago, plaintain, and *pân* (betel pepper-vine) while, close by, the Khassias at Bolahgunge have recently discovered that the apparently infertile sand-*churs* exposed during the cold weather, are so impregnated with the mineral as to yield heavy crops of *dhal*, potatoes, and yams. Those who are under the impression that limestone is inimical to tender vegetable life, may be surprised to learn that the most delicate of all the ground orchids, *Anœctochilus*, is found in the most flourishing condition in the clefts of limestone reefs. To such as would wish to see the effects of the mineral upon Tea, we recommended a visit to the Sundai estate in the Jaintia Hills. It will thus be seen that limestone is suitable for enhancing the yield of the fruit-bearing trees, not plants and pure vegetation, as demanded by our tea-planters. Our object in advocating its use as the basis of a compost, is that it is procurable in limitless quantities and at a nominal price—recommendations that should have due weight with tea proprietors at the present juncture.—*Indian Agriculturist.*

INFORMATION ANENT MANURE.

Sir,—Given good soil and site, is it beneficial, useless or harmful to apply manure,

(*a*) when planting out;
(*b*) after the first year of planting;
(*c*) any time before plucking commences;
(*d*) any time before the deterioration of the bushes commences?

2nd.—If you have once commenced manuring at any of the above periods, is it necessary to keep up the treatment, or may you drop it at any of the stages?

3rd.—What is the best time of the year to manure?

4th.—How close to the bushes may it be put without being injurious?

5th—How far may it be put without being useless?

6th.—How deep ought it to be put?

7th.—Is there any benefit in putting it very deep?

If you or any of your correspondents will kindly answer the above questions *seriatim*, I am sure you will confer a benefit on the planting community generally, and especially on—

"Your Humble Servant."

Dear Sir,—The subject on which your correspondent asks for information is one which may be written on by the hour.

Seriatim.

(*a*) Useless;
(*b*) Useless;
(*c*) Useless;
(*d*) Beneficial; nay more, necessary. Some may differ, but remember he says "*given good soil* and site."

2nd. You may drop it, but you'll drop the benefit of it as well.

3rd. From the 1st of January to the 31st of December, as you have the manure and labour available, is the best time of year.

4th. As close as the majority of the spongelets or spongioles.

N. B.—Where these are, "Your humble Servant" can best ascertain by having the greater part of the earth beneath a tea-plant *carefully* separated from the roots. This is a task that will have to be gone about *very* carefully and gingerly, and a pronged koorpee, pretty strong, will be a good thing to use. But it *can* be done, and well too.

This task will, for fibrine perfection, occupy two men quite the best part of two days—with a largish bush. A "coloured man"—a Georgian—might do it in less time by himself, but not Thakoor Dass, nor Kaniya Keyot, nor Poopooh Sawmi.

5th. This is virtually answered by the last reply.

6th. Just so: that when the earth is filled over it, all will be as level as things were before.

7th. I should say not, because the rain will take it down in time; and to feed *both* upper and lower circles or rootlets distinctly is not, at present certainly, part of our plan, though it *might* be a good plan. Let Y. H. S. try it.

To conclude, the flower of my experience (so far) is, that to make the tea-bush flush and flourish, and most effectually to nourish it, there is nothing than can come up to a good basketful of farm-yard manure, *i. e.* cow-dung, ashes, and decayed straw; the "basketful" to mean, for an ordinary sized bush, about from 10 to 12 seers, and for a very fully developed bush half as much again, or double, indeed.

And in my humble opinion three points ought to be observed :—the first, that your manure be well kept and sheltered from sun and rain while being "made," to as great an extent as is fairly practicable, by being stored indoors during the heavy rains, and by being protected at other seasons by coverings or "fixers" of earth pretty well broken up ; the second, that it be laid in just about under the circumference of the bush (*N. B.*—not the *stem*); and the third, that you see that the fair quantity *is* given, (and as quickly as possible after being carted to the field), and that the coolies do not humbug and make one basket go to more than one bush.—F.

A Cheap Manure.

Dear Sir,—Here is a simple sanitary "wrinkle." It is so simple that one feels that he may be thought simple to suppose that others are so simple as not to know it. *However* ; engage an active, good sweeper, and give him a hoe, and tell him to go round the outskirts of the lines steadily—to be always at it for a fair proportion of working hours of the twenty-four—and wherever he sees any excreted matter, tell him to throw a couple of hoefuls of earth over it.

I am trying this plan this year, and I certainly have found that there has been an improvement. It *may* be fancy, but I hardly think it ; and my nostrils have had a better time of it. Indeed, fairly and broadly, to judge by one's senses, this single sweeper, at five rupees a month, has done a vast deal of good, and without worrying the people.

The man should get instructions to make himself quite aware of the places he frequented ; and should be warned not to give any bother to the people, but to go round about with his hoe after they have gone off to work ; and also to take a turn round before dark.

I think that this plan will be found to be worth the cost, and far over. Of course extensive lines would require more than a single hand.—F.

A Cheap Fertilizer.—This consists of sulphate of ammonia, 60 lbs. ; nitrate of soda, 40 lbs. ; ground bone, 250 lbs. ; plaster, 250 lbs. ; salt, ½ bushel ; wood ashes, 3 bushels ; stable manure, 20 bushels.

A Patent Fertilizer.

This invention relates to a combination of chemicals to be used in connection with dry peat or muck and unbleached ashes, or with any refuse matter having fertilizing properties, to form a fertilizing compound ; and it consists in combining dissolved bone, ground plaster, nitrate of soda, sulphate of soda, and sulphate of ammonia, in proportions substantially as follows :

Dissolved bone, three bushels ; ground plaster, three bushels ; nitrate of soda, forty pounds ; and sulphate of ammonia, thiry-three pounds. This mixture is incorporated with, say, twenty bushels of dry peat or muck, and three bushels of unbleached ashes.

The manner of preparing a fertilizing compound from the above ingredients is as follows : The peat or muck and ashes, if such matter is used as the base of the mixture, are first thoroughly mixed with the dissolved bone, and the nitrate of soda, sulphate of soda, and sulphate of ammonia, after being dissolved in water, added thereto. The ingredients are next incorporated with the ground plaster, after which the compound is allowed to stand for, say, thirty or forty days, when it becomes ready for use.

A New Manure.

A correspondent writes : "I am making some very careful experiments in manures—chiefly saltpetre, which I believe will be found most effective, and being in such small compass, carriage will not amount to much. Experiments on the Government farms at home point strongly to nitre being the chief fertilizer ; also to the necessity of the ground being covered with some quick-growing crop during rains, when the loss of nitrates by drainage is very heavy. I am sowing in Sirgooja oil-seed, which grows very quickly, and I then dig it in a month afterwards. I believe this is one of the cheapest and most effective ways of manuring."

Lime as a Manure.—The importance and value of this is being recognized in Ceylon. A recent letter to the local paper says :—

Within the range of the limestone deposits, indeed, plants either of tea, cinchona, coffee, or vanilla, enjoy an immunity, and this fact attracting attention led to the employment of crushed or rather pulverized limestone as a manure. One garden that had suffered so severely as to be on the point of being thrown up, was thoroughly renovated by the application of two pounds placed round the base of the stem of each plant. The cost of application being for an acre of tea, 2,722 plants, at a task of 5,000 for 3 annas, a little over a rupee per acre. If there is no limestone in the vicinity, the cost of getting it from Bengal would not amount to so much as the indulgence in those highly priced artificial manures at present in vogue.

Lime is the most powerful renovator known (renovation must not be confounded with stimulation, whose effects are transient.) Lime contains all the elements of strength-giving vitality, and plants, so strengthened, will be as well able to encounter disease as a strong healthy man does. The puny effects from renovating pits filled with cowdung and weeds avail little, and cost three times as much as a seer of limestone would. It is unreasonable to expect that our plants of tea, coffee, cinchona, cinnamon or other spices, can go on standing the exacting demand constantly made on their leaves, berries, and bark, without some corresponding nourishment as compensation, and though disease must be endured, our plantations must be strengthened to fight it, even, where it can be afforded, at the expense of abstaining for one whole year from growing a crop, after liming.

SECTION VII.

DRAINAGE.

Importance of Drainage.

Different sorts of Drainage for different Soils.

Sub-Soil *vs.* Open Drainage.

IMPORTANCE OF DRAINAGE.

Drainage, though but very little understood by planters, is a very important operation in the cultivation of Tea. Through the lamentable ignorance, upon this subject, which is displayed by some of the planters on the nearly dead flats of Assam, we have seen parts of a garden where Tea, though repeatedly planted, would not, and indeed could not, grow. We have noticed stunted bushes, with their bark perfectly covered with lichen, which, though itself no cause of disease, is a sure sign that the soil is cold through the presence of a superfluity of moisture, and that, as a result of this, the vital juices of the plants have been chilled and caused to stagnate: the bark has thus become diseased, and in its diseased condition has afforded a suitable resting-place to the lichen.

In Sylhet, drainage becomes a very simple matter; indeed most of the country appears to enjoy a perfect natural drainage,—at least as far as many planters appear to understand its action. The real fact, however, is, that the sole use of artificial drainage lies in the removal of stagnant water from land *visibly* suffering from a water-logged condition; and most, if not all, soils may be vastly improved by a judicious system of drainage, varying in its best methods of performance with the characters and several combinations of country, soil, and subsoil.

The effects of drainage may thus be briefly summed up; *Firstly*, soil, which from surplus moisture was sour and unapproachable by the atmosphere, becomes sweetened by the access of air, and admits of the chemical operation above-mentioned under the head of *simple cultivation*; *secondly*, the removal of the surplus moisture, which by evaporation kept the internal temperature down to a very low degree, causes a much higher temperature to succeed the previous cold condition of the soil; and *thirdly*, where an excess of soluble salts in the soil gives rise to an incrustation upon the surface by evaporation of the stagnant water holding them in solution and bringing them with it by its continual flow upwards through capillarity, the removal of such stagnant water *from below* entirely prevents a recurrence of this condition, while the drain remains in working order.

In commencing to drain, therefore, the first points which should occupy our consideration are, the level of the nearest river, bheel, or rice land, in the cold weather, and also in the highest floods. The next object is a suitable outfall, from whence the system should be commenced, beginning with the main drains, and proceeding, after their completion, with the arterial. A little more attention to this most important operation would soon prove its inestimable value to the tea-planter.

It would be well to stick to the old open drains, taking care to give them a decent fall, and to clean them out once annually during the cold weather. Tile draining would cost a great deal of money, and the drains would, I think, owing to the inordinate rainfall during the wet season, soon silt up and become useless.

The only objections to open drains are the drying of the adjacent soil through exposure during the cold season, and occasionally, if there be a considerable fall, to the washing away of mineral matter—some of it useful as plant food—in a fine state of division.

Pipe and tile drains at home are of course covered in as soon as the pipes or tiles, as the case may be, have been laid; but we must remember that the trifling rain-fall in England renders it impossible, without direct local experiment, to form, from a knowledge of the efficacy of these systems of drainage in that country, any reliable opinion as to the probabilities of their efficiency, or its converse, if tried in the Tea-districts of India,—in some of which they would have to dispose of a rain-fall at least *five* times as great as that with which the British agriculturist has to deal. There is, in our opinion, serious cause for apprehension that by silting up and by choking, from the roots of the Tea-bushes, (for the deeper the drainage, the deeper will their tap-roots descend) the enormous outlay which would have to be incurred in tile or pipe draining,—an expenditure suited only to the performance of a real and permanent improvement—might be utterly and irremediably thrown away.

We have seen made—upon stiff, wet, low-lying clay—open drains which have answered their purpose admirably; they are inexpensive to make, and there is no fear of their ever giving trouble. An ordinarily strong coolie will cut and throw up 108

c. ft. of earth per diem,—that is, each man will do 3 × 3 × 12 feet, supposing the drains to be 3 × 3.

In some of the almost dead levels of Assam, drainage is a very difficult operation, on account of the height in the soil of the water-table in the rains. Without a good outlet, real drainage is of course impossible, and the drain should be commenced not from the top, but from the *outlet*, and be taken thence *up* the slope.

Wherever there is any doubt about the fall of the block to be drained, a "Dumpy" level should be used, and any intervening rises met with in the drain-line be cut through at whatever greater depth may have been rendered necessary by the height of the rise, so as to leave the slope at the bottom of the drain unchecked ; thus, if, at 10 nulls, for a distance of 3 nulls a rise gradually increasing from three inches to sxi inches be encountered, the drain through the said 3 nulls will have to be cut from 3 to 6 inches deeper than the first 10 nulls were dug. If attention be not paid to this point, silt will accumulate wherever the smallest check is encountered, and the drains will require more work in the cold weather to clean out than they would if dug as directed. We should advise to dig the drains, on a field of stiff water-logged clay, at distances varying according to circumstances, but not exceeding 36 feet; some may have to be made even 18 feet apart. The depth will vary greatly with local circumstances, but we should not advise to make drains shallower than 3 feet on the average, and the deeper one can make them the more effectual will be their action. If there be no appreciable fall until near the outlet, (which we are assuming to be some natural water-course, "tola," or river) dig the drains at a depth of 4 feet, or more if necessary at the portion near the oultet, and gradually slope them up to 3 feet, or even less, if advisable, at their termination.

If you have labour to perform both operations in one and the same season, we would advise to drain first and to trench-hoe afterwards, taking care of course, while performing the latter operation, to leave a few inches of untouched earth adjacent to the drains : and if you cannot perform both operations in one and the same season, give the right of precedence to *drainage*, without which the otherwise splendid operation of trench-hoeing would, in water-logged land, be of small cultivatory value to the tea, and would certainly not aid in getting rid of the over-plus of moisture in the soil. We have seen more damage caused to tea in Assam from want of drainage than from any other cause (want of cultivation included), and yet—strange to say—planters are, as a rule, although they admit its utility, reluctant to incur any expenditure under this head.

DIFFERENT SORTS OF DRAINAGE FOR DIFFERENT SOILS AND LAY OF LAND.

In the first place it is absolutely necessary that different sorts of draining should be adopted for different soils. As far as my experience goes—1st, Heavy clayey soil should have deep main drains of say 3ft. deep by 1½ft. wide at bottom, and 4ft. or a little less wide at top. These drains may be placed 4 nulls apart, and running parallel to one another ; cross drains of only 1½ or 1ft. deep by 2½ft. wide at top should run slanting into these (every null apart) from one to the other : this will be found the best for clayey soil, and if they are kept clean twice in the year after making in the cold weather, it should be ample. It is a mistake to throw all the low soil taken out of the drains all over the beds, and as it were raise the centre of the beds ; and yet I have heard this advocated ; surely it stands to reason that drains are not intended to draw away the water from the surface, but from underneath, and the stiff clay spread over the alluvial soil already on the top cannot have a beneficial effect. Moreover, by raising the beds in the centre the surface wash from them will tend to silt up the drains ; yet I have heard people who advocate "pit-terracing" on teelahs, and also water receptacles on flats round each plant, declaring against the low clay soil being left near the mouth of the drain from which it was taken,—simply because it does not look well, I suppose, and because they have always done the other way. Now as regards good dark loamy or fibre soil which has water underneath it, in fact is a floating mass of good soil with the entrance to let the water off probably blocked up, this sort of land simply wants a very large wide drain up to it, and other drains smaller, say $2\frac{1}{2}$ to 3ft. deep, all round it, and in the next year a few surface drains will make it the most valuable of tea soil.

When the drains are first made, let the clay taken out from the bottom of the drain remain where it is put, on the edges, but when the drains are being cleaned periodically, then let the soil be spread about over the beds ; but in no case allow the centre of the beds to be raised higher than the edges of the drains. The reason is this, that the clay soil forms a stiffer wall for the edges of the drains, when in time (say in one season) it gets beaten down by rain, and hoed in until almost level with the surrounding soil, and by its mixture with the more fibre soil or surface soil at the edges of the drains : this in a great measure protects the drains from the sides falling in occasionally; whereas if it had been spread over the bed, it would not have benefited the surface soil from which the lateral roots of the plants get nourishment. Afterwards, when cleaning out the drains, this soil from the drains (which will then be all surface soil) can with advantage be spread over the beds.

SUB-SOIL *vs.* OPEN DRAINAGE.

The question naturally suggests itself, how can planters who have selected bad soils and bad sites, and who have expended considerable amounts of money in their cultivation, retrace their steps ? We will take two instances, connected with the *physical* characters of soils, into consideration. First we shall have regard to gardens which have been established on steep slopes, on the sides of hills. The common complaint of their managers is the gradual impoverishment of the soil occasioned by each rainy season. The force of the water crossing over the lands, removes, year after year, portion of the uppermost, *i. e.*, the most fertile lay of the soil, and the wash resulting from the resistance of the tea-plant is sometimes so great that the roots are laid bare. Such a tea-garden is placed at a great disavantage, for the higher the soil is cultivated the greater the loss. Much digging during the rainy season is out of question ; weeds consequently spring up in abundance, and any manure which may happen to be applied is sure to be washed down, to benefit the nullah or river.

The remedy which appears to us to meet this case is the construction of a network of drains, 2 to 3 feet deep, firmly embanked on both sides to a height of 12 to 18 inches.

We would make each area enclosed in the first instance not less than 100 yards square ; but in any case the drainage should be sufficient to draw off all rain water *through* the soil, and prevent it from washing *over* it. The expense thus incurred will, in our opinion, be fully compensated by the lasting benefits accruing : first by staying the further impoverishment of the land, and secondly by permitting a high cultivation of the soil.

From site we will pass to soil, and take into consideration tea-gardens where a not less serious error has been committed in the selection of the soil. We refer to those which have been established on heavy clay soils, either throughout, or porous in the upper layer, say for a couple of feet or so, but containing in the lower layers strata of impermeable clay which not only obstruct the passage of the tender rootlets of the tea-plant and force it to become a surface feeder, but result also, in insufficiently-sloped sites, in the formation of stagnant water, so fatal to the plant.

Sub-soil drainage is the means open to the planter to improve such gardens. We should have drains not more than 20 yards apart on level or only slightly sloping lands, and not less than six feet deep on steeper slopes.

This distance may be increased, and as material, such as tiles, pipes, &c., would be out of reach of the majority of planters, we would form the drains by stones, loosely put on a basis formed of twigs and boughs, and then level up with the dug-up soil.

The results which can be expected from thus sub-draining a heavy clay soil will be better understood when we bear in mind that in most clay soils the portion within two feet of the surface is almost always more retentive than that which lies below ; simply, we apprehend, because its particles have been comminuted, and pack closer by the alternative influence of wet and dry, heat and cold. Fine-dried below by drains, and above by evaporation, it is certain to crack and become impermeable and friable by the access of the atmospheric air, thus allowing, in course of time, the most tender rootlets of the plant to pass through.

This is of great advantage in flat gardens, or where the soil is damp : it removes all water which might remain, and keep the soil *cold, damp, and sour*. One can notice the advantage derived, the plants looking so healthy ; and after heavy rain, *the water can be seen percolating through the sides of the drains, which otherwise would have remained* about the roots of the bushes, keeping the plants cold and non-yielding. Open drains 18 to 20 ft. apart, 2½ to 3 ft. deep, 12 to 15 inches wide, are the kind which do best on the face of nullahs. There should be no surface drainage. All rain falling on soil should have to pass through it, not over it. Thus not only do we get all the valuable manuring properties in the rain, but no manure or rich surface soil is washed away. This can only be done by throwing the earth from drains on either side of their top, so that it is higher than the rest of the land ; 20 ft. apart is the distance to give for each drain, but of course this would depend on soil ; 3 ft. is minimum depth which would be any good. The author contemplates covered drains, but I am told by an Assam man who has tried draining, that open ones do equally well, and are of course much cheaper. The late Dr. Barry, he tells me, effected wonderful results by draining.

I have only partially tried this thorough draining myself, but have seen wonderful results therefrom, and am now going in for it thoroughly. Professor Johnson, in his work *The Elements of Agriculture*, says, page 183, that it is only in naturally dry or artificially drained land that a plant can at all benefit from high cultivation or rich manure ; and I have myself seen tea refuse to grow in particularly rich soil well manured and cultivated : simply, I now see, because it was not properly drained.

I write this simply to challenge any experience against Professor Johnson's views on draining being applicable to this country : they certainly were written for England, though his arguments equally apply to any country, *vide* p. 165 : " It is a curious and apparently paradoxical observation, that draining often improves soil in which the crops are liable to be burned up in seasons of drought."—T. T. T.

SIR,—If your correspondent T. T. T. wants to determine whether sub-soil drainage is applicable to India, let him apply to Mr. Robertson, Superintendent of the Sydapet Farms, Madras, where it has been introduced on a very large scale, and found successful. To be sure, expedients carried with half-heartedness can never be successful.

No other system of drainage can possibly beat covered drainage : next to this is the plan which your correspondent has adopted, *viz.*, open drains fully 5 or 6 feet deep, with both banks raised, so that water cannot flow, but must percolate, into the drains. With light soil they ought to be 20 nulls apart, but with heavy clay there must be a drain every 10 nulls.

A NOVICE IN TEA.

P. S.—Open drains are objectionable when a field is ploughed, but not hoed.

SECTION VIII.

TEA SEED AND TEA SOWING.

Picking and sowing Seed.

Tea-seed garden.

Seed sowing.

PICKING AND SOWING SEED.

By Percy Swinburne.

The seed should be plucked when it is quite ripe, which is generally in October and November. When the seed is ripe the capsules lose their fresh green colour, and turn dry, and dark, and finally split, allowing the seed to fall. The difficulty is to avoid plucking the seed too early, as unripe seed will not germinate, and also plucking too late, when a large proportion may be lost. A few seeds daily gathered and cracked will show which part of the garden is ripening. The capsule being broken, the shells of the enclosed seeds should not be too thin, and the kernel should not be all pulpy, but consistent and not too wet. The seed when gathered should be spread thinly, about 2 to 3 inches in thickness, on a machan in a cool house, and turned over three times a day. If it is collected in heaps, and allowed to sweat, it is completely ruined, as sweated seed will not germinate. If it gets too dry on the machan it should be sprinkled with water. After being turned over on machan for ten days, it should be ripe, and the capsules will most of them have split, and those which have not, must be cut in order to get the seed. It is not advisable to put the seed in the sun in order to get the capsules, but it is better to let them split naturally in the shade. The seed now being passed through water, any light seed which floats is rejected. It is now packed in boxes, which contain one maund of seed, and about one maund of mixed charcoal-dust and mould. First, a layer of seed, mixed with charcoal-dust and mould, is put into the box; then, a sheet of paper to cover this is pressed down, and the operation repeated until with alternate layers the boxes are full. Although the contents of the box be pressed down, they become loose in the box and shrink in transit, and this is really an advantage, as the seed is turned over whenever the box is moved. When the seed arrives at its destination it is at once tested. It is also generally tested on the road by a forwarding agent who is a disinterested party. The best way to test seed is to take 100 out of a box in different places, and crack them, counting the percentage of good, bad, and doubtful ones. Seed often arrives very dry, in which case it is very difficult, if not impossible, to give the percentage within 10 per cent. Anything over 90 per cent. is excellent, over 80 per cent. good, and over 70 per cent. fair. 70 per cent. is often guaranteed good.

Germinating.—All tea-seed should be germinated in beds or pits, whether it is to be planted in nurseries or seed at stake. On the arrival of seed the boxes should be opened at once, and any germinating seed, even if it has only split, should be planted in the nursery without delay. The seed which has not already germinated in the boxes should be passed through water. That which floats is altogether bad, or else the kernel of the seed has shrunk. Seed will endure for a time excessive moisture, as well as excessive cold or heat, but it succumbs to a sudden change from one to the other. Seed which has become very dry or shrunk should therefore be placed in almost dry soil, the moisture in which should be slowly increased as the kernel of the seed swells within the shell. The seed which shrinks can be placed at once into well-moistened soil, and as it cracks it should be put into the nursery. A plan which has been adopted with great success is to choose suitable places for germinating-beds in the jungle adjoining the nursery. Bamboo jungle is the best, as the soil of it is friable. Moist and well-shaded hollows can be found, as well as places which are almost dry. A space of about 5 feet square for every maund of seed is cleared, and dug to a depth of six inches: the soil is removed to one side, and the surface smoothed. The seed is then spread out, and the soil, which has been previously thoroughly pulverised, sifted over it. If the seed is very dry it is placed in almost dry soil, and removed every three days to a moistuer place. Nothing is more fatal to dry seed than to be at once watered heavily in either pits or nurseries. The moisture in the pits can be regulated to some extent by the quantity of jungle branches which are spread over the bed as shade, the shade of the overhanging jungle not being heavy enough. In sowing in the nurseries, care should be taken that it is not sown at too great a depth. The shallower it is sown the better, as if the seed becomes exposed, soil can be easily sprinkled over it. Seed which is healthy and almost bursting can be sown 3 inches deep with less danger, but light dry seed sown at this depth almost invariably rots. The seed should only be just covered with soil, and the whole covered thickly with dead leaves. It must be borne in mind, however, that the soil shrinks in drying, and seed which is lightly covered with soil becomes exposed. The rain also beats some of the light surface soil away. The top of the seed should be about half-an-inch below the surface ; but as it is impossible to ensure accuracy, it is better to err on the side of planting the seed too near the surface. The nurseries being daily watched, and the dead leaves being brushed to one side, in a few places, any exposed seeds are soon detected, and a few children with baskets of moist well-pulverised soil go round and cover them up. Besides the dead leaves, the beds should also be protected by a "chull," or rough bamboo framework supporting sungrass, or any kind of grass or branches which can be bound together so as to serve as a raised shade. This should be about 3 feet high, running along the bed, and not covering the drains which serve as paths. If the grass or mill is supplied to them, the Bengalees will run up the chull with kae bamboo, or any other kind which may grow near, for 1 anna per nul of 12 feet, that is to say 54 square feet, as the beds are $4\frac{1}{2}$ feet wide. Nurseries in low-lying tâl land treated in this way will never require watering, but if they are situated in places where the soil is liable to get too dry, they should be watered freely. All nurseries should have a path round them, and be continually watched, the jungle adjoining being cleared away for some distance to prevent risk of fire ; and if any animals, wild or tame, are likely to stray in that direction, they should be surrounded with a fence.

Seed Rake, and distance apart of Seed.—If the nursery is to be planted out when it is six months old, the seeds will not be too near at 3 inches by 3 inches. If the plants are to be allowed to run for eighteen months, 6 inches by 4 inches would be about the distance. Seed-sowing-rakes, with pegs driven in at the required distances apart, may be made either singly or of several rows joined together, and they are very useful, saving labour, and regulating the work.

Col. Money gives the following figures regarding seed, but remarks that the higher the class of plant the less durable the seed :—

Seven maunds seed, with capsules, give 4 mds. clean seed.

One maund clean seed	(fresh)	= 26,000 seeds.
,, ,,	(ten days old)	= 32,000 ,,
,, ,,	(one month old)	= 35,000 ,,

Say therefore, in round numbers, that one maund Tea seed = 30,000 seeds.

With good Tea seed, sown shortly after it is picked, about 20,000 will germinate.

If you get 8,000 to germinate with seed that has come a long distance, you are lucky.

After a two months' journey 3,000 is probably the outside which will be realised.

TEA-SEED GARDEN.

1st.—Should leaf not be plucked, the crop of seed would be double of what it is when both crops are taken

It is very difficult to state any average, as so much depends on circumstances, and there are not a sufficient number of purely seed gardens to draw a reliable average from.

2nd.—The soil best suited is that which is dark in colour, friable, and rich in organic matter. The deeper these qualities continue, the better the soil.

3rd.—With good indigenous seeds the bushes might be planted 8′ × 8′ or 10′ × 10′, if land be not scarce. They ought never to be nearer than 6′ × 6′.

4th.—Weeds ought never to be allowed to interfere with the free growth of the plant. Some (richer) soils grow more weeds than others, and require more cleaning.

A good deep hoeing in the cold weather, just after the crop has been taken off, is a good thing.

5th—Hand weeding and the use of the koorpee for the first year, and light hoeing enough to keep the weeds down afterwards.

6th.—If planted 10′ × 10′, the bushes ought to be allowed to grow to the height of 4 feet before they are "headed down." If 8′ × 8′, a height of 3½ feet is sufficient. If planted 6′ × 6′, a height of 3 feet is preferable.

The bushes ought to be made to throw out lateral branches as much as possible, and for this purpose may be plucked about once a month after they have reached their appointed height. Should the bushes grow too vigorously in height to be kept down by plucking, the knife may be used, but constant plucking is a bad thing for seed. Once a year, after the removal of the crop, and before the deep hoeing, the bushes should be pruned down to let in the light and air.

Seed is ripe when the capsule becomes brown; and when breaking the latter, the inner brown covering of the seed adheres to the seed, and *not* to the capsule.

SEED SOWING.

SIR,—In a controversy of this kind you should first look to what nature does, and conform as far as is practicable.

In its natural state, in the jungles, the seed is sown with no covering at all more than a few leaves that may casually fall. It is certainly grown in shady jungle, and possibly a small percentage only is productive.

In adapting the plant to our artificial purposes we cannot follow out nature entirely, but we should endeavour to differ as little as possible.

In selecting a place for your nurseries, you choose a spot that is sheltered from the afternoon sun by a belt of jungle or bamboos. If the soil is dry, as it often is in the cold weather, instead of going directly against nature, and placing the seed unnaturally deep in the soil, you should endeavour to assist nature by providing the soil with an artificial shade of branches or grass, care being taken that the shade isn't too dense, and that it is removed at the proper time.

If you examine a young seedling, you will find that the coverings provided for the roots and the stem are of two distinct kinds,—that of the stem being most delicate, while that of the root is of a very tough nature, and the impression given is that the split seeds provide an outer covering to the roots to specially protect them. This covering springs from the seeds; should the seed be sown near the top of the soil, the plant sometimes takes it up an inch or two above the ground; but should the seed be sown deep, the soil prevents its rising; *the extra covering ends at the seed*, and the part of the stem in the soil has to bear the attacks of insects, the caking of the earth, &c., without any extra covering.

I don't know on what scientific ground any man can advocate deep sowing, and, in practice, I know it is ruination to fine jât; and though it may not have the same effect on hybrid and China, it may account for many sickly or backward nurseries and clearances. I sell a large amount of Indigenous seed to all parts of India, and I have known cases in which seed sown deep has come up most satisfactorily, but during a "hot spell" the plants died off in lines. No reason could be given at the time, but it was afterwards proved that the seed had been sown unusually deep, and that the soil caking, and catching the plants in an unprotected part, had killed them off.

There is such a difference in the soil, temperature, and rainfall of the various tea-growing districts, that a hard and fast rule could hardly be laid down for most of our operations; but in seed-sowing we must endeavour to assist nature as much as possible, and afterwards you will probably find that nature will provide for the plant in its artificial existence.

SIR,—With reference to the sowing of tea seed, I have found one inch of well pulverised earth quite sufficient to cover the seeds with, but the ground should be keept damp, eithen with shading or watering, or both.—X.

AS TO DEPTH OF SOWING.

SIR,—I note in your *Gazette* a correspondent wishes you to invite discussion on the subject relative to a correct depth of sowing Tea seed, and I also notice he mentions, in a later number of the *Gazette*. "Your correspondent, a man of 20 years' experience, advises sowing seed 3½ to 4 inches deep."

I fancy he alludes to my article of 20th February, "The Laying out and Cultivation of a Tea Garden," and to the first paragraph in it, which dealt with the subject of nurseries; but if so, he has misquoted me with regard to the depth I advocate sowing seed. He quotes me as having advised sowing seed 3½ to 4 inches deep, whereas I very distinctly mentioned 2½ to 3 inches as the best depth to sow, according to my experience. But mine may not have been the article he alludes to.

But let that be as it may, since it is required to discuss the subject of correct depth for sowing, I would like to mention the following:—

I have planted seeds, as an experiment, from 1 inch to 6 inches. The seed at 1 inch came to nothing; it germinated, was a weak plant, and dried up. The seed from $2\frac{1}{2}$ to 3 inch depth came up well, and turned out healthy plants; 4 inch depth rather weakly, and seed at 5 and 6 inches never came up at all.

This was a trial I made for my own edification in my early days of tea planting at Borkholla tea garden, when managing the southern Division of the Brahmapootra Tea Company's Garden. A sirdar still in the Company's service there can verify what I state, and I am only too happy, for the interests of tea cultivation, to give my experience on the subject. Your correspondent states, the effect of deep sowing is to kill the plant should you have a run of hot dry weather. "The soil cakes, and causes a sore in a very tender part of the stem." I consider and say it would be the reverse, for if we had a run of hot dry weather, and planted no depth, 1, $1\frac{1}{2}$ and 2 inches would never show any seedlings, and I fear the writer would have very few healthy plants, if any, to show in his nurseries.

Why should seedlings once having appeared above ground, be liable to suffer any more, from any sore in a tender part, if the seed from which it germinates, was planted 1 inch or 4 inches? for I take it your correspondent means that the sore he mentions arises from chipping of the sides of the tender seedlings against the edges of the surface of the soil, which of course in dry weather is naturally hard and jagged. That is, the sore he complains of breaks out at what is called the collar of the plant, and any seedling through the ground would be equally liable to dry weather and consequent chipping. But that which sprang from seeds deepest sown would, I should say, be strongest in the stem before coming through the surface, and therefore better able to stand the chipping or friction against the edges of the soil, caused mostly from winds or atmospherical disturbance. But perhaps the collar of the plant is not the part your correspondent alludes to. It would have facilitated a discussion of the matter, which your correspondent gives us to understand was his object, had he mentioned exactly the *particular part of the seedling* which he considers so tender, and the exact nature of the sore he has discovered arising from sowing tea seed over any depth beyond that sufficient to cover it, which would be under *one inch.—John Wallace.*

In a later number of the *Gazette*, your correspondent—a man of 20 years' experience—advises sowing seed $3\frac{1}{2}$ to 4 inches deep. This may do for some soils and climate, but it has ruined many nurseries of pure Assam *jât*. The effect of deep sowing is to kill the plants should you have a run of hot dry weather—the soil cakes, and causes a sore in a very tender part of the stem. Seed ought to be just covered. Men go very much by the rule of thumb, and you have done good by having noticed the subject.

SOWING AT STAKE.

SIR,—In a clearance made by me last season I planted 4 seeds at a stake. Almost all have come up, strong, healthy plants. These surplus plants I do not require for further extensions, and I want to know whether I should leave the plants as they are now, or pull up and throw away all but one at each stake. I may state that the jât is a good hybrid, the distance planted 5 × 3, and the garden a flat.

Will any of your readers be good enough to give me their opinions, or experience, of leaving 3 or 4 plants to grow up together in a clump, and if against such, when is the best time to weed out the extra plants?—*A young planter.*

"A Young Planter" asks us if he should pull up some of the plants which have come up (the whole four seeds sown at stake having matured). The distance planted is 5 × 3, and the garden is a flat. We should say better leave the plants alone. A bush with four plants is worth the plucking, and the distance is sufficient to give adequate room.

Sowing is named "at stake" because stakes are put along in lines to show where the Tea-trees are to be, and the seed is sown at those spots.

The *modus operandi* is very simple. A month before the sowing time (which should be as soon as you can get the seed) at each stake dig a hole at least 9 inches diameter and 12 inches deep, put the soil taken out on the sides, taking care however, if it be on a slope, to put none *above* the hole. Do not put the soil near enough to the pit, to make it likely it will be washed back. Such soil as should be washed in ought to be the new rich surface soil. For this reason the upper side of the hole should be left free on slopes. The pits are made a month beforehand to admit of this, and to allow the action of the air on the open sides to improve the mould.—*Col. Money.*

Seed put down in Nurseries in beds of $3\frac{1}{2}$ feet wide, with drains of 10 inches and main intersecting road of 4 feet, in rows 4 inches apart and with $1\frac{1}{2}$ inch space between seed in rows, occupies 17 nulls per maund, or say half an acre for 9 maunds. If 3 inches between seeds in rows, half an acre for 6 maunds.—*Dowling's Tea Notes.*

PRESERVING VITALITY IN TEA SEED.—A correspondent of the *Ceylon Observer*, writing on the above subject, says:—" Mr. R. D. Cruickshank, a returned Assam tea planter of ten years' experience, had made the discovery in India that tea and other similar delicate seeds, can be kept sound and vital for a considerable length of time if packed in air-tight boxes amidst perfectly dry mould. He recommended the use of strong, loamy soil which had been thorougly dried in the sun, afterwards broken small, then passed through a fine sieve; and it was stated in the letter that tea-seed had been kept sweet and in life for fourteen months by that simple plan, germinating readily and without appreciable loss at the end of the period. As a visible proof of the honesty of the assertion, it was further mentioned that, before leaving India, Mr. Cruickshank had gathered some tea-seed on the 1st November 1879, preserved it in dry earth hermetically sealed tins, and had it planted near Glasgow in one of the Garscube hothouses on the 20th June 1880. Every seed germinated, although the removal from tropical Assam to temperate Lanarkshire, and an interval of nearly eight months must have proved a crucial experiment."

SEED.

16,000 seedlings raised from the 30,000 seeds which a maund is supposed to contain, are a fair average to expect. Planting 4 feet by 4 feet, 2,722 seedlings fill one acre, and a maund of seed is thus about enough for $5\frac{1}{2}$ acres of new land.

SECTION IX.

TRANSPLANTING.

Importance of Special Care regarding.
Jebens' Transplanter.
Filling-up Vacancies.

TRANSPLANTING.

By P. Swinburne.

Staking.—If the land is flat, the lines can run accurately and uninterruptedly for long distances, but it is almost hopeless to aim at this result on land much broken. The main-section roads can be used as base-lines, the staking can be done diagonally or in square, thus:

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*   *   *   *                      *   *   *   *
  *   *   *                        *   *   *   *
    *   *                          *   *   *   *
      *                            *   *   *   *
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Two lines should be worked together to ensure accuracy. Three men work, on one line, at the nerrick of 1,200 stakes, or 400 each. It is sometimes asserted that an advantage is gained by diagonal planting, because a greater number of bushes are included in the acre, with no loss of growing-space. This would be true if bushes always grew with their roots and branches in circles, but on the contrary they have a wonderful power of adapting themselves to circumstances, and bushes planted squarely waste none of the space or ground for the sake of preserving their symmetry of shape. The most approved method of planting is 4 by 4 feet square for hybrid, and 5 by 5 feet square for indigenous. The indigenous plant is supposed to grow larger and require more room than the hybrid, and no doubt it is a taller and larger tree in its wild state than the latter is capable of becoming under similar circumstances; but the chief reason that indigenous bushes under cultivation are usually larger than the hybrid is, that the first are expected to grow larger, and are more lightly pruned and plucked. It would be hardly profitable in these days to plant out places where, on account of the poverty of the soil, the bushes did not at their maturity meet across the rows at 4 by 4 feet; and there are very few plants where the soil is rich enough for a reasonably quick return from 6 by 6 planting; consequently, 4 by 4 feet and 5 by 5 feet are the distances now generally adopted under peculiar circumstances, such as hedge-planting, to avoid wash on slopes.

Planting.—The success or failure of an Estate depends on the way the plants are planted and cared for when they are young. Consequently, no reasonable amount of trouble should be spared in this particular, and also in extra-careful cultivation during the first two years. It has become a custom to aim at a lower and lower capital account, and "to rush out" large areas quickly, but it is much safer to push economical reforms in the working expenditure when a Garden is in bearing, than when it is being made. The good old custom of planting each little plant with a ball of earth is abandoned as being too expensive, and everything is sacrificed to being able to show a large acreage at a low cost. A few trustworthy and experienced hands should be told off to the duty of cutting the seedlings out of the Nurseries, and they should not be changed, and long cutting-instruments, the shape of kookie-dhows, should be given to them. A trench is cut at one end of the nursery-bed, and the plants taken out in rows, with balls of earth, and as often as possible with none of the root exposed. Two baskets-ful of plants are carefully carried in a banghy by one man. The hole-diggers should each carry a piece of bamboo one foot long, and the most unwavering firmness must be shown to keep the depth of the holes up to the required standard. A plant planted in a large hole grows more quickly and vigorously on account of the cultivation which has been given to the soil around and beneath it. At the commencement of the planting, the manager should take his assistant and the baboo and the planting-sirdars to one side, and should with his own hands plant a seedling as systematically as possible, and each sirdar should in turn do the same, so that no contrary orders can by any possibility be given to the coolies. First, the plant should be taken up in the left hand, the ball of earth resting in the palm of the hand,—any part of the tap-root which may be exposed being allowed to run through the two middle fingers. Next, the plant is held against the side of the hole close to the stake left on the same side of the hole. The soil is drawn in with the right hand, and pressed round the tap-root and sides of the plant until the left hand can be released. Now, the planter using the handle of the short kuntee, beats in the soil lightly down below and round the sides of the plant. This last is very important :—seedlings, or large plants transplanted into loose earth, invariably suffer severely in consequence. The Nurseries may be more forward than usual, and a heavy shower or two, measuring about an inch to two inches of rain, may fall early in April, and the planter is tempted to begin operations ; but it is dangerous to do so, as at this time of year the sun is very strong, and two to three weeks of droughty weather may follow the showers. The little seedlings are too young and delicate to stand the drought immediately following the shock of transplanting. As the seedlings in the Nursery appear above ground, the shade should be gradually removed, and when the bulk of them are up, no shade should be left : this hardens them ; and by the first of May, if the Nurseries are forward ones, a faint tinge of red will be noticed in the stem near the collar of the young plants, showing that the wood is ripening. Now, the planting can be done with safety, as a fortnight without a heavy shower seldom passes in the month of May. The soil should be moist at time of planting. Dry weather will not injure the plants if the soil be moist. When the rains have not yet fairly set in, and the sun quickly dries up any loose soil, it is necessary to dig the holes as the plants are put into them. In the rains the hole-diggers can be kept two to three days' work ahead of the planters, and shallow holes are then easily detected. After a heavy shower of about two inches, the planting can be continued for 4 to 6 days even if the weather is hot and dry, but it is then advisable to suspend the work until the next shower has again moistened the soil. This applies more particularly to districts which are subject to drought, such as Sylhet. An extra row in every ten is sometimes planted for filling up any vacancies which may occur, but this—though an excellent plan otherwise—is too costly, because almost as good a result may be obtained by transplanting the surplus plants from the Nurseries, which is a much less troublesome and costly operation. If only 10 per cent. vacancies as a rule occurred in original planting, it might be worth while adopting the more costly plan, but 20 per cent. would be nearer the average.

Nericks for planting, and planting without earth, with the best time for the latter ; *marking out into sections, &c.*—Unless the Garden is flat, and can be easily divided into sections of uniform size, it is better to use natural boundaries, such as hills and streams, as much as possible, making the area of each section not less than 10 or more than 30 acres. The straight paths running north and south and east and west will as a rule form one of the boundaries of each of the sections. The average number of plants per planter, including hole-digger, lifter, carrier, and planter, should be about fifty—that is, fifty plants for a hazree of 3 annas. In very wet weather, plants may be lifted from the Nurseries without earth, and carried in bundles. Holes a foot deep can be easily made by driving a pointed bamboo into the ground ; and, the plant having been placed in the hole, a new hole is made on one side, and the earth pressed tightly against the roots by the leverage of a long bamboo. In this way 200 plants or more can be put out for 3 annas. The hole at the side of the plant can be left without danger of injuring it. The sections may be again sub-divided into "pies," or plots of one day's full task or nerrick. The plots should be of equal size, and permanently marked out by stone heaps, or earthen mounds sodded over. From 25 to 30 nulls (144sq. feet) is a convenient size. If three men work together, they can mark out 40 to 50 pies a day, and raise up small mounds at the corners. The mounds can be gradually increased in size, and sodded as they are hoed, each man repairing one of the mounds of his pie. The pie-makers follow the planters, and, the newly-planted area being marked out, an accurate check is kept upon the daily area planted. In 4 by 4 feet planting, 16 bushes square, 256 bushes make a convenient pie of about $28\frac{1}{2}$ nulls, and between 10 and 11 pies to the acre. In 5 by 5 feet square planting, 12 bushes square or 144 bushes make a pie of exactly 25 nulls, or 12 pies to the acre; 13 bushes square of just over 29 nulls, or $10\frac{3}{4}$ pies to the acre. It is a matter of no consequence to the planter that his pies should measure an exact number of nulls, or that a certain exact number of them should represent an acre. What is of more importance to him is, that his pies should be of a convenient size, and they should fit in with the rows of his planted bushes. A register is kept showing the exact number of pies in each section, and these can easily be converted into acres, roods, and poles, to be entered in their proper place. The great advantages of the pie-system are, that better work can be secured with less supervision, and that there is much less danger of favouritism and short measurement. When a section has been laid and hoed, every man should stand at the corner of his pie, and the assistant should go out with a writing-sirdar and pass up and down the rows, the men's names being written down ; or, better still, he carries a bag containing a number of tickets equivalent to the number of pies in the section. Any bad work is at once detected, and paid for according to its merits. Coolies will not do bad work if they are encouraged to do well, and are kindly treated ; and, most important of all, if they know they are sure to be found out : consequently, very little supervision is required beyond that which is done at paying-time. When the pies are originally made, a chain the length of one side of the pie should be used, so that the planting may always be checked by the chain ; and when there is any difficulty, or when there is a fault in the staking, and the rows of plants do not agree with the chain measurement, the latter may be followed.

TRANSPLANTING.

By Sioma.

Having raised a lot of vigorous seedlings, six to eight inches high, it will be necessary to remove them from the nursery-beds, where they would cramp and stunt one another, to their final home in the tea-fields, as soon as the rains have saturated the ground. The holes or trenches which have already been dug and staked out will require to be hand-weeded, and the less-dug land between them lightly hoed over, so that the seedlings may have a fair start with the weeds, which will increase in vigour and numbers as the rains continue. The fields must all be freshly stirred and weeded just before the rains commence,—for a day lost in the Transplanting Season means a week's loss of growth to the seedlings ; and were the first six weeks of the rains to be lost, it would be tantamount to the loss of a year's growth. This estimate may at first sight seem overdrawn, but let any planter compare plants transplanted in June with those put out in August : six months after being put out, that is, in February, the June plants will be well-grown thriving little bushes, while the August plants will have hardly a new leaf, and a serious percentage of them will die in the ensuing summer. The causes of such different results are obvious : the seedling put out in June is a small one ; consequently it was easily lifted out of the Nursery, and was better transplanted in every way than the August one, which had a much longer taproot, was most probably injured in being lifted, or was bent and altogether badly housed in its new abode. The June seedling sustained a gentler shock, and recovering, easily, pushed its roots deep and wide during six-months when the earth was easily penetrable, and these probably put out four or six-new leaves, when the August one was newly transplanted, and was trying hard not to die of the shock to its entire system. However, it manages to live, and just begins to push out its roots, when the rains stop, the ground becomes hard, and the weather becomes cold ; and then, good-bye to all growth, and a struggle for bare existence commences. Meanwhile, the June seedling, now developed into quite a respectable little tree, manages to live very comfortably through winter and summer, being able to reach moisture with its longer tap-root.

However, to return to the business on hand,—*Transplanting.* The Nursery having been equally saturated with the rest of the land to be planted out, and having been kept scrupulously weeded, and the crust open for the past months, a trench is dug at the end of a bed, about six or eight inches wide, and two inches deeper than the longest tap-root. A long four-pronged fork, fourteen inches long, with a breadth of ten inches, is pushed straight in, right in the middle of the space between the first and second line of seedlings, and when deep enough, pushed forward towards the trench, when a clod, containing three or four seedlings, topples into the trench, but is just saved by a coolie who picks it up, divides the clod equally, and, gently squeezing the rather stiff clay, raises each plant into a cone, deposits it carefully in large shallow baskets, with all the balls of earth inside, and the little plants in a fringe all round the edge. The forker keeps on row after row in regular order, never treading on the plants, but standing in the side path and disengaging half the row from one path and half from the other. As soon as a basket of plants is collected, it must be immediately carried off to the transplanters, who, *koorpie* in hand, make holes large enough to admit the ball of earth round the plants, which, being placed upright, the earth is replaced, and firmly pressed down all round. Care should be taken not to imbed the plants right up to the collar, as the earth is sure to sink, and the plant will be buried too deep by the end of the rains.

It will be seen from the above, that if the plant is properly lifted out of the Nursery with a fair amount of earth round it, but little care will be needed to transplant it properly ; but it often happens that the Nursery having been badly made, and the seedlings carelessly lifted, they are received by the transplanter without any earth round about the roots ; in fact, some planters send the plants tied up in bundles like bunches of carrots, and trust them to the tender mercies of the transplanter, to be stuck into badly-dug land anyhow.

If it should happen that the seedlings are bare of earth round their roots, the transplanter should dig his *koorpie* into the earth : and, working it backwards and forwards, make a wedge-shaped opening. Into this the plant should be carefully introduced, with the tap-root as straight as an arrow, and the earth firmly pushed back into position. A tea-plant will stand a good deal of illtreatment, yet there are limits to its endurance. If possible, transplanting should be carried out under constant European supervision, and, in default, the most careful, though slow and plodding, native on the Estate should superintend, and be held solely responsible. Remember, no after-care will compensate for a badly-planted lot of bushes. Good luck may befriend in all others save this one great operation.

TRANSPLANTING!

Importance of Special Care regarding.

It need hardly be said that the operation of Transplanting is one requiring special care and attention, and it should be closely supervised by the out-door manager. The native's idea is, that if he raise the plant out of the ground it is sufficient, and he is quite regardless of the fine suckers which he may break off in the process. He fails also to see the necessity of at once, on removal, *replanting*, and is content to accumulate a good heap of the young plants, so as to save himself trouble in going backwards and forwards. This should not be allowed, but as soon as a small basketful of plants have been unearthed, they should be at once replanted.

Col. Money gives good advice as to the subject of preparing the plant for removal, by moistening the soil. This is most important, as even with the use of a proper transplanting tool, the soil is apt to fall away in removal unless adherence be caused by sufficient moisture applied beforehand. This is what Col. Money says on the subject:—

On the day you intend to take up the seedlings from any bed, if you have water enough at command, flood the bed. This, as you take up each seedling, will cause the soil, being moist, to adhere better to the roots.

The difference between young plants transplanted with a ball of earth round the roots, and those moved with their roots bare, is no less than three months' growth, if even it does not make the difference between life and death.

* * * * *

Four or $4\frac{1}{2}$ feet are, I think, the best distance between the lines.

They give space enough for air to cultivate, and to pass along, even when the trees are full grown.

Where manure is obtainable, and the soil can be kept up to a rich state by yearly applications, a garden can scarcely be planted too close.

I see no objection to trees touching each other in the lines.

On considerable slopes, to prevent the wash of soil, the plants should be placed as close as possible, say $3\frac{1}{2}$ feet between and 2 feet in the lines.

We do not know whether a patent Transplanter invented by Mr. Jebens, is as well known as it should be. It is a cylindrical tool, to be placed over the plant, lifting it and its surrounding earth for a foot space. The following extracts refer to it :—

Jebens' Transplanter.

Sir,—There is nothing like Jebens' Transplanter for lifting year-old plants. A Cachari coolie whom I employ for the work, lifts 400 plants in a day. If the whole length of the cylinder be driven, and thus a foot of earth be secured, there is no danger of the plants dying, provided they are not more than 18 months old. It requires a little skill in discharging the cylinder of its earth and plants. The foot put on the bar should be kept steady, while the hand will raise the handle and cylinder.—*Hanstir.*

Mr. J. W. Mountjoy, of Pandawbrang, Arracan, writes as follows regarding these tools :—

" The Transplanter has, in working, proved to be a complete success. The fact is, the young plants do not know that they have been transplanted. No manager of a Tea or Coffee plantation, who had once seen this instrument at work, would ever again be likely to recur to transplanting by hand, and not a single seedling should die when removed from the nursery and carried to its place of ultimate growth by means of the transporter.

Sir,—Allow me to inform your correspondents in hill districts, such as Hazaribaugh and Loharduggah, where tea is extensively grown, that it would be nothing uncommon to transplant 18 months' seedlings with a Jebens' Transplanter.

The growth of tea in those districts is very slow in comparison with Assam and such places, and if seedlings be left for 18 months in a nursery, they do not, as a rule, grow more than a foot or 15 inches in height.

When intended to be kept thus (a common custom) the nursery is previously hoed only to a depth of one foot, which prevents the roots from striking deep.

Before using the Transplanter, the ground should be well saturated with water.—*Up Yonder.*

FILLING UP VACANCIES.

The filling up of *vacancies* is one of the hardest and most thankless tasks the planter has imposed on him. The old saying, "prevention is better than cure," is nowhere better illustrated. The bulk of vacancies are undoubtedly due to careless planting at the very outset. If all that care and labour could do to preserve plants in the first and second year of their existence was done, there would be about ninety per cent. less vacancies to complain of. Lengthened and severe drought of course is a calamity which no forethought or trouble could successfully cope with; but the poor seedling's careless transplanting, and the unchecked ravages of insect pests, should certainly not, as they very often are, be allowed to be causes of patchy unproductive fields of tea. A certain number of vacancies or deaths among the best-planted acres must be inevitable. Some three to five per cent. may be completely beyond the help of man, and a certain percentage of plants will degenerate and certainly occupy a place, but yet be quite unproductive. However, the fact remains, that whatever be the cause, fully ten per cent. of an entire plantation must be replaced or replanted almost entirely. This may seem inapplicable to certain splendid-looking patches or few acre plots, but let an acre's full enumeration be made of plants *non est* or unproductive for some reason or another, and the above estimate will be more than confirmed, it is much to be feared. If, as soon as the transplanting is finished, the newly-put-out plants be carefully examined and persistently filled up with the best seedlings from the *supply* nurseries during the remainder of the rains, and from the *reserve* ones the second and third year, a very fair lot of plants of the right sort and number will be the result. Let extra trouble be taken with the lifting, planting, weeding, and perhaps watering, of a seedling placed in a vacancy; the chances are, there will be no cause to grumble.

However, the most troublesome and fruitless task is to fill up vacancies among large old bushes. Before commencing the actual work of replacing the missing plant, it would be as well to discover why that plant died? If it was washed out, all the soil that a seedling could possibly live in must have been washed away as well. If white-ants destroyed the old plant, its surroundings, *viz.*, clay, denuded of an upper layer of mould, must be favourable to the seedling being attacked as well. If grubs cut up the old roots, they will then more eagerly devour the tender new ones. In short, the tender substitute is more than ever liable to be also destroyed. Therefore, we must try and remove the cause of death before risking a new plant. If the *slope* on which the plants have washed off is to be replanted, it must either be terraced or re-sorted, or perhaps both; for it is no possible use putting a seedling to be starved on a substratum of hard clay. If white-ants have killed the former plant dig out what remains of the old roots and stump, fill the hole, previously limed with fresh mould and manure. If procurable, plant in it a healthy seedling, and keep it carefully hand-forked. If grubs have eaten the old roots, exterminate them first, replace the mould if necessary, and be continually on the look-out for the leaves of the new plant looking yellow; for if they do, the grubs are at their former tricks again.

Not only must the most practicable expedient of sowing seeds, or previously transplanting seedlings, into baskets, flower-pots, earthen or bamboo tubes, which again are bodily put into the vacant holes to be filled up, be practised, but the plants must be protected when once they have been put out. Three stakes driven firmly in and tied together at the top, or bamboo bottomless baskets pegged down, or merely a single stake, must be placed to mark its presence; but all such plants must be specially hand-weeded and hand-forked, previous, to the general hoeing the neighbouring bushes receive. The coolie when hoeing is either much too busy or too careless to notice the little fellow, and it is either chopped down or dug up, and thus ends all the poor planter's hopes!

Large deep holes, fresh mould, continual hand-weeding and protection from rude assaults, in order to enable the young stranger to cope with its big neighbours with any chance of self preservation, must be an axiom in filling up vacancies. All this trouble must be taken to avoid the stunted, seed-laden, degenerate over-grain seedlings that one so often sees trying to do duty for a defunct bush.

I venture to proffer a word of advice on the wretched matter of filling up vacancies. I would say eschew the "cheap and nasty" style. Have good plants, and put them out *very* carefully, at the best season, according to the locality. I would advise that moderate area only should be replenished in one season ; and that this should be well-looked after. This, I feel sure, will be found to be a far better plan than sticking out a vast number of seedlings, and then leaving them to their fate —to bear the hard rubs of life without special care.

I would say that thirty acres are, in a garden of ordinary size, quite sufficient to replenish in one season ; and having put the plants *with great care* in their homes, I would tell off a small number of old men or boys to look after these plants, and *to do nothing else at all.* They will have enough to do to attend to each plant with the *koorpee* once every six weeks ; and let these men or boys be always *at* them with the *koorpee,* making wide and well turned-up spaces around each plant ; and give them orders to be particularly on the alert when the leaf-pluckers come round, so that they may save their little *batches* from mutilation. Never touch the plants for fully two years after putting them out, and promise the guardians of them a present when the "last joined" shall make their presence well apparent to the naked eye by their height and superior bulk, or by their healthiness and largeness, anyhow. Do this ; and I venture to say that good money will *not* be thrown after bad, and that "filling in" will not be the heart-breaking process that it too often has been.

SECTION X.

THE SAU-TREE.

THE SAU-TREE AS A TEA FERTILIZER.

CORRESPONDENCE REGARDING THE SAU-TREE.

SUMMARY OF OPINIONS.

THE SAU-TREE AS A TEA FERTILIZER.

The Tea Syndicate have just published a pamphlet containing the experience of several leading Planters as to the remarkable influence of the Sau-Tree on the Tea-bush. Although there is no agreement as to the *cause* of this influence, there is a general consensus of opinion that the " Sau " (*Albizzia Stipulata*) does possess peculiar properties in improving soils where tea is cultivated. Judging from what we have read on the subject, we should be inclined to attribute this improvement to the fact, as suggested by Mr. Raban, that the roots of the Sau-Tree, penetrating down much lower than those even of the Tea-bush, drain the sub-soil ; for, as is well known, although Tea will stand almost any amount of moisture, it must be moisture from above, which, when it falls, shall be carried quickly away, and not lie at the roots.

It has hitherto been generally held that trees on a Tea plantation are undesirable, and much pains is often taken to clear the ground almost entirely of them ; but with the Sau-Tree no such prejudice need exist. The shade cast is very light, and of the two, beneficial than otherwise, moderating the strong heat of the sun's rays, and thus lessening evaporation from the leaves, whereby, says Dr. Simons, the flushes come in quicker and larger than on those growing exposed in the open. He mentions, also, that he saw tea bushes at the Borsillah Garden growing underneath the " Sau ;" that they looked uniformly healthy ; and there were no vacancies ; while bushes not far off, growing in the open, looked scraggy, with leaves of a pale greenish-yellow colour, which appearance may generally be traced to imperfect drainage. Such bushes become an easy prey to blight, and insect attacks.

The " Sau " grows to a very large size, and in planting this tree, regard should be had to this circumstance. It is mentioned that a Sau-Tree in the Botanical Gardens, 20 years old, measured 13 feet in circumference ; but there is a tree in the Borsillah Garden larger than that. The wood of the " Sau" is brittle, but it makes excellent charcoal, as it burns slowly. Natives scoop out old trees for canoes, which, they say, last longer than those made of the " Poma. "

All who have had any experience of the Sau-tree speak highly in its favor, and it is credited not only with the virtues already mentioned, but, it is stated, keeps away blight. One planter writes : " I have seen all sorts of blight on this garden, but have never noticed any on the spot where ' Sau ' was planted ;" and he adds that whereas the yield in other parts was not more than 7 to 8 maunds an acre, in that part of the garden where "Sau" was growing, the yield was not less than 10 maunds an acre. Another planter, Mr. Eyre, writes : " I have planted the whole of the Tea here with ' Sau,' * * * and the effects on the Tea within the influence of the ' Saú' are extraordinary, and such as no other of the same family produces." Mr. D. M. Lumsden also testifies to the benefit derived from the cultivation near the Sau-tree. He says, " Beneath and around them, all the tea bushes are without doubt of greater dimensions, with a better plucking surface, than those outside the spread or radius of the trees."

What the precise action of the Sau-tree is, in producing results such as are so freely testified to, this is certain—that the beneficial effects are invariably to be seen in Tea around clumps of " Sau." We are not sure whether the Tree would thrive in the higher localities—probably not, but it should certainly be introduced in all low-lying lands. We have never heard of it in the Terai. We should say it would flourish there well, and we would recommend its introduction there and in the Dooars, if it does not already exist there. Experiments might also be made at higher elevations.

CORRESPONDENCE REGARDING THIS SUBJECT.

Dear Sir,—With reference to your article on " the Sau-tree as a tea fertilizer," in your issue of January 20th, will you allow me to suggest that perhaps the influence of the tree is after all not due to any chemical action, but merely, as indeed you suggest in your article, to its light, well distributed shade, and to the very small leaflets causing the drip from it in rainy weather to be less harmful than that from broader-leaved trees. I suspect that these are the real reasons for the better yield of the bushes under "Sau" to those in the open.

In regard to the question of its influence on the soil, might I suggest that some of the gentlemen who are interested in the question should get analyses made of the soil taken from under "Sau" and in the open, in portions of the gardens which otherwise appear to have the same soil, and where the difference in the bushes is noticeable.

I think the wood would be a very useful one for tea-boxes, but it has one drawback common to all the Albizzia woods—that of having a very large proportion of sapwood, which sapwood is utterly worthless, and decays or gets eaten by insects at once.

J. S. GAMBLE.

February 25th, 1885.

SIR,—With reference to the discussion now going on in your Paper on this subject—might I ask, has it been noticed whether the "*Sau*" was *self* or *artificially* planted in the spots around which the Tea bushes were observed to thrive better than in other patches where no "*Sau*" trees were?

If *self* planted in these spots, might it not be that it—the *Sau*, *naturally* thrives in a soil that is the best adapted to Tea? and thus account for the vigour noticed in the bushes in the vicinity of "*Sau*." But if the same effects are noticable where the "*Sau*" has been *planted with the object* of improving poor patches of Tea, then of course this *theory* falls to the ground at once.

I am, personally, *totally* unacquainted with the tree, and have only just procured some of its seed, and thus, perhaps, it may be deemed presumptuous on my part bazarding an opinion on the subject; but the idea having occurred to me, I give it for what it is worth, candidly avowing my incapacity for saying *anything* positive on it.

Unquestionably the "Sau" was originally self planted, but its cultivation has been artificially extended on account of its proved benefit to Tea,—ED., *I. T. G.*

THE EFFECT OF SAU, SIRIS, KOROI, OR MEDELOA, ON TEA.

SIR,—I see in your's of January 20th, page 61, a "selection" on this question, and many attempts to solve the mystery as to the cause of Tea thriving under the trees above named.

Like many others, I at first thought it must be due to the fertilizing effect of the fallen and decayed foliage,—peculiar, probably, to that group of trees. Subsequently I found so many cases where the effect was produced, though the tree, stem, branches, and foliage had all been removed for some three years, that I was compelled to modify that opinion.

On one occasion, some seven years ago, when carefully going over a tea-garden with the manager, we found patches here and there where the tea was growing far more vigorously than elsewhere around. I suggested it looked as if a Sau-tree had been there lately. On enquiry it turned out that, at the place, there *had* been a Medeloa some *three years before*.

At another spot, where the tea was very vigorous, we found in the middle of it an old stump of a Medeloa tree that had been cut down some three years before, and in another instance one of these stumps was not dead, but had some few leaves on it near the ground, by which I recogniz d it. I would, therefore, ask, what we are to believe in such a case?

If the effect is produced by the "decay of foliage" (which is, of course, possible), this effect must be a very lasting one, as in several cases the stumps were so far decayed as to be unrecognizable, and in several there was little or no stump at all left, and the effect due to "decayed foliage" seemed to be too far removed in time. Can any reader, who has experience in these matters, explain the above?

For many reasons I do not think it due to drip, or shade, or drainage; and, bar these cases I allude to, which were very conspicuous ones, I should have held to the view that the effect was due to decay of foliage.

Observe, I do not say it is due to dead roots, "but to some chemical process due to the roots, as the effect on tea is often seen long after the tree has been felled, and when the stump alone remains, at *times*, dead." This was why I felt compelled to think that foliage had less to do with it than roots, and I should mention that in these trees the roots keep alive for long, and often shoot up after the tree and the stump have been removed. The roots of Medeloa die last of all, and it is because they retain vitality so long, and shoot so freely, that I recommended planting them in places.

But I could not explain how the effect might be produced by the roots, and the case is worth investigation, inasmuch as if it is not produced by the roots, but by the foliage fallen and decayed, the effect seems to be a very *lasting* one. I may also say I have seen a case where the effect was produced in a young nursery of tea, and by Sau-tree seedlings that had, so far, *not shed any of their foliage*.

S. E. PEAL.

THE "SAU" TREE, "ALBIZZIA STIPULATA."—SELECTED OPINIONS.

The "Sau" (Albizzia Stipulata) is fully described in Gamble's Manual on Indian Timbers, page 160. It is common in most parts of Assam, and may be generally found in land lying rather low. Some years ago a gentleman in Upper Assam first drew the attention of tea planters to this tree, (see Tea Cyclopædia, page 198), very properly calling it a tea fertilizing tree; but it is only within the last few years that experiments have gone to prove that the "Sau" tree possesses peculiar properties in bringing round exhausted soils, thereby causing tea bushes to flush vigorously: in fact, imparting a vitality which we are now beginning to find old tea sadly deficient in.

I am not in a position to state the reason of the "Sau" exercising such an influence on tea, and I believe a thorough chemical analysis of the soil can be the only means of ascertaining the cause.

An area of three acres planted with "Sau" about 10 years ago has yielded, for the last four years, more than double as much tea as any other part of the garden.

I think we may put aside shade as the cause of this increase in yield: in fact, the generality of planters condemn shade. It tends to make the bush throw out long stalky shoots, racing with each other to reach the light, and the flushes from such trees are necessarily meagre and woody.

Such, however, is not the case under "Sau." The tea bushes under this tree, which casts a light shade, are broad in proportion to their height, have an even growth over the whole surface, and yield flushes equal to the finest tea I have seen in the open, where the condition of the soil and age of bush are both in its favour. I do not wish to contend that "Sau" is capable of improving tea plants, where the soil contains elements which in some instances nature has abundantly supplied for the support of the bush, but I do assert that the vitality of the tea bush is limited, probably in a great measure depending on the character of the soil; and unless we restore some of those essential parts, we are yearly, I may say weekly, abstracting, the tea planter in a few more years will find himself surrounded by tea which the very best cultivation and the most scientific pruning can never bring round.

The mere fact that blight has, during the last few years, been more prevalent than formerly, strengthen the argument that soil is deteriorating, and there is the strongest proof to show that tea under the "Sau" is particularly free from blight when the surrounding trees are suffering.

Professor Johnson, in his Elements of Agricultural Chemistry, says, the improvement of land, therefore, by the planting of trees depends in part upon the quantity of organic food which the trees can extract from the air, and afterwards drop in the form of leaves upon the soil, and in part upon the kind and quantity of inorganic matter which the roots can bring up from beneath, and in like manner strew upon the surface. The action, therefore, of a tree is two-fold:—

1st.—It causes vegetable matter to accumulate on the surface.

2nd.—It brings up from beneath certain substances which are of vital importance to the growth of plants, but in which the upper soil may have been deficient. The same author also proves that land can be improved ten-fold by planting trees.

In some trees certain mineral salts are supposed to exude from the root-cells into the water of the soil: these salts acting in some instances, we all know, as a poison. From the same cause may not some mineral salts prove beneficial to the tea bush?

My object in collecting the following circumstantial proofs of the efficacy of the "Sau," principally, and of a few other trees, partially in restoring exhausted soils, is to call the attention of the tea-planting community generally to this important fact, and to urge the necessity of a careful chemical investigation of the matter on the spot. My thanks are especially due to the gentlemen who have come forward so liberally with their opinions in this matter.

J. BUCKINGHAM.

Amgoorie, *October 23rd, 1884.*

Mr. Newington writes regarding the "Sau" tree:—

I was out at one of the out-gardens this morning, and took particular notice of tea growing under the "Sau" trees. I feel confident that it is beneficial to the tea plant, and will increase the yield. In the first place, it is a cultivator, as the lateral roots grow so near the surface, which seems to open the soil and make it porous; then again I notice this tree does not thoroughly open its leaves until about 8 A. M., just when the sun is getting hot. When leaves are quite open, it gives a slight shade, while at the same time it does not exclude the sun; this is beneficial to the tea plant. Also this slight shade prevents the ground getting dried and baked by the heat of the sun. As far as the fact of the leaves acting as manure is concerned, this is very slight, as the foliage is comparatively light. I quite believe in the tree. For the last three days I have been planting out my "Sau" nurseries among the tea 50 × 50.

Mr. Raban writes:—

Regarding the "Koroi" or "Sau" tree, from what I saw at Amgoorie I was quite convinced that it benefited the tea growing under it: so much so, that I have this year planted out 100 acres of it myself. I find it difficult to account for the beneficial effects it produces on the tea plant, but it is possible that Acacia trees take up nourishment from the soil not required by the tea plant, give sufficient, not too much shade, keep down jungle, and, sending their roots down much lower than the tea plant, drain the subsoil, and enable the latter to send roots down lower than it otherwise could. I do not say this is a sufficient or satisfactory explanation, but it is the only way I can account for the beneficial effects produced.

Dr. Simons writes:—

I will endeavour to give you all the information I can collect about the "Sau" (Acacia Stipulata). It is a tree worth cultivating among tea more than any other I am acquainted with, for, in the way the branches spread, it does not keep the sun entirely off the plants but moderates the strong heat of the sun's rays, through which evaporation from the leaves is lessened and the flushes come in quicker and larger than on those growing exposed in the open. The "Sau" grows to a very large size and quickly. Dr. Roxburgh in his "Flora Indica" states that one tree planted by himself had a trunk 48½ inches in circumference, 4 feet above the ground, when only 7 years old. Another tree in the Botanical Gardens 20 years old measured 13 feet in circumference. I do not know whether you took notice of the "Sau" tree which was growing in Borsillah Factory, not 100 yards south of the Iron Tea-house. I once measured the trunk, and, as far as I can recollect, 3 feet above the base it was 14 feet in circumference, and the branches spread over at least one-twentieth of an acre. There were no vacancies among the tea plants growing underneath it, even to within a few feet of the trunk. They always looked uniformly healthy, with deep green leaves, while those growing in the open not far off had several vacancies; some looked scraggy, with leaves of a pale greenish-yellow colour, and would be often affected by blight, either red spider, green fly, and fungoid spots on the leaves.

The "Medeloa" (Acacia Elata), which I presume you know as "Koroi," is another desirable tree to grow among tea, but from its slow growth, and not having spreading branches, it does not answer so well as the "Sau."

The timber of the "Sau" is not useful for posts, as it decays in the ground quickly. For marolies and planks it would answer, but it is rather brittle. Natives scoop out old trees for canoes, which they say last longer than those made of the Poma. It makes excellent charcoal, as it burns slowly.

I would surmise, by your writing to gain information about the "Sau," that you want to plant it among tea as a shade. I think it is time that a move is made in this direction, for in consequence of the indiscriminate cutting out of all trees, and leaving none for moderate shade to the tea plants, all the blights now prevailing have been introduced. Fruit trees require planting in the open to receive the heat of the sun, but to treat a plant from which the leaf is required, moderate shading is necessary to prevent evaporation from the leaves.

Mr. Macdonald told me there are some "Sau" trees growing among tea in a garden named Burasoli, of the Grob Company, and they cover about 5 acres of plants. He is of opinion that the tea plants growing underneath the shade of these trees have looked uniformly healthy and kept free from blight, while those in the adjoining open land are generally affected by blight, when prevalent. The yield of the whole garden has averaged 8 maunds per acre, but he considers the greater portion of this yield is plucked off from the plants growing under the "Sau" trees.

Mr. Peal writes :—

Yours of 7th to hand, and I have noticed for many years what you allude to regarding "Sau." I first clearly noticed its value in tea at Bursali in 1868, and later on found that "Medeloa" was even better; I fancy it is peculiar to all that group, *i.e.*

Medeloa	Albizzia elata	
Sau	,,	Stipulata
Hiris or Siris	,,	Procera or Sirisa
(Jati) Koroi	,,	Marginata or Odoratissima.

These used all to be called "Acacias."

The benefit to tea is obviously neither shade nor drip, but some chemical process due to the *roots*, as the effect on tea is often seen long after the tree has been felled, and the stump alone remains, at times DEAD. I have planted "Medeloa" by fids of root best, and it grows easily. Yes, Hingori is bad, and Sawa, which Dr. Simon calls "Englehardtia Roxburghiana," is WORSE, and I have seen "Sum" bad. What is the chemical that the "Sau" and "Medeloa" roots evolve? Worth knowing.

Mr. Phillips, in writing about Sau, says :—

It is undoubted that they exercise a most beneficial effect on the trees near and under them, and from the appearance of them at Magoorie, as also elsewhere, where I have observed it since you called my attention to it, it is undoubted, I think, that they would increase the yield of tea considerably. I am so sure of this, that I am following your example, and am arranging to plant out the trees extensively in our gardens.

How the trees benefit the tea I do not feel competent to state, but that they do so is undoubted.

I was glad to have the letters that you sent me, and to find that the tree is now named by Dr. Simon correctly,—at least I think so.

Mr. Lawrie writes :—

In reply to yours of the 20th, regarding "Sau" shade, I am not at all certain why tea improves so much under trees of the above family, but I think it is either the drip from the leaves, or the leaf cast and hoed in with the soil. It cannot be the shade, as I find the tea the most exposed to the sun just as good as shaded from the afternoon sun. Under any large trees I see that as far as the branches reach, the tea is good; and beyond, it is the same as other parts of the plot. Three years ago, when I bought Borsillah, I observed that under some very large "Sau" trees the tea was much better. In a new clearance in another garden I noticed the young plants grew quickly under the "Sau." Again at Naganijan, the same story. So I have for three years been planting our gardens and anxiously await to see whether the tree benefits the tea, or the soil where the "Sau" grows is better suited for tea. Next year ought to tell me, as we have some 50 acres now where the plants are from 8 to 10 feet high. Should it fail, it is very easy to get rid of, and it makes excellent charcoal.

Mr. Walker writes :—

Received yours of 20th instant some days ago, with regard to the "Sau" benefiting tea: there is no doubt that under certain circumstances it is so, but my opinion is that tea will grow as well without shade of any kind as with it, provided the soil and cultivation are of the right kind. On gardens with poor soil and bad cultivation, shade from "Sau," Medeloa, and "Korio" seems to do good, but where soil, jât, and cultivation are first class, I consider shade of any kind unnecessary, if not detrimental. These are my ideas, but I am open to reason if facts are shown contrariwise. A few plants round a tree looking in better health than those in the open garden is no proof that they give more or less leaf during a season.

Mr. MacDonald writes :—

With regard to your enquiry regarding shade for tea, I must confess from experience that I do believe in some trees for shade. The "Koroi" I know little of from experience, but I should fancy it is too slow a grower. I should give the palm to "Sau" next to "Medeloa"; perhaps there is very little choice between them. One of this Company's gardens has a plot of about 10 acres of tea, and about 8 years ago had about 20 to 30 indigenous large trees here and there, but they are now fast dying out, owing to old age, and the sudden change from the being exposed to the open instead of being surrounded by jungle. There are now, perhaps, not more than a dozen alive, but still, for three or four years, the tea round the old trees shows superior growth and vigour to the plants not so situated. This garden has been repeatedly attacked by red spider and green fly. I have never noticed the former touching tea near a "Medeloa," although all round might be perfectly black. The green fly does attack it, but does not seem to do anything like the damage it does outside the radius of the tree.

Another garden of the Company's, 12 miles off, has a plot of indigenous "Sau" tree, probably not more than 10 trees on the acre. I have seen all sorts of blights in this garden, which is only a small one, but have never noticed any on this plot for the last nine years. I cannot say what the probable yield of this plot may be, as it was never kept account of, but judging from the steady outturn of from 7 to 8 maunds an acre for the whole garden, including some very poor plots indeed, I should think it cannot be less than 10 maunds an acre. Many trees are good for tea, such as "Amluckie," "Modar," &c., but not to the extent that these are. I am not in a position to say how tea is actually benefited by shade or chemicals in the soil genial to it. It is a subject that certainly should be brought to the notice of proprietors in a manner that it would leave little doubt in their minds as to the experiments being at least worth a trial.

Mr. Eyre writes :—

I have planted out the whole of the Tea here with "Sau," which is the same, I understand, as "Bihkoroi," and the effects on the tea within the influence of the "Sau" are extraordinary, and such as no other of the same family produces. I agree with Mr. Peal so far, that the cause is chemical action of some kind, and I have seen no theory so plausible as that you pointed out to me at Amgoorie, *i. e.*, the leaves absorbing inorganic matter from the atmosphere, and imparting organic matter when they wither and drop to the soil below. The drainage theory is too general, and to my mind utterly wrong in principle, and I should say botanically too.

Mr. Peal thinks the *chemical action* takes place as from the roots. This may be the case, but as he bases this theory on the fact of *decayed* roots of the tree forcing the tea more markedly, his opinion is weakened, as decayed roots have the same (modified perhaps) effect as manure.

As the roots and the leaves are structurally and componently similar, I should say that his argument is in favour of the decayed leaves being the cause; and more of the chemical principle being stored in the roots, the effect when they decayed would naturally be more marked and rapid, but still only temporary. I know nothing of either botany or chemistry, and Mr. Peal is well versed in the former, I believe, so I am not prepared to argue the matter with him, but I disagree *in toto* with his logic of the cause. A chemical analysis of the leaves of all these trees would settle the question, and would be valuable, for if the fertilizing principle can be artificially prepared, we would have a manure to our hands instead of waiting till the "Sau" grows to manhood, which may occur when none or few of us are there to see the result of our labour.

Mr. D. M. Lumsden writes :—

During the last week I have had a careful look about for the "Sau" tree amongst my tea, but have only discovered four, three a short distance apart from each other, and one about ½ a mile distant in a separate block of tea.

Beneath and around them all, but specially under that of the last-mentioned, which is the largest and oldest, the tea bushes are without doubt of greater dimension with a better plucking surface than those outside the spread or radius of the trees. Noting the above, adds to the opinion I formed when at Amgoorie, where I was able to observe the evident good results on a much larger scale, though I am still unable to give the reason why. There seems to me to be no doubt that, from some source or other, the "Sau" tree exercises a beneficial effect on tea growing within its radius, and I consider the subject is one which merits the attention of all interested in tea planting.

Mr. Gibbons writes :—

I find from long experience that shade of any description retards, rather than promotes, excessive growth of leaf in the tea plant, and this will be seen at once by comparing the number of growing shoots on a healthy plant in the open with the number of growing shoots on the same class and age of plant under shade. Although the latter no doubt looks darker and apparently stronger, still I maintain the producing power of both plants stands in the ratio of 1 to 4, at the very least, *i.e.*, for every pound of leaf grown under shade, you will get four pounds in the open. The shade of some trees is more detrimental than others, but on the whole my opinion is, the more light, heat, and air, the tea-plant gets, the greater will be its productive powers.

Mr. Pringle writes :—

The seed I got from you never came up, so I should very much like to get some more and give it a trial, as certainly, from what I, saw at Amgoorie, I think there is no doubt it is beneficial to tea.

I have a good many "Koroi" trees scattered about the garden here, and since you drew my attention to the matter, I have noticed that the tea looks uncommonly healthy and well grown in their vicinity. It might be the "Koroi" keeps a happy medium in taking moisture out of the soil, enough in the rainy weather, and not having any heavy foliage to keep the sun from getting at the soil round about it, and not taking too much in the dry season. Here I notice that most trees dry up the soil tremendously round about them in the cold weather, and the drip from heavy foliage in the rains is certainly bad. Jack-trees I have found deadly for tea.

Mr. Dowling of Chittagong writes :—

(Alluding to the "Albizzia Odoratissima," or "Jati Koroi") Bengal "Siris" :—

The tea bushes are decidedly better under this tree than in the surrounding parts, and the "Koroi" also improves the tea in light soils, but not in clay.

Mr. Earnshaw writes :—

In reply to your question as to my views on the advantage of planting the "Sau" tree among tea, my observation leads me to the conclusion that in some way, which has yet to be explained, it is undoubtedly beneficial, as I have nearly always remarked that the tea-trees immediately under and around the "Sau" are more vigorous in general growth, as well as fuller in top leaf shoots, than elsewhere : the growth is quite different from that delicate, thin kind usual under most other shade.

"Koroi," and "Moj," I have also noticed affect tea in the same manner as the "Sau" does.

It would be most interesting and useful if the chemistry of the question could be explained to us, as without understanding that, it is difficult to venture an opinion as to the reason of the good done by these trees. It would seem that somehow their roots, in drawing their nourishment from the soil, threw out the property which the tea-tree required, and in this way restored to the soil what had been taken out of it, to an excessive extent, by the tea.

I hear it has been noticed that young tea is not much affected by these trees, and the benefit done is in *old* gardens ; this would point to the feasibility of the above idea. The leaves of these trees are so small and light that they would hardly act as manure to any appreciable extent, but that the light shade is useful in checking excessive and sudden heat from the sun seems quite reasonable, I think. The fact that the beneficial effects are to be seen in tea round stumps of "Sau" confirms the correctness of the root-action theory, but would not altogether exclude the probability of some good arising from the light shade, when it was present.

Whether the gases thrown off from the leaves of these trees could in any way affect the tea, only a chemist could say. It certainly would be worth while to have the whole question gone into by a scientific man, as it seems very certain that in many old gardens something is wanted to restore vigour to the tea-trees, and to stop the mortality which is going on among them, to a considerable extent, from some cause or other ; and if, by planting certain trees which are close at hand, old gardens can be very materially improved, the fact should be realized, and acted on as soon as possible.

SECTION XI.

CULTIVATION.

Terracing.

As to Steam Ploughing on Tea Gardens.

Ploughing and Hoeing Machinery.

Hoeing and Weeding.

Deep *vs.* Light Hoeing.

TILLAGE.

The whole art of Cultivation consists in tillage and manuring, and the profit of the husbandman depends on the perfection of the tillage, and the economy of labour in producing the effect. A defect in tillage will cause a great deficiency in the crops in ordinary years. To ensure good crops, the soil should be in such a state that the rains and dews may readily be diffused through it, without giving it a wet appearance, or evaporating too rapidly. It requires great knowledge and experience to give any particular soil the exact portion of tillage which is suited to it. A fine garden-tilth, as it is called, is the most perfect for light soils which have been long cultivated and manured. When they can be brought to such a state that after continued rains the surface dries without forming a crust, and crumbles of its own accord, the tillage has been good; and the deeper this soil is stirred, the more it will produce: but where clay abounds in the soil, which in dry weather can be readily pulverized by crushing the dry clods, and be reduced to the finest powder, too much tillage may do more harm than good. The fine clay is soon converted into mud at the surface by the least rain, because it is not sufficiently porous to let the water through it; dries into a hard crust, which effectually precludes the access of air, and consequently stops the vegetation of the seed. It is only by abundant manuring with organic matter, especially of animal origin, that this natural tendency in clays to cohere can be overcome, and until this is effected it is best to stir clay soils as deep as possible by means of subsoil-ploughs, but they should not be pulverized so that the water cannot run down between the lumps and clods; and, especially, the surface should be left in such a state of roughness that heavy rains cannot cover it with a coat of mud. The clods which are left on the surface imbibe the moisture more gradually, and in drying fall to pieces, by which the young plants are invigorated, and, as it were, moulded up. This is particularly the case in winter after a frost, as all clay-land cultivators are well aware. It is very easily ascertained whether a soil will bear much tillage or not. It is only necessary to try some of it in a large pot or box: make the surface very fine by breaking the clods; then water it abundantly, and let it dry in the sun: if a crust is formed in drying, that soil will not bear too much harrowing and pulverizing, and should be left in a moderately rough state after sowing or drilling the seed; but if, after it dries, the surface is loose and porous, then the finer the tillage the better the seed will vegetate. The whole depends on the ready admission of air, or its exclusion.

CULTIVATION.

Young plants should remain untouched for a month after being transplanted, to prevent any disturbance of their roots, and to allow them to recover from the shock. The jungle between them has now grown to such a length that if no further cultivation could be given, it would be necessary to clear it away with the dhow. Each man should not do less than 60 nulls of this work, unless from some misfortune the jungle has been allowed to grow for two or three months, when 30 nulls is enough. Any jungle which grows within a foot of the plant should be weeded, but if the jungle is allowed to grow too long, much damage is done to the young plant. First, the plant is weakened by being closely shut in by jungle ; and next, when the jungle near it is pulled up by the roots, large balls of earth are removed with the jungle-roots which have now taken firm hold of the ground, and the little seedling is shaken, and its roots disturbed. The best treatment is, at the end of the month to hoe gently all round the young seedling : but great care must be taken. The hoe must not strike within six inches of the plant—that is, a circle of a foot in diameter must be left, with the plant in the middle. The hoer stands close to the plant, and hoes over it, drawing the earth towards the plant ; he then turns gradually round, repeating the operation, until the circle is complete. Now, he places his hoe on one side, and with his hands pulverizes the soil, and draws it back from the collar of the plant. Each of the plants now stands in the centre of a hoed clean circular space of about $1\frac{1}{2}$ to 2 feet diameter. The land remaining between these spaces need not be hoed until the end of the year, and the jungle, on its being repeatedly chopped with the hoe, gradually dies out. This work can be done for $1\frac{1}{2}$ hazrees for a pie of 16 bushes square, 4 by 4 feet planting, 256 bushes, $28\frac{4}{9}$ nulls; and afterwards, as the work gets lighter, it can be reduced to $1\frac{1}{4}$ and 1 hazree. It should, however, be borne in mind that this work is much heavier in close planting than in wide. There are 270 bushes in 30 nulls planted 4 by 4 feet square. Pulverizing the soil should be repeated at least once in six weeks, and not oftener than once in three weeks. Bamboo stumps, or other troublesome jungle which is hard to kill, should be smothered with cut jungle and clods of earth. The heat generated by fermentation kills the young shoots effectually, and the stump dies, and can be easily hoed away the next year, when it will have become rotten.—*P. Swinburne.*

The soil *over* the rootlets of Tea-plants cannot be stirred too often. The oftener it is done, the oftener the trees flush ; and when young, the more vigorously will they grow. What is the best way to do it ?

I believe simply by digging *round* each plant. I go to show why this is, I believe, the best :—

Putting aside the waste incurred in digging a whole Garden when not necessary, the way the soil is then dug near the plants is, I think, objectionable. The ground is dug in a straight line *up to the plant* ; and in doing so, if the digging is deep, roots are very apt to be cut. Again, when the work is task-work, the men shirk as much as possible digging close up to the stems under the branches, and thus the soil, over much of the roots, is not stirred at all. This is not easy to detect, for you must look under the branches of each tree to see how the work has been done.

In digging round plants the men should *follow* the kodalee round the tree, and *the position of the blade in the same line as the roots* makes any injury very unlikely. Even if tasked, as, when the work is examined, it is *only* round the plants, it is more readily perceived if the ground has not been stirred close up to the stems.

I therefore prefer digging round plants, with the view of cultivating them, to digging the whole Garden. I believe the object is better attained.—*Col. Money.*

TERRACING.

I notice a little error that the *Agriculturist* has fallen into—that "terracing will not preserve the soil from wash." This all depends on the instructions given to the coolies. If the planter clears away all jungle, roots of trees, &c., and makes the whole of the hillside loose soil, and then attempts to terrace, no wonder that the whole of the loose soil slides from top to bottom. It reminds me of a journey in a Railway carriage, with a Candian who was going to settle in Algeria, where the rain, when it *does* fall, comes down in buckets. The Arab of that country has a small plough, very much like the native plough of this country. There are clumps of grass here and there—a stump of a tree—a big boulder-stone, but the Arab ploughs round each, does not root them out, and does not plough too deep, and, in spite of heavy showers of rain, secures a crop. The Englishman comes, abuses the whole system as being ante-diluvian, and commences to show *the man of the country* how to work. The clumps of grass, stumps of trees, and large stones, are all rooted out. He then goes to work with his improved English plough—ploughs beautifully loosens the soil tremendously. A heavy shower of rain comes, saturates the loose soil, which then commences to slip from top to bottom, leaving the hillside bare.

We in Darjeeling have improved on this style of working. We notice the heavy jungle: no sooner is one weed eradicated, than another springs up; therefore, in God's parlance, the weeds are guardians (chokeedars) of the soil, and to throw them all away shows a want of common sense. Weeds, like fire, are good servants, but bad masters. The proper thing is, after the jungle is cut, to make your terraces about 3½ to 4 feet wide, out of the solid soil, and cultivate in the terrace *afterwards*. The upper jungle is burnt first, so as to kill as many insects and grubs in the soil as possible, and then each terrace is cut in the lower part, flat, about a foot wide, so as to give a base to the upper jungle which is placed upon it, and rests firmly, for it has a flat base. The inside of the terrace is then cultivated, leaving a foot width for the edge of the terrace: the jungle being put topsy-turvy at the edge, keeps up and arrests all the loose soil. The earth of the terrace being scraped to the edge, all the seeds of the weeds go with it, so that in the weeding, for a year or two, there is very little trouble: the weeds grown on the edge of the terrace are only sicklied,—therefore there is less labour than in flat land. Once in three years, when the weeds at the edge of the terraces are troublesome, they are turned topsy-turvy, and for a time the exposed roots arrest the soil till the weeds grow again. Pits, of course, will assist to retain the soil, but on properly-terraced land they are not required. In course of cultivation all the light vegetable mould is buried by the action of the fork, under direction of the skilled planter, before the seeds are planted.—J. S.

Method of Terracing.—Old, as well as new, *tila* gardens can easily be terraced by aid of a triangle and plummet, which would enable the soil to be cultivated without loss by hoeing; the loss by wash is small compared with the loss caused by hoeing the surface-soil off the tilas into the swamps below, leaving the plants on the bare faces of the tilas without nourishment or cultivation.

Jungle is very much abused, but it has its uses in keeping the soil from being washed away while it is growing; and when turned topsy-turvy, it still does the same thing. Grass at the edge of the terraces, is very useful. It should not be allowed to grow too large or too high, but should be kept down with the knife or sickle. One of its greatest uses in the cold weather, is keeping the ground damp, and protecting the exposed side of the terrace from drying effects of the westerly winds. Two small gardens in which, this year, the grass was left on the edge of the terrace, and not deteriorated by any use of the knife, flushed earlier than any well-cultivated, well-pruned garden in the hills ; so that, in my belief, *grass at the edge of a terrace is useful*; but it should not be allowed to get the mastery. If it is left for a whole season without trimming and reducing, no wonder it is a nuisance, but as the gardens ought to be hoed six times in the year, so each time the edge of the terrace ought to be trimmed, and the grass cut down to within an inch of the ground as part of the labour.

AS TO STEAM-PLOUGHING ON TEA-GARDENS.

The first question that arises in regard to this subject is "Would it pay, even if found feasible?"

In Assam, Cachar, Sylhet, and other places where labour is scarce, it is probable that the introduction of steam cultivation would be a great boon to the Tea Planter. The first cost of a steam-ploughing apparatus with ropes, plough, and everything complete, as in use in England, on what is called the "single system," that is working with only one engine, is about £950. This is heavy, but as a much lighter cultivator would be used for Tea, I think the cost might be reduced to £800—say Rs. 10,000 on the garden. Under moderately favourable circumstances the machinery, making all allowances for native attendants, and the usual difficulties we have to encounter in India through their laziness and stupidity, should cultivate 800 to 1,000 acres per month of twenty working days. The remaining ten days might be occupied, in the rains, by taking the engine and gear from place to place where it might be required; for, as the expense of a steam-engine and apparatus would be too much for any Concern, except a very large one, to bear, I suggest that two, or three, or four Gardens unite and purchase one. There need be no clashing or quarrelling about terms with the cultivator at the end of the season: each should pay his share of the cost of the fuel, upkeep, wages, &c., according to the number of days it was on each garden. It would be thus to the interest of each Manager to forward it on to the man whose turn was next, without delay. Remember, please, that in saying that it would cultivate so many acres in such a time, I mean that it would cultivate to the ways—that is up and down and across. There would remain a little hoeing, &c, round the inner part of the roots of the bushes, but not much, as the cultivator I would design would go partly underneath the laterals, and still not hurt the roots, the outer lines being much shorter than the inner ones.

Now, it is a simple matter to calculate, according to the rates of the district in which the reader may be, the comparative cost of cultivating 1,000 acres of tea by hand and by the steam-plough. The plough would be worked for Tea by an 8-H. P. Portable Engine of any maker's manufacture. Wages for one engineman, one cooly to cut wood, possibly one pair bullocks and cart-driver to bring barrels of water, two coolies to shift the anchors, and two more to assist them (possibly) in shifting the rope, added to the cost of fuel, and 15 per cent. per annum added for repairs and deterioration, seems to be the cost of working. This would be lessened by the rope and anchorman and wood-cutter, on the days when the plough was not at work. Put it, however, at the cost of elephants or bullocks to take the engine, &c., from garden to garden, I think it will be found that the saving in expense would be very great on the side of the steam-plough as regards cooly labour.

Now, as to the feasibility of the scheme. It is difficult without the aid of plates to describe how steam-ploughing is done. The engine remains stationary at one corner of the field. Near it is a large double windlass, which, when the cultivator is at work, winds up the dragging-rope with one barrel of the windlass, whilst from the other, the rope is uncoiling, which will drag the plough down the next furrow. When the plough comes to the end of the furrow, two men, one at each end of the rope, shift the anchors on which are the pulleys round which the rope runs : one furrow-breadth forward the plough is double, one set of coulters and shears being at work, while the other set is tilted up in the air by the weight of a man who sits on and guides the plough. When the plough is to return, it is not turned round, but the man simply tilts up into the air the set of ploughs that have done their work, and brings down the others. Of course, ploughs like this would not do in Tea: a special cultivator would be needed. At the end of the furrow the motion of the windlass is reversed, and the drag-rope becomes in its turn the following-rope. In England there is an ingenious mechanical contrivance for shifting the anchors, which does away with two men, as it works automatically. Now the greatest difficulty in the whole matter will be best explained to the reader in Messrs. Howard's own language in their letter to me. They say :—

"The obstacle to the use of steam ploughs through rows of bushes of trees, is the practical difficulty of bringing the slack or following-rope into position for following the implement back on its return journey. The rope cannot be lifted over the intervening row of bushes, and to employ draught animals to take the rope up the next alley between the bushes, would add to the expense of the work, and would impede it." They continue : "If it is important that the land be broken up to a depth of 9 inches, and the obstacles to effecting this by animal power are practically insuperable, the steam-plough, worked on the single system, with animals to convey the slack from end to end of the land, would probably be the most effectual and economical method of working."

Now if this difficulty could be overcome, (and I confess it is a rather formidable one) I quite believe that on fairly straight land, even if somewhat sloping, with straight rows of bushes, and the land clear of stumps, steam cultivation would be easy. On hill gardens, or gardens where tea is irregularly planted on ground much traversed by nullahs or having stumps left in, the steam cultivator could not work. There may be some method of lifting the rope over the bushes. Coolies might be stationed at intervals, along the row, and with the aid of a very light block and tackle might hoist long bights of the rope high enough to clear the bushes. The block and tackle would be fastened to the top of a light pole. One man would hold the pole while the other hove up, and (the pole being midway between the two rows) might incline it over till above the next row, and then lower away. A strong 10ft. bamboo, a pair of light wooden blocks, and an inch and-a-half Manilla rope, would be all that would be requisite. Other projects for effecting this may strike some of your readers : and what I want is, that those who may think the idea of steam ploughing of any value, should co-operate together to work it out in a practical form.

We can scarcely hope, in the present depressed state of the tea market, that proprietors will club together to subscribe to bring out a set of steam cultivating apparatus in order to institute experiments on the subject Should there come better times, something of the sort might be done, and it is as well to have the matter well thought out and discussed beforehand, so that should a series of experiments take place, people would be prepared for any contingencies which might arise, and perhaps be better prepared to overcome these difficulties through the matter having been previously well discussed.

It is quite possible that steam ploughing for tea cultivation is a thing of the future, and may be nearer than you imagine ; therefore be careful to have your lines of tea very straight, both along and across, so that there would be no obstacle to the plough or cultivator working. If you object to the expense of taking out stumps, they may remain in, as they could be taken out afterwards.

"TEA MACHINERY."

PLOUGHING AND HOEING MACHINERY.

Dear Sir,—Various agricultural instruments, such as ploughs, &c., have, I know, been tried in old times, and not with the best results to the bushes; but there is no reason why, because the ordinary machines have failed, that Planters should be sunk in the belief that that costly article—the coolie—must endure as long as Tea does. Darby's Digger is an instrument possessing the principle we require in deep hoeing, *viz.*, turning the earth completely over, and bringing subsoil to the surface, although of course far too unwieldy, costly, and weighty, to be used in Tea. It is, however, the first step in the right direction, as it closely copies spade action; and we may hope that before long a machine with that principle, and capable of being worked in a tea-khet, will be brought out. For light hoeing, last cold weather I procured from Messrs. Vipan and Headly, Church Gate, Leicester. England, two expanding horse-hoes, which I worked all the hot weather, and which did their work admirably, and at a much cheaper rate than can be done by hand labour. Two of these hoes hoe a 12-acre khet in six days up the lines of tea and across them; but to make a thorough job, it is better to go over the work again.

The total cost of this— planted 4′×4′ is—

For one hoe.	Pay of boy and man 12 days	—3	6	0
	Food of bullocks @ 4 as. per diem, Barley @ 24 per Rupee ...	—2	0	0
Cost of light hoeing 12-acre khet		5	6	0
				2
		10	12	0
Nirrikh for 136 bildars, light hoeing 240 spaces, 4′×4′, per diem @ 0-2-9 each ...		—23	6	0

Or a saving of more than 100 per cent.

I gave one 12-acre khet four of these light hoeings during the hot weather, which so thoroughly destroyed the grass seeds, that, although heavy rain has fallen here for the last month and a half, the grass in this khet is thin and not more than 6″ high, a fact which to those who know how the jungle springs up in cultivated ground in the Doon when the rains set in, will be a sufficient proof of the success of these instruments. The frame of the hoe is only 7″ high, and when the blades are buried in the ground is only 4″; and as the handle projects from the centre of the back of the hoe and not from the sides, there is no danger of the bushes being injured. The hoe will expand from 14″ to 20″ at back, and from 3″ to 7″ in front; and as the standards of the blades are curved outwards, the whole, in its greatest expansion, cultivates a breadth of 27″ of ground. I found that one bullock was too weak to drag a hoe, although a good pony was quite equal to the work, so I put in a pair of bullocks. The bullocks and the hoe take up between them three rows of tea at once,—the bullocks on each outside row, and the hoe in the centre one. A boy walking up the centre row leads the bullocks, which are harnessed to the country ploughs, but with longer julas of course. These hoes are, I find, useless during wet weather, as they clog dreadfully, but during hot dry weather they are invaluable. What we now want is a machine that, either by bullock, horse, or steam power, will do our deep hoeing as well as the light hoe does the light hoeing.

PLOUGHING *vs.* HOEING.

Dear Sir,—Some Managers have taken up the idea of ploughing instead of hoeing. It is an idea which I have been dinning into the ears of tea planters ever since I saw a tea garden. Mr. Lyell deserves credit, and so will everyone who assists to introduce ploughing instead of hoeing. The saving of labour would be immense. The gentlemen who are interested in the subject will be glad to learn that I wrote home last month to several leading agricultural machinery people, asking the fullest particulars as to *steam ploughing machinery*, with a view to seeing how far suitable it would be for tea cultivation. As soon as all my information arrives, and I have thought the matter out, I will give the planting community my opinion. I have, as far as I am personally concerned, already formed it; and am confident that at no very distant date the steam plough will supersede the *dhangar* or other hand labour. But of course I must make out a strong case for it, or my opinions would be supposed to arise from a professional predilection for machinery.—C. B. F.

HOEING AND WEEDING.

Hand Weeding.

I observe that the attention of some of our Managers has been drawn to this mode of cultivation, so successfully practised in Ceylon, with the object of having it tried, at least experimentally, in Assam

The advantages claimed for it by Ceylon planters are, that it costs less than our system, and yields better results.

The chief objections urged against it from the Indian planters' stand-point are, *first*, that the greater abundance and more prolific growth of seed-bearing grasses and other weeds would either render the system impracticable, or neutralize the economic advantages claimed for it. *Secondly*, that even if practicable, it would be undesirable on the ground of the exclusion in much greater degree of the beneficial influence of light and air to the soil.

With regard to the first objection, it would be a great mistake to assume that similar conditions are non-existent in Ceylon, with its moist forcing climate. It is their prevalence, in fact, which has led to the adoption of incessant rapid hand-weeding as the only effectual means of keeping the growth of weeds in subjection.

The second objection has no doubt a certain degree of abstract scientific validity; but in dealing with a question of this kind, fine-drawn theoretical principles may be safely subordinated to the plain practical consideration—which of the two systems yields the more profitable results.

Judged by this test, in a comparison of the working of tea estates between the two countries, Ceylon would seem to have decidedly the best of it. Paying quite as much, if not more, for his labour, the Ceylon planter produces his teas at a lower cost per ℔., of a quality at *least* equal to ours, and obtains a higher yield per acre from plant of the same age.

If the climate tends to force the growth of tea, it should have the same effect on the growth of weeds, thereby enhancing the cost of production.

In natural fertility of soil and surface configuration we should be at least on a footing of equality—a good deal more, one would imagine, in respect of the large tracts of old Coffee-land put under Tea. We thus arrive at the fairly logical inference that the superiority possessed by Ceylon is derived mainly from its system of culture. Be that as it may, the Ceylon planter has this advantage in the argument, that while we have left his system untried, he has tried ours, and tried it to condemn it as little better than ruinous. It was found a very troublesome and costly process to restore to its former condition the land on which these hoeing experiments had been made, but it was held that there is no alternative between that course and absolute abandonment. This fact points to the most serious impediment to be encountered—though I believe not an insurmountable one—in the application of the system to our old gardens, In new clearance, however carefully made, with the weed-roots eradicated, there appears no valid reason why it should not be found to answer. In the case of a clearance made on grass-land on a method tried by me, many years ago, with complete success in the objects then aimed at, it would have the best chance of success. The method is simply to dig or trench the ground to a depth of about 18 inches—starting with a clean-cut trench by casting on one side the soil dug out of it, then carefully putting at the bottom of each successive trench first the grass-roots, then the surface-soil, and *finally* the sub-soil thoroughly pulverised at the time of digging. While the tea plant will readily establish itself and grow freely in such ground, finding nourishment for its tap-root in the underlying surface-soil and decaying grass-roots, the subsoil now on the surface is so inimical to ordinary vegetation that no weeds will take root in it for many months after breaking up. Land treated in this manner will also be found to retain moisture in a much higher degree in dry weather, and to part with it more freely when in excess, especially where there is a stiff bottom—often a hard pan till thus broken up. This system would be inapplicable to ordinary forest land, nor could it be carried out in its entirety where a large extension on grass-land had to be made in any one year. That it would be more costly than the ordinary method, is obvious, but the extra cost would be largely recouped by the saving in cultivation in the first year, whilst the gain to be derived from the plant being established under conditions ensuring the minimum of vacancies and the maximum of healthy development, is not easily estimated. I may add that after the people got used to the work, a three-tar nirik was got without difficulty. In the experiments made by me, the land was prepared early, and the seed sown at stake with the least possible delay. This might not always be found practicable and safe; and where transplanting had to be resorted to, care would have to be taken, in digging the holes, to return the soil in the order I have described, so as to always have a pure subsoil on the surface.

While advocating this system of clearance of grass-lands, on its merits, one, and not the least of my objects in bringing it so prominently in view is my belief that it furn ishes the key, so to say, to the introduction of "hand weeding" in our old Gardens.

To attempt this before eradicating or destroying the tangled mass of weed-iroots now in full possession of the soil of old Gardens, would be simply to court faliure; and this object will be more effectually attained, I believe, by following in its main lines the plan I have described, than by any other. Precautions would have to be taken to preserve, as far as possible, the chief lateral roots of the plants from injury, but I think we may safely reckon that any partial damage in this way will be fully compensated for by the thorough breaking up of the soil and destruction of the weeds, even if not followed up by hand weeding.

To those who may doubt the efficacy of this plan in destroying the vitality of grass-roots by burying them at the depth indicated, an alternative procedure is open to them by digging to about the same depth, and carefully separating, collecting, and removing, all weed-roots. As an illustration of the beneficial effects of this mode of treatment, I can point to an experiment made on a patch of old tea purchased from Monyram Dewan more than 20 years ago, and which formed the nucleus of the Cinnamara Garden.

This piece of tea was in a sadly neglected condition, and with at least 25 per cent of blanks, but its response in the first year to this thorough treatment, and malgré considerable apparent damage done to lateral roots, was a return of nearly 800 lbs. of dry tea to the acre, followed by nearly 700 in the second year, under ordinary treatment. Hand weeding was unthought of in those days, but it would have been an excellent opportunity for trying it, though I am inclined to think the first method described would be fully as effective, and perhaps cost less. However, this is a point which can only be determined by practical experiments carefully conducted, and my primary object in throwing these observations together is the hope that some—a good many I trust—of the managers of Iadian Tea Gardens may be induced to make such experiments as may help to solve the problem of whether, and how far, the Ceylon system can be advantageously introduced on Indian Estates. The process must be a gradual one under any circumstances, but that is all the greater reason why no time should be lost in making a beginning.—G. Williamson.

DEEP *vs.* LIGHT HOEING.

Deep hoeing.—The rate for hoeing is 10 tars to each man: two good strokes of the hoe between the lines, turning up fresh subsoil and turning down the upper soil. In this hoeing great care ought to be taken not to have hoeing near the stems of the bushes. Allow 18 inches clear round the stems, and hoe all ground over the 18 inches. Scrape round the stems to remove all weeds, and earth up. In hoeing near the stems there is a great risk run of cutting the lateral roots or feeders of the plants, by which the bushes get stunted, weakened, and become liable to the attacks of red spider and other diseases and pests.

Light hoeing.—This is generally commenced after deep hoeing is finished, at the end of February, at 20 tars per man (or hazree) hoeing one stroke of the hoe, also being very careful not to hoe near the stems of the bushes, by which feeders or suckers are liable to be cut, and damage done; further, the bushes lose strength, and decrease their yield. This I have noticed frequently where hoeing has been carelessly done.

The ordinary cultivation by the hoe reduces the outturn by an unknown quantity.

Loss incurred by "Deep hoeing."—Planters wonder how the outside branches of the bushes give over flushing, and go to seed so much sooner than the centre of the bush. One reason is, that when the garden "gets a good hoeing," every feeding-root of the plant, within reach of the hoe, is sliced off. To remedy this, and increase the outturn, gardens may be dug with pickaxes in the cold season, and only scraped during the rains with hoes; or cultivated all the year round with digging-forks, and so save the feeding-roots as much as possible, while giving at the same time better cultivation.

I do not at all agree "that hoeing a garden reduces the outturn by an *unknown quantity*."

If we say—Let x represent the *unknown quantity* (which is the outturn lost), then we have x — hoeing — what?

Again, as to *loss incurred by "deep hoeing :"* as far as my experience goes I have found it the very reverse, and fancy Mr. Tod must have written from theory. As far as cutting roots are concerned, I never found any harm come of it. I think that to cut a few of the laterals, in a place not cultivated for some time, renews and invigorates the bushes, rather, but I do not say that my opinion about this is founded on fact, *viz.* a trial given of cutting roots. At the same time I believe an occasional root-pruning would do good to old uncultivated bushes.

Every one knows that, no matter what sort of cultivation may be given, the sides of bushes never give the same yield as the centre, simply because

1st. The course of sap is more direct in the centre.

2nd. The branches are shorter and thicker.

3rd. They get more light.

4th. They are protected by the side branches from storms, &c.

5th. The greater portion of new or leaf-giving wood rises straight up from the centre.

REPLIES TO QUERIES.

DEAR SIR,—I beg to give the following answer to inquiries on Tea Cultivation :—

1st. Does throwing the earth up round the stem of a tea bush do any good?

(Ans.) It does good to a bush which had already lost the earth from its stem by being washed away, &c., by rains ; but I do not see what good it can do otherwise. The former I have tried and seen the good effects of, but have not tried the latter.

2nd. Whether is it good, bad, or indifferent cultivation to hoe deep during the rains?

(Ans.) This question greatly depends on the class of soil you deal with ; I should say that with stiffish soil one deep hoeing in the middle of the rains does great good, but I should not give more, and not at all when you have sandy or light soil; but after pruning, say March, if you can go round the garden with a deep hoe, then it does great good; but few gardens can leave their deep hoeing to run so late as March, through shortness of labour.

3rd. Whether is it better to let weeds grow, and then hoe them into the ground, or not to let them grow at all?

(Ans.) It is bad to do away *entirely* with weeds : all that should be weeded is just round the stems of the plants, and the rest light hoed, if not very dirty with long grass, in which case it had better be cut *first*, and must be weeded once or twice *after* the hoeing to prevent the weeds getting too far ahead of the usual cultivation.

SECTION XII.

BLIGHT.

Bhanji Leaf.

The Tea Mite and the Tea Bug of Assam.

Mosquito Blight.

Other Blights.

Insecticides.

BHANJI.

There seems to be a certain amount of ignorance on this subject, so I will offer an explanation of the matter, as far as I know. First of all, the word is an expressive one, of Assamese origin, and means *barren* ; when applied to Tea, it indicates that the terminal leaf on any shoot (long or short) has a more or less dormant eye at its footstalk or axil, and that the growth of the shoot *in length* is arrested.

All kinds of Tea throw bhánji leaves, and they are seen least in the centre or axis of the tree, and more at the sides : most of all at the edges, and under them.

Being the signs of arrested growth, it is therefore only natural to expect to find them most where seed and flowers are formed. A flower is botanically simply a stunted branch, where linear growth is arrested, and the natural foliage is jammed into a bunch, and converted into petals, anthers, &c.

Thus a bhánji leaf is a first step, though a small one, to a flower, and we find them on a bush more or less in proportion to rapidity or slowness of growth, and more at the sides than centre. In many trees the plan of growth, so to speak, is carried out all through, and as far as possible the leaf repeats the general form of the tree, if not mutilated (by wind, insects, or creepers). It is the case in Tea, the natural form of which, as a tree, is much the same as its leaf; the Jack, Simol, Sopa, Sotiana, Sahm, and many other trees, show the same law, which however is not universal.

Tea growing thus, naturally, as a pointed cone, say, gives a very different shape to what we want, and we try to get a growth the very opposite, *i. e. low, flat,* and *wide.*

It is the Tea-tree's *natural* and *persistent struggle* to shoot up again into its own proper form that enables us to keep on cropping its shoots all the year as we do; and as the attempt is persisted in more or less from March to December, despite so much discouragement in the way of plucking, we may take Tea as a very fair emblem of the quality we need now so much ourselves, *i. e.* " perseverance."

But the growth of a tea shoot, unless in the very centre of the bush, is not always steady and uniform, but in spurts.

At the end of the year, if the longer shoots at the side that do not branch are examined, it will be seen that, after first starting, the leaves increase somewhat in size and then decrease, and stop at a bhánji eye; this after a time again opens and grows, repeating the process, each growth from bhánji eye to eye being more or less lanceolate, and the same form as the tree and leaf.

Bhánji leaves being the last ones on a shoot where the eye is dormant, there is no " tip" (as usual), and from being a result of arrested growth, they have less juice in them than other terminal leaves, and hence make worse tea ; they are also, thus, stiffer, more leathery, and harder to roll.

Anything that tends to arrest growth produces bhánji leaves, as cold, especially cold dry air, as in our cold season ; moisture and warmth have the opposite effects, and promote rapid growth.

Want of "cultivation" conspicuously tends to produce bhánji flushes on some soils that in consequence suffer more than people think from paucity of labour ; but these kind of flushes are not strictly confined to the beginning of the year : if anything they are more seen at the end, as the growth fails and the cold season begins. When seen at the beginning of the year it is due to leaf coming out and being checked again by cold,—a very common occurrence, and one to be expected. A good deal, perhaps, depends on the pruning, if heavy. Bhánji flushes early are seldom seen, growth being more forced; but if lightly pruned, Tea is often seen to go bhánji with very little provocation, and if the weather be not cold or dry, is a pretty safe sign of want of cultivation. So the causes are plain enough, and the *cures,* in some cases possible, in others not, as in temperature.

S. E. Peal.

"Bhánji leaf" is, in my opinion, the result of *heavy plucking and heavy pruning,* and I daresay to partial observers the first necessitates the second. Such observers, however, are almost invariably fanatical disciples of the "hair of the dog that bit you" school. I, however, know some who have found another way out of the difficulty :—

Thin out the tops of bushes, and always keep as much leaf on them as will be required to elaborate the crude sap sent up by their roots. When there is not sufficient leaf left for this purpose, the surplus crude sap is deposited in the cell-walls, near the tops of the bushes. This causes a sluggish circulation, the result of which is "bhánji leaf." In a word, the aim of all judicious plucking is to pluck so as to leave a sufficient quantity of leaf on the bushes to enable them to digest the crude sap sent up by their roots, and so prevent the young wood from becoming scrubby and prematurely old ; and the aim of all judicious pruning is to remove the old wood,—by old wood I mean useless not thick wood—the sap canals of which have to a great extent become silted up, and on which the leaf developes sluggishly.

I avoid all such pruning as implies the removal of nearly all the leaves of the plant during the semi-dormant season.

AUR KYA.

One of the causes of the above evil, is heavy plucking in the previous season, and little or no pruning in the cold weather following.

In such a case I maintain that a good pruning, even in the middle of the season, would be the first necessary step, just as I should advise a dose of jalap in a constipated subject. Now any Doctor will tell you that he looks to the causes of a disease before he exhibits a remedy.

If, therefore, bhánji flushes happened to be the fruits of over-pruning and over-plucking (which they are only in some instances), then in those cases I should say treat with tonics, and give the subject rest, *i.e.* manure, cultivate, and don't pluck until the flushes are strong and healthy.

As for the matter of pruning in general, all I can say is that few planters prune even two years running in the same way, and the reasons are as follows :—

1st.—The state of the bushes has to be considered.

2nd.—Previous treatment do. do.

3rd.—Different soils have to be considered.

4th.—Do. do. do.

5th.—Quantity may be required. (Ask Agents).

6th.—Quality, do. do. do. (Ask Proprietors).

Under these conditions what thinking man would ever attempt to lay down any single rule for pruning ?—Not

OUR DOCTOR.

THE TEA-MITE AND THE TEA-BUG OF ASSAM.

A very opportune Work has lately made its appearance, in which the author, Mr. Wood-Mason, of the Indian Museum, tells us all that he has, after careful research, been able to gather respecting the formidable pests mentioned above. The Work is rendered all the more valuable by several admirably-finished coloured Plates, showing the pests enormously enlarged, and giving, thus, a very tangible idea of the destructive capabilities of these enemies of the Tea plant. It is difficult to say which of the two is the more deadly. The Tea-Bug or Mosquito Blight attacks the young shoots, which then curl and dry up, while the Red Spider more particularly confines its ravages to the full grown succulent leaves. A curious circumstance in connection with both these forms of Blight is, that neither of the two has yet been met with on any other plant,—at least, so says Mr. Wood-Mason ; but some planters dispute this, and we should be inclined to think, also, that the Tea-bush is not the only plant patronized by these gentry. The difficult matter, in applying any remedy for Red Spider, is, that the eggs are laid in *hollows* close to the ribs of the leaves, and are not scattered over the whole surface, so as to be at once perceptible and get-at-able. Although heavy rain is one of the best antidotes, still the eggs are so firmly attached to the leaves, that it requires a good deal of continuous downpour to wash them away, and even then the spider itself takes shelter underneath the leaves, and is thus on the spot ready to commence anew. When at Darjeeling some years ago, we visited a Garden there heavily afflicted with Red Spider ; and, going out after a heavy downpour of rain, we picked several leaves, and placed them under the microscope, when it was seen that though many eggs had been washed off, a good many still remained ; the Spider itself was in such cases seen on the underneath portion of the leaf, almost as free from wet as if it had been under an umbrella, as it were, which Nature had kindly provided.

There appears absolutely to be no remedy for Spider-blight. In fact, if there were, it must necessarily be most difficult of application over anything like a large area. Syringing with muddy water has been recommended, and for the time it has seemed to be efficacious, but as the eggs revive under the influence of the sun, the relief is only partial; besides which, it is difficult to apply such a remedy over a large area. Some have propounded the theory that the Red Spider only attacks weakly plants, and therefore that nutritious or well-manured soil is all that is needed. No doubt to a certain extent this is correct, in so far that a strong and healthy plant will better be able to recover from a partial attack than one growing on impoverished soil ; but it is hardly likely that the Spider should prefer old and exhausted, to young and vigorous plants. We believe that, on one estate, "burning" was tried on a bad patch, and with some success ; but as a matter of fact, any *real* remedy remains to be found.

LETTERS *re* THE RED SPIDER, "ACARUS," LALL MAKEE.

This pest resembles a mite, and is one of the worst of pests that the Tea-plant suffers from, throwing back gardens at the commencement of the season, from long drought, and even deficiency of rain. This contagious pestilence predominates, but it is not so fatal or so injurious as the "Leropsy" or "Mildew-blight."

The red spider is a very diminutive insect, reddish colour on the back, and white on the under part of the body. It lives and feeds on the sap of the leaf. Its eggs resemble white dust or very fine *soojee.* The eggs have a very slight adhesive feeling, by which they adhere to the leaf ; the numbers that are to be found on the leaves are sufficient to extract all sap, after which the leaf withers, showing in bad cases a resemblance as if the leaf had been scorched by fire, leaving white stains. The red spider, as I have generally seen it, is worse to tea without shade on flat land, but bushes along the slopes of hollows where jungle is growing, are rarely had with it.

Its Causes are

Excessive drought, sterile, water-logged, and partially-exhausted soil ; deep hoeing too near the stems of the bushes, thereby cutting away runners, feeders, and young shoots, which come forth from the main root of the plant, thereby weakening it.

The Remedy

And prevention against this horrid pest is to have good hoeing between the lines of the bushes, and avoid hoeing any depth within 18 inches of the stem, thereby not running the risk of cutting any suckers or feeders, which supply the nutriment of the bush, which if done, each lateral root cut away weakens the bushes (same as bleeding would act on the human system,) and exposes it to various diseases. Drain all stiff land where it is necessary, leading the drains into hollows or any other outlet. When pruning, thin out all superfluous twigs and wood, *i.e.* non-bearing old wood, attacked by lichen, &c., and allow free ventilation through the bush ; retain a fair height, with all breadth attainable.

I have considered, after seeing the way manuring has been done on a very extensive scale at several friends' gardens who I have been staying with, instead of the manure being placed close to the stem of the bushes, placing it so as to be hoed in between the lines, it would not have the effect of being too powerful in heating the bush.

I quite agree, with all who manure, that it reinvigorates the soil, adds fresh vigour into bushes which have had previous hoeing promiscuously, plucked year after year, nothing put into the soil, but all taken out, thereby gradually impoverishing and making the land quite sterile, laying it open to the attack of pests.

What would be the consequence to farmers at home if they tried to take crop after crop off their farms, and not fertilize their lands either by manuring or draining? The result would be downright failure. *Drain only such lands as require it,* and have good cultivation, and there is little chance of being much troubled with the red spider, "Acarus," Lall Makee.

On dit where a jungle of a certain species of tree has been cut down, another, and quite different species, takes its place : on which I theorize : If you take away jungle, shade-loving insects will disappear, and in their place sun-loving ones will appear.

I am told, on inquiry, that red spider appears at the sunniest time of the year, and affects the sunniest and hottest localities, such as hollows and slopes facing southward.

I have only lately arrived among the red spiders, so for the present I accept the above as fact, and on it have based all the ruminations I am laying before you.

I have an idea—whether right or wrong I cannot say—that it is difficult to infect a healthy-blooded animal with diseases caused by parasites—and easy to infect an old, infirm, and impure-blooded one.

On the plantation which I am now managing I find most of the Tea-bushes with old wood stems covered with lichen and fungi, and by reason of the stems being old it is natural to suppose that the cells which carry the sap up are, many of them, closed and useless, so that the full quantity of sap does not reach the leaf-buds, and what does, arrives so slowly that a swift and vigorous growth (which almost by itself would overcome most evils that vegetable life is heir to) is impossible. To remedy this, and *aid* in expelling the spider, I would suggest that each year—from the many-stem bushes—a few stems should be cut to the grond, so that in four or five years the whole bush may be renewed, and that for the future no wood over say six years old should be allowed to remain, so that there may always be free and active cells forcing on and supplying a luxuriant top growth.

Acarus Telarius.—This is a minute mite, belonging to the family of spiders, *Holetra.* It is of microscopic size, and is just seen with the naked eye as a red moving speck. The genus to which it belongs (*Acarus*) contains an enormous number of species, mostly parasitic in their habits, either upon plants or animals. The present species mostly begins to attack exotics when they are young and tender. The female red spider deposits its numerous eggs upon the under side of leaves; they are exceedingly small, whitish, and scattered over the leaves. The larvæ, as hatched, resemble their parents, save in size; when mature they are of a dark-brown colour and slightly hairy. Like spiders and mites in general, they moult several times before reaching maturity. They spin for themselves silken webs, which shelter them from weather and other influences. The cause of red spider is a dry, arid atmosphere, and to keep these pests down, the plentiful application of clean cold water is the best means. Soft water, in which a little sulphur-soap has been dissolved, is a very good remedy.

THE TEA BUG.

Sir,—I saw a letter in the *Englishman* on the subject of 'Tea Bug,' signed by a 'Blighted Planter'.

As I can answer some of the questions, I write to you, as in your columns the subject finds a fitter place.

1st. What is the origin and primary abode of the Tea Bug, *i. e.* mosquito? There is no doubt but that this pest is indigenous in the jungles of Assam, as the inhabitants will tell you that it commits great havoc on the *Pân*, crop. From this I should say it feeds chiefly on the wild *Pân*, which is a creeper growing on the trunks of trees.

2nd. Its habits, with regard to its time of breeding, period of hatching, and development.

The little insects generally appear with the first of the new season's leaf; but they also seem to keep on increasing, often to the end of the season, although the heavy rain interferes with them somewhat.

There are often 'two at a litter.' I can't say how often one pair will breed in a year, nor how long they live, and when they come to maturity.

3rd. Whether it has any period of hybernation or lying dormant, or is active throughout the year? If the former, when does it take place? If the latter, is it migratory in all or any of its stages?

It certainly has a 'period of hybernation,' and that is in the cold weather, when the tea has no young leaves for it to feed on.

It often leaves a garden for no visible reason, but again at times sticks obstinately to certain patches of tea for all that is done to clear it out.

I have known it to desert a piece of tea that was allowed to go into jungle. The jungle was *kher* and other grasses, which completely hid the bushes.—"Up Yonder."

The Utilisation of Ants as Tea-bug Destroyers.

Sir,—I have for years past taken the keenest interest in the numberless efforts that have been made for the extermination of the various tea pests; but no method yet devised, to my knowledge, has proved thoroughly effectual when put to the test. Universal syringing of the infected bushes with carefully prepared drugs and disinfectants, sulphur and other fumigations, and the liberal application of chemically prepared manures, have not, so far, succeeded in eradicating the evil. After noting these numerous failures, I come to the conclusion that we have to look to Nature alone to produce a remedy; at the same time not ignoring the fact that Nature can largely be assisted and encouraged by artificial means. With regard to tea-pests of the bug and spider types, I maintain that the only effectual means of extirpating them, or sensibly reducing their numbers, will be found in the discovery and introduction of some *other* insect which will make these pests its natural food. With this idea in view I tried several experiments on the common Tea-bug, which we also have up here, but which, I am happy to say, has not yet proved itself a plague. After trying the carnivorous propensities of a variety of insects, I gave up the thing, for the time being, as hopeless, as almost in every instance they refused to have anything to do with the Bug; but one lucky day last year I quite accidentally discovered what I had been so anxiously looking for before:—while tending and training up a favourite creeper in my verandah, I noticed the young tendrils were swarming with the common large black ant. On closer observation it could clearly be seen they were destroying and devouring, in a most wholesale fashion, myriads of small greenish-looking insects, very much resembling the Tea bug in its earliest stages of development. It was this resemblance that struck me, and I immediately detached one of the tendrils of the creeper, with about a dozen or twenty ants upon it, and placed it on one of the infected tea bushes. After the creeper had been cleared of all its occupants, the ants in the most natural way possible took to eating up the tea bugs! Next day, on carefully examining this particular bush, not a single tea bug could be seen! The ants had likewise decamped, but I noticed a few stray individuals afterwards on the adjoining bushes, probably seeking for more of their newly-acquired food. Several other small colonies of ants that I transferred in like manner behaved in exactly the same way as the first lot. So far, so good. My experiments were at last crowned with success. But on thinking the matter over, I feared the utilisation of these ants on an extensive scale would be found impossible in practice. But now I have good reason to think otherwise, as I see that ants have actually been used for this very purpose for centuries, in China. I quote a paragraph from a recent number of the *Gardener's Chronicle* which bears out my idea, and leaves no doubt, I think, as to its feasibility:—

Professor Riley contributes the following note to a recent number of *Nature*: Dr. C. J. MacGowan has sent me from Hanchow, province of Hainan, China, a little Paper on the utilisation of Ants as insect destroyers in China. It seems that in many parts of the province of Canton the orange-trees are injured by certain worms, and to rid themselves of these pests the inhabitants importants from the neighbouring hills. The hill people throughout the summer and winter find the nests of two species of ants, red and yellow, suspended from the branches of various trees. The orange ant-breeders are provided with pig or goat bladders baited inside with lard. The orifices of these they apply to the entrance of the bag-like nests, when the ants enter the bladders and, as Dr. MacGowan expresses it, become a marketable commodity at the orangeries. The trees are colonised by placing the ants on their upper branches, and bamboo rods are stretched between the different trees, so as to give the ants easy access to the whole orchard. This remedy has been in constant use at least since 1640, and probably dates from a much earlier period.

If ants have been turned to such good account by the Chinese, in the management of orangeries, why should not the same be found to answer in the case of tea plantations? The ants I experimented with so successfully were the ordinary large black kind, so familiar to everybody in India, and are easily procurable everywhere. Slight bamboo rods could be used from bush to bush, to facilitate their spreading over the plantation, while a circle of tar and kerosine mixed round the stem of each bush would prevent their running off on to the ground.—ALISTE.

MOSQUITO BLIGHT, &c.

[*From our Ceylon correspondent.*]

The mosquito blight or *Helopeltis Antonii* is attracting a good deal of attention in our local papers,—more so, may be thought, than the extent of its ravages justify. But Ceylon planters are resolved not to be caught napping, as they were over the advent of *Hemilia Vastatrix* or leaf-disease in their coffee, and are determined to attack this new enemy, whenever found, before it has thoroughly established itself in their estates.

A planter sent some of the eggs of this little insect to Dr. Trimen, the Director of our Botanic Gardens, and asked his opinion regarding the probability of the pest extending on tea as it has on cacao, and, indeed, as it *has* done on tea in some places, though not in many. Dr. Trimen says in reply: The extracts from Mr. Wood-Mason's treatise on *Helopeltis* in Assam, which have lately been reprinted from Indian papers, are of much interest. I have not had an opportunity of seeing this Book as yet. Mr. Wood-Mason's descriptions of the eggs agree with my own, above referred to, as also that of their position in the young. These points are not novel, being only confirmatory of Van Gorkom's observations on chinchona in Java. The proceedings of *Helopeltis* are clearly identical on chinchona, cacao, and tea, and what I have stated with reference to cacao applies, *mutatis mutandis*, to the other plants. From the observation of only two eggs *in situ* I do not like—having no pretensions to any entomological knowledge or training—to generalize as to their position in the shoots, but I have recommended the removal of the latter in cases where the presence of the eggs could be detected. It is to be hoped that Mr. Wood-Mason will give some help as to how this is done.

There are no data as yet to enable us to determine whether this small creature has been recently introduced, or whether it is indigenous to the jungles of the country. On this point our Director says: "That the insect should prove to be native to the island is perhaps on the whole a matter for satisfaction; as experience teaches us that organisms which have in course of time established a balance with their surroundings in nature, have less opportunity for great increase in numbers than is the case with many introduced species which found their new environment to be in their favor. But, no doubt, our cultural operations do much to upset or modify the easily-influenced equilibrium which has resulted from ages of a complicated strife." It appears that the *Helopeitis* has been scientifically described in the Annals of the French Entomological Society, by Professor Signoret.

SIR,—In your valuable paper of the 2nd September—article "Ceylon Notes"—your correspondent writes of the Helopeltis or mosquito, which is the same pest that troubles our Indian Tea gardens, and is called the mosquito blight, the insect being *a good deal larger* than a mosquito, with long legs and proboscis.

There is but little doubt that this is the most destructive and formidable of all blights, Red spider has been much commented on, though I doubt if it is *nearly* as destructive as the green-fly, which is becoming most common in the Darjeeling Hill Gardens, the effect of which is to deprive the leaf of its ordinary amount of sap. The leaf is small and stunted, as is the length of the flush, which would not weigh one-fourth of its ordinary weight; and this takes more than twice the ordinary time to come on, and if left, the bushes shrivel up, and the buds or tips die off. No efficient remedy has been found that could be applied for this blight, up to this, that would be cheap enough. I am anxious to know if any of your readers have tried placing small pans on the garden, filled with kerosine oil, and put somewhere near the bushes affected, lighting the kerosine in the night so as to attract the insects to their destruction?

I have no doubt this would be a valuable method of destroying the mosquito when mature, for it is well known how all insects are attracted by lights during the night. A muster of coolies with lighted torches, paraded in lines through the bushes, and made to pass the torches *quickly* under and around the bushes, so as to avoid scorching them, would, I presume, do great havoc among the mosquito.

I should say a tin of castor oil, mixed with about three or four quarts of kerosine, would be the best oil to use with the torches, as it would create a large flame, and not be so liable to be extinguished by wind. The experiment is simple, and would destroy more mosquitos than could be killed with the hand by ever so large a staff of coolies.

I would much like to know how this succeeds, and if the writer of "Ceylon Notes," or any other person, would let me know through you, Mr. Editor, or through your valuable journal, I would feel gratified, for simple as the medium is, I am sure it has not had a fair trial, *if any at all*. I do not think that the mosquito would be extirpated by it, but the attack would be *greatly lessened, I feel sure.* I have seen some gardens in low-lying flats and hollows in the Darjeeling district, closed by mosquito for two or three months of the manufacturing season, and at that time I never thought of trying the plan above mentioned, or rather I should say of suggesting it, for the gardens in question were not in my charge.

"GREEN FLY."

OTHER BLIGHTS.

WITHER BLIGHT.

No. 1 *Question.*—Does the blight attack solitary plants, certain areas, or the whole garden?

No. 1 *Answer.*—Very seldom solitary plants; of course it begins on one, and in the space of three weeks thirty to forty bushes grouped will be suffering from it; and the surrounding plants quite free from it. Groups varying from five to as many as sixty bushes are to be found over all the gardens.

No. 2 *Question.*—The age of the plant?

No. 2 *Answer.*—25 down to 15 very badly attacked.

15 ,, ,, 9 not as heavily
9 ,, ,, 3 lightly, groups of five.
3 to pullies, rarely.

No. 3 *Question.*—Class of soil most liable to attack, and lay of land?

No. 3 *Answer.*—Any soil seems to suit, as there is soil varying from rich red loam, through yellow down to blue, which may be flat, with no drainage, and high well drained: the latter comprises the greater portion of Tingri, say 75 per cent., medium 20 per cent., and low 5 per cent., of the whole.

No. 4 *Question.*—Season of appearance, and weather?

No. 4 *Answer.*—End of July and beginning of August, with heavy rains and occasionally hot blazing days, after one or two of which the blight begins by the edge of the leaf getting black, which gradually spreads till a fringe of green is left on top, the under leaves being withered of a brown color, with a perceptible white thread on them, which extends to the stem or stems of the bush.

No. 5 *Question.*—Does it attack same plants or areas yearly?

No. 5 *Answer.*—No. I have marked down several bushes of three successive years' attacks, and have not found it attack two years in succession the same plant (and it is as well it does not.)

No. 6 *Question.*—Is attack a gradual or simultaneous one?

No. 6 *Answer.*—The attack goes on for a month, appearing in several places at the same time. After the first month is over, the blight seems not to spread further.

No. 7 *Question.*—Answered under No. 2.

No. 8 *Question.*—Effect of heavy rain?

No. 8 *Answer.*—Heavy rain, if continuous, checks its spreading till the first day's sun sets it agoing; after second week from its appearance, rain or sun have no effect, either way; it simply runs its course.

Manuring has no effect upon it, as it is to be found in the Hybrid near the coolie lines, possibly as well manured tea as could be found.

Pruning down does not root it out entirely, but considerably reduces its ravages, but then these same low-pruned bushes gradually get more and more of it as they are pruned up year by year.

It began here six years ago on a piece of old tea near the river Tingri, then striking some eight or ten bushes in one group only; now there are groups equal to at least ten acres or 2,400 bushes attacked by it, the rate of increase to this having been gradual.

Class of plants.—It attacks all sorts of *jât* indiscriminately—China, Hybrid, and indigenous; goes even to the forest seed-gardens, and lays hold of those (30 feet high,) seed-trees which are growing in their natural soil and condition, with the same ease as it strips a China bush of 1½ feet high, three feet plucking-surface.

That is about all I know of this *Wither Blight*, and my notes are from experience of it for the past six years.

Mr. F. P. Hainworth, of Debrughar, says:—"I would like to know in what Garden it is to be seen. I have an idea that it is no blight, but a white thread-like parasite, that creeps all over the leaves and branches of the tea, and causes the bush to appear as though it were withering away; it requires pretty close observation to find it out. I had a quantity of it in the gardens under my charge when I first took them over, but by cutting out year after year I have got rid of a very great deal of it. I find it most near the jungle round the skirts of the garden, and in damp shady places."

The Beetle Pest.

Some time back a reference was made to the Botanical Gardens, Kew, regarding this, and it was very correctly replied that one of the conditions which has been ascertained to conduce to the spread of this pest is the presence of manure or decaying animal refuse, which the insect selects by preference in which to lay its eggs. When once the beetle appears on a garden, it spreads with great rapidity, and therefore instant detection should be made wherever possible, and every means should be taken to free the soil from the larva, and the bushes from the insect itself.

In Europe the following methods are pursued for this purpose:—

1 *Collecting the beetles.*—This may be done by picking them from the low bushes and shaking them from the trees in the plantation on to sheets spread underneath, as practised in the forests of Germany and France. Smaller trees are shaken by the hand, whilst the beetles may be precipitated from the larger trees by a smart blow with a heavy hammer against the trunk. Trees which stand singly or at the edge of a plantation, and the leaves of which are eaten by the beetles, shelter generally the largest number. The early morning is the best time for collecting the European species, as they are then most torpid. In the evening and during the night they are in full activity. 2 *Collecting the larvæ.*—Care should be taken to destroy all grubs found in manure-heaps and in manure when it is spread out over gardens. 3. The soil also should be frequently ploughed or dug up, and the larvæ should be sought for and destroyed. In nurseries and in vegetable gardens, when the plants are in rows the grubs generally follow the rows, making their progress by the dead plants above ground, and in such cases the grubs will generally be found near the plants that last died. 4. All birds feeding on the perfect insect, such as crows, jays, magpies &c., should be strictly preserved; likewise shrews and moles, which feed on the larvæ, and also such carnivorous ground-beetles as the *Carabidæ*.

Caterpillar.

We have to acknowledge the receipt of a box containing specimens of a species of caterpillar, of a dark brownish color, which has done a considerable amount of damage to a garden in the District of Mungledye, Assam. This pest has devoured every leaf, both young and old, on all the bushes of about 75 acres, and off one bush alone 2 lbs. of caterpillars were taken. The trees visited by this insect, although *bare* as regards leaf, have not received any injury to their wood, and it is further noticed that as soon as the caterpillar turns into the chrysalis stage the bushes begin again to "flush." The Manager says that all the hands are employed "picking" them off the bushes.

These insects are no doubt identical with those described in the following communication:—

About the end of May numerous caterpillars, about an inch long, and of a dullish brown color, were noticed; but they did not at first attack the tea plants. However, they shortly began to do so, eating the bark of the one, and two-year old shoots, and causing the plants to die back; in some cases nearly to the ground level.

Small low *jât* plants suffered most. At first only a patch separated from the rest of the garden by a road was attacked, but later they spread over the rest of the garden.

I have only just finally got rid of the caterpillars.

I had millions gathered and destroyed, and in this operation I found that laying down pieces of mango, which attracted large numbers of caterpillars, was of some assistance. In gathering the insects it was necessary to use a small piece of bamboo as a pair of tongs, as the caterpillars induced an itching sensation if touched with the skin.

This pest has hitherto been unknown in Lower Assam, as far as I can ascertain.

White Blight.

White Blight, a pale livid white leaf, resembling Leprosy on the human system in first stage, but afterwards turning quite pale. Caused from a red mildew or fine red mould, a very minute fungus, which attacks the petiole or foot-stalk that supports the leaf, as seen through a powerful magnifying glass. This species of blight is more fatal and deadly than any pest I have seen attack the tea plant. Whichever stalk it grows on, it gradually extracts the sap, thereby killing the vitality of the stalk, which dies. This fatal pest may by degrees run over all the petioles of the bush, or only attacking the weak parts, or where the sap is deficient on the bush, and prevalent on poor exhausted soil.

Remedy.

Careful pruning, with good men to supervise. To have all twigs and old unbearing wood removed, thereby allowing free circulation of air and moisture to nourish the bush: *not to cut down but keep surface* with all vigorous strong wood; to have no hoeing close to the stems of the bush within 18 inches, which if done there is danger in cutting the runners, feeders issuing from the collar of the main roots, which has the tendency to weaken and reduce the strength and vitality of any tree, shrub, or plant causing diseases of various kinds and ultimately killing the tree shrub, or plant. Bushes when noticed badly attacked by this blight, should have the petioles that are affected pruned out and burnt, thus stopping the disease or pest from overrunning the whole bush.

During the manufacturing season the parts of the garden should be marked, and the ensuing cold season give a good hoeing, turning up fresh subsoil, and careful pruning, removing all old wood and twigs.

Tea Stick Insect.

Mr. H. Mackenzie, of Roopabally, Cachar, writes as follows regarding this pest:—

"This insect is found in different parts of a garden, but mostly in secluded spots, and cool flat corners, where I have generally found them. The damage they do appears mostly to take place at night. In the day you will observe them making for the base of the bush, or hiding under the foliage, should any be left at this stage of their attack; but that is what generally goes first. Afterwards, they attack the bark, and Tea beiog a hard wooden plant, is very likely to be killed should the pest remain long enough—as you will be able to judge from the specimen of shoots sent you along with the insects."

Mr. Mackenzie goes on to say that the bushes even when first attacked are easily recognisable from a distance, the young leaves on the plant then appearing riddled. On examination the insects will then be found under the leaves.

INSECTICIDES.

Kerosine to kill Insects.—An American Paper says that since Paraffire oil came into general use, it has largely been employed in agriculture as an insecticide, and with considerable success, and that it has not been found to destroy plant-life as might have been supposed. Why not try it on tea? This is what the *American Agriculturist* says on the subject:—

"The oil in its concentrated form can be tolerated by but few plants. The first improvement in its use was to add a very small quantity to a bucket of water, enough to make but a mere film upon the surface, then diffuse it through the water by violent stirring, and apply before the oil and water had time to separate. This answered fairly well, but was troublesome. The next step was to divide the kerosine, not by dissolving it, but by diffusing it in the form of an emulsion. It is well known that oils may be suspended in water by means of gum, sugar, etc., and may be kept thus for some hours or even days. It has been discovered that milk, either fresh or soured, is a convenient medium to unite kerosine and water. Mix together kerosine and half as much milk, stirring them thoroughly to form a cream-like mixture. When the two are so completely united that no oil is visible, dilute the mixture with twelve times its bulk of water, adding the water gradually, and stirring thoroughly, This emulsion has been found especially useful in the treatment of the various scale insects, so difficult to destroy by ordinary insecticides, and is used for various other insect pests. For trees use a syringe or force pump, and for house-plants, often injured by scale insects, apply with a sponge or swab."

A good Insecticide.—We take the following recipe from *Land and Water*. The experiment is worth trying on a small scale, for getting rid of Red spider:—

Dissolve camphor in methylated spirits to saturation, and mix with soft soap to the consistence of cream; dilute this as you require it until it is thin enough to be served with a syringe, and you will find it most efficacious in destroying scale, red spider, and mealy bug, together with other greenhouse pests. The hon. and rev. J. Boscawen discovered this remedy.

Anti-Blight growths.—The *Colonial Mail* refers to a statement made in the Cape papers, that insects shun land on which tomatoes are grown, and the cultivation of the *Lycopersicum esculentum* is accordingly recommended. Now, as this vegetable will grow readily under shade, there would be little difficulty in having a large cultivation scattered over tea land, amongst the bushes. As the esculent would be grown not for profit, but as a prophylactic against the inroads of insect pests, its destruction in hoeing and clearing seasons would not much matter, and it is probable that its growth would keep down jungle. The experiment is, at any rate, worth trying.

SECTION XIII.

PRUNING.

Sap in Tea.

Pruning Tea.

Correspondence *re* Pruning.

SAP IN TEA—A QUESTION OF IMPORTANCE.

A QUESTION of the utmost importance to those interested in our Tea-gardens is beginning to crop up, which, though occasionally pooh-poohed, will have to be answered some day, and perhaps at no distant date. The question is, whether, as the plants grow older and the old stems in consequence become tough and gnarled, the sap does not, in penetrating the tissues, lose a great deal more of its vigor than when rising through the stems of the new plants ; and, in consequence, is there any soundness in the assertion that the teas from our old gardens show a marked deterioration in strength and flavor as compared with the produce of young plantations ? So large is the capital now sunk in Tea, that no subject connected with the business is too trivial to be discussed. The matter under present consideration can be easily set at rest by chemical analysis. Let, for instance, the constituents of some fresh leaves from two or three indigenous and ordinary class of hybrid bushes, each about two years old, be carefully investigated, and let the result form the standard of excellence : it will be easy then to deduce a formula by which any planter may from time to time ascertain whether or not any deterioration is perceptible in his plant. It is of little use seeking to solve the problem by testing manufactured leaf, as even if one uniform system of manipulation were pursued in the tea districts, atmospheric exigencies, begotten by the different sites on which the tea houses are built, would alone lead to confusion.

But by whatever process, should a deterioration be established beyond doubt, we should have then the question to consider, first—whether such deterioration is due to the old wood and knots formed by pruning retarding the distribution of the sap and consequent loss of the plant's vigor, or whether the virgin constituents of the soil have been exhausted. In either case Science must be resorted to. Were not our tea planters hounded on to get as much as possible off the gardens, there can be but little doubt that periodical 'cutting back,' almost to the ground, of certain portions of the Concern, in rotation, would be beneficial, inasmuch as it would result in having fresh, straight, bearing stems, springing direct from the roots, with no knots in them to retard the circulation of the sap. We cannot help thinking, however, that an immense amount of mischief is done by the severe 'cutting back' of young plantations. No doubt the first effect, where the soil is rich and the growth of the plant vigorous, is a prolific yield, but it is at the expense of future crops, and the formation of knots and contortions which must retard the distribution of the sap. The subject of pruning has not received that amount of attention, when considered from the sap distribution poiut of view, that its importance demands. Our planters' efforts appear to have been directed too much towards obtaining the greatest possible yielding area, without ensuring that the distribution be equal over that area. It has been in this way that, in a five-year-old plant, while we may have a large quantity of leaf, a small proportion only is contributed by fresh wood springing direct from the natural reservoir, the root. Hence we are of opinion that a considerable difference in the strength of the usual properties that form the constituents of the flush will be found. Assuming our opinion to be correct, it is manifest that in a garden of, say, twenty years old, the proportion of leaf taken from fresh-bearing wood must bear but a small proportion to that taken from stems full of knots and old pruning obstructions. And herein lies perhaps the reason of the falling-off in strength and flavor of teas from what were once known as favorite gardens. We do not dogmatically assert this as the only reason ; we express merely an opinion based on many years' experience, with a view of directing attention to the matter. The remedy will strike any professional man, but the difficulty will be to get proprietors and managing agents to give their assent. Great care and attention will be required in carrying it out The old, and all gnarled stems, must be thoroughly excised down to the ground, and all growth emanating from the old stem, systematically cut away and discouraged, the object to be kept in view being to evolve fresh upright growth direct from the roots. The crop meantime, would be considerably diminished, but it would possess uniform strength, The question as to exhaustion of soil requires the assistance of the analyst. A sample of soil, similar to that on which the Garden is formed, should be taken from some uncleared portion of the grant, and compared with a sample taken from near the roots of a five-year plant. We have little doubt in our own mind but that considerable loss in valuable constituents will be discovered ; for not only will evaporation have thrown off the more volatile elements, but the organic ones must be more or less absorbed by the plants: and it would indeed be a wonder if even the best soil should be found little affected by the demand made on it. If this latter experiment is carried out, we venture to assert that impoverishment will be found to be very considerable. The analyst however would be able tell us what particular constituents had been exhausted, and, as they must all exist in the neighbourhood, there is no reason to doubt but that many gardens that are now referred to as "old and worn out" could at a small outlay be made to resume their old pristine position. During the period that new growth is being trained from the roots it would be better if no leaf were taken from that portion of the plantation under treatment, as the difficulty in preventing " pluckers" from cropping the new shoots would be insurmountable ; but the interval might be profitably occupied in returning to the soil those properties that the researches of the analyst would indicate had been taken from it. Instead therefore of going to the expense of large extensions, the renovation of certain plots in rotation are recommended, and the *jhuming* system, which some proprietors have of late years adopted, should be discontinued.—*Indian Agriculturist.*

SIR,—About the question " Sap in Tea" I shall merely point out some facts which I hope will satisfy the inquirer, and solve the question to a certain extent.

It is erroneous to attribute the deterioration, in strength and flavour of the old tea-gardens, to the plant. The tea-plant shows, by the pruning, and cutting back, of the stem every year, its readiness to renew itself and to throw out new shoots, and as long as a plant keeps its vitality in such a degree as is the case with the tea-plant, it keeps also the full capacity of converting the nutritive substances of the soil into strength and flavour, if these substances are present. The reason why the tea-plant from year to year loses in strength and flavour (which is an indisputable fact) especially if left without manure, is only to be attributed to the exhaustion of the virgin constituents of the soil: and to nothing else.

Try, after the lapse of two or three years, when you think the strength and flavour commences to decline, to dig out the ground round the plant to a depth of only 5 to 6 inches, and fill up again the space with virgin soil, and you will get the same strength and the same flavour from that plant as you had the first year: no other manures will produce that effect. You may, to a certain extent increase the lost strength and flavour by applying animal manure and ashes to the plants, but you will never obtain the same *aromatic* flavour and strength of the tea unless you give the plant virgin soil round the rootlets, as manure.

It is with the tea-plant the same as with all plants, that they absorb first the nutritive substance of the surface soil, which always contains the chemical substances necessary for the plants (potassium and phosphoric acid, besides other organic matters) in a more accessible and easily soluble form than the underground ; and this virgin surface ground just contains the matters which the plant converts into flavour and strength in a higher degree than the underground.

The chemical analysis of Tea, and all connected with it, has been done many times by Liebig, Stenhouse, Mulder, Saunders, Siebold, Fortune, Chevreul, Peligot, Dr. Zoller, and many other scientific men, and they all confirm that young leaves contain more potassium and phosphoric acid than old leaves, which are richer in lime and silic acid ; and Dr. Zoller has proved that the more or less abundance of mineral matters in the vital organs of the tea-plant thoroughly depends upon the more or less abundance of mineral matters in the soil: so that if the ground is rich in potassium, the plants also contain a greater proportion of potassium and a lesser proportion of other matters ; and also, old leaves, in that case, are richer in potassium and poorer in lime and phosphoric acid. X.

Bandong, Java, *31st July.*

SIR,—Your correspondent " X." from Bandong, Java, seems to take quite an erroneous view of the tea-plant, its habit of growth, and nourishment. The tea-plant accommodates itself greatly to circumstances. For instance, in the Darjeeling Terai, in some gardens, where water is to be found by digging only a few feet, the tea bush has only a bunch of lateral roots and barely a tap-root worthy of the name, whereas, where water is to be found at a greater depth, it has a tap-root six feet and over that length considerably. In the first case " X." might be correct ; not so, however, if the plant was found, as it generally is, with a long tap-root, and barely any laterals, which would suggest that it looks for nourishment deep in the soil, its tap-root increasing in length with its age, and further requirements as it exhausts the soil. Some of the oldest gardens in Darjeeling bring top prices, and these gardens have not been manured.

"X." must evidently look elsewhere for deterioration—in flavour at least.

Rank and succulent growth no doubt cause deficient flavour. Let "X." prune *heavily*, and from the flush produced on the top of that, make his tea, and he will find it is wanting *in flavour at least*, as I said before. Teas wanting in cup may be produced very easily by various defects in manufacture, also by leaf attacked by mosquito or green-fly blight.

Sunshine is advantageous to growth; but our most flavoury teas are not made then. Wet, cloudy, and cool weather, when the flush is not growing so rapidly, is the time the most flavoury teas are manufactured. Again, leaf attacked by green-fly, *I have reason to know*, is much stunted, and takes some time to mature, makes flavoury tea, but wanting in cup.

Ceylon makes good flavoury teas, but this I attribute to the very fact of its gardens manufacturing all the year round, and to its bushes being continually plucked, thus subduing what would be an extremely vigorous growth Some seasons are more favourable to manufacture than others as regards quantity; others as regards flavour. I state these facts, which have been much spoken about by old planters; and mention them myself, though I am perhaps no great authority: yet I am aware of the facts from having enquired into them, being anxious to know myself if certain statements were correct, though I am but a—"GREEN FLY."

P. S.—"X." must find the medium amount of fermentation which will give him the greatest amount of flavour with the fullest cup. To be sure, the fact is well known that the least amount of fermentation over a certain stage destroys flavour, though strength of liquor will be obtained; fermenting over and above that point, again, the teas will be quite destroyed, and acid. Much rolling improves strength of liquor, but destroys the tips. Breaking teas in sieving (but not to such an extent as to make them unsightly) also increases strength of liquor. The defect may lay in tea-making, or in heavy pruning,—not in the deterioration of the plant: which will barely tally with facts. I believe it is bard to say at what age a tea-plant deteriorates if it is grown in suitable soil; if it is planted in unsuitable soil, it only depends to what extent the soil may be unfit for its growth, even though the tea-plant will accommodate itself, as I said before, wonderfully to circumstances, and is extremely hardy.

PRUNING TEA.

There are three ways of pruning,—heavy, medium, and light. *1st*, As to heavy pruning: this is necessary when bushes get aged over 12 or 14 years, when they gather moss and lichen, and get stunted; but still the pruning must be done by method, *i e.* the bush must be well-examined, and then operated on. There may be a quantity of old dead wood, which must be removed with old unbearable wood covered with moss, lichen, &c., which the knife cannot remove, but must be done by the saw, cutting in a slanting direction. After the branch or limb has been sawn off, use the knife in taking off all rough surface left by the saw, making it quite smooth, so that all rain and damp is not so liable to penetrate, and being cut to green, fresh, and vigorous wood, young shoots will sprout out, giving fresh life to an old stump. Some old tea I have seen so far gone, that it was necessary to cut down to the ground, but which afterwards threw out strong vigorous shoots, and the bush revived. This pruning requires great care, and no plucking should be allowed ere June, until the young growth is fairly developed, when great care must be taken by the planter. *2nd*, As to medium pruning on bushes in a healthy and vigorous state of health, this can be done with the knife, cutting out all wiry, thin and unbearable twigs, cutting out all growth where several shoots are clustered on a stem, like a crow's foot. Removing this, fresh vigorous yielding shoots and *good* young wood will be the result. Preserve as much young wood as possible by pruning the same lightly: further, be careful not to lessen the girth of your bushes by over-cutting away the *lateral branches*, which tipping will do, cutting under what stems or twigs have been plucked. Clear out all thin twigs, when the bush will give vigorous flushes. *3rd*, *Light pruning:* this do to all young tea coming into bearing, by only cutting to measure, leaving the young bushes 3 feet full. What is necessary is to cut all off over 3 feet, and not to touch a lateral.

Colonel Money speaks of the care and system with which a gardener prunes a favourite fruit-tree, but does not seem to be aware that no inconsiderable part of the gardener's art consists in the care and forethought shown in distributing the young wood and fruit over the whole tree in as equal a manner as possible, so as to have no overcrowding, and to have every shoot and fruit receive a fair amount of air and light; and that result cannot be attained by either pruning out the centres, or pruning so as to cause lateral growth, but only by the plan of thinning and regulating.

The leaf-buds becoming hard after the first flush, are, I believe, principally occasioned by water at the tap-root, and are not so much due to atmospheric changes of the weather; but it often shows itself after the third flush, when there has been long-continued drizzle-rain. The right thing to do is to pluck off these hard roots, and dig deep and well, pressing the soil close to the roots. We ought, as in indigo, to have fixed rules for work. I mention this, as "Inquirer" calls pruning in January and February early pruning. This is about the right time, 10th January to 15th March, for the hills of Darjeeling, when the sap is commencing to circulate. Formerly, people pruned in October, November, and December; and all the ends of the trees drew up by the westerly winds, and so many trees were cankered and gave *bhánji* flushes. Higher up the hills, 5,000 and 6,000 feet, it may be right to prune later; but each planter should find out, by experiment of a few trees here and there, what is the proper time for pruning his garden, and not listen to every idle breath of wind he hears. A manager, by idle, careless, mis-called high cultivation, can do a great deal of harm. The Assam Company bury their prunings; so do I, and with great advantage; *but the right place to bury them* is the question. If on the top of the surface-roots close to the stem, then no doubt great damage is done, as above, through fermentation; but if placed some eighteen inches off, at the tip of the surface-roots—as all fruit-trees in England are done, whose surface-roots are pruned to bury them within reasonable space for manuring them—no doubt great good is done.

Clean Stems *vs.* Outside Shoots.—A discussion has been going on in Ceylon as to whether suckers (side shoots) should be encouraged or not; and a Nilgiri planter's advice as to cleaning the stem up to say six inches from the ground is disputed. We should say that if suckers were encouraged, the fresh growth from the principal stems would be retarded, and the size of the bush would spread undesirably. The object in a tea-bush is to develop leaf, and not new wood; and this is best done by nourishing the principal stems with all the available sap, and not diverting it to unduly enlarge the bush.

There seems little or no difference of opinion amongst planters regarding the season of the year at which pruning ought to be done The period during which the bushes are at rest is invariably recommended as the time at which it can be best done.

CORRESPONDENCE *re* PRUNING.

Heavy Pruning.

Sir,—With regard to the heavy pruning of Tea, I think your correspondents on the subject have omitted to mention one important point in connexion with it.

The mistake people often make is not in the heavy pruning itself, but in the treatment after it.

In some cases—for instance when the bushes have been carelessly pruned for years,—it is most necessary to prune heavy, if you wish to get anything like decent young wood to pluck from, or to raise the standard of the bushes.

However, the process ought not to end with the pruning.

The roots ought to be opened out, manure applied, high cultivation kept up throughout the season, at any rate; and lastly, the bushes ought not to be plucked until they have formed their full supply of young wood.

Of course there will be a certain loss of leaf that year, added to the extra expenditure, which will only be recovered in the ensuing season; and if you are not prepared to allow for this, then it is much better not to prune heavy.

I quite agree with those that hold heavy pruning to be harmful if the bushes have always been properly pruned, and have a fair supply of young wood about them.

As to the stripping of most of the leaves off the bushes,—a system of pruning resorted to by some—I beg to state that I have tried it on China bushes, and proved it to be a thorough success.

The bushes were too closely planted for the use of the *kodali*, so I put on children, with turnip-hoes, and had them carefully hand-weeded round the roots. I used no manure, but I got a bumper crop of leaf off the plot, and the bushes improved vastly in appearance.

MIZPAH.

Wherein does the merit of the so-called "stick pruning" lie? Upon what theoretical grounds is an *evergreen* deprived of nearly all its leaves at any time? The roots of evergreens we are told are always "at it." Lindley says: "Since evergreens are never deprived of their leaves, so they are never incapable of forming roots; on the contrary, they produce them abundantly all winter long." Now I never believe in the nonsense of opposing theory—so termed—to fact; and if it be a fact that *stick-pruning* is good, I should bow in the first place, and search about for the theoretical reason in the second. But I should like to be sure of the fact before saying more. Theory, and I fancy true theory, appears to me at first sight against this practice, which I understand to be the denudation of the plant almost entirely, at its season of rest. I am certainly no believer in *rule* of *thumb*. But on this subject, as well as on the other of China plant and Hybrid plant, I should be glad to hear from some obliging friends.

F.

Our correspondent F. refers to what he conceives to be a mistake in denuding bushes of their leaves. We entirely agree with him, and can find no ground, theoretical or practical, to justify the practice. At the same time it may be said that few agree on the subject. Still it may, we think, on grounds of common sense, be safely affirmed that to deprive a bush entirely of its leaves is virtually to kill the plant, and render it valueless for the purpose for which we desire to use it. Pruning which aims at cutting out dead or unprofitable wood, or with the object of producing a larger flush, is one thing, and can only result in good, since we do not cultivate the Tea-bush as a tree, but as a *leaf-yielding* plant; but denuding the bush of its leaves in the hope of stimulating vitality, we hold to be an utter mistake.

BRANCHES DYING OFF AFTER PRUNING.

DEAR SIR,—I do not agree with reason about insects being the cause of the great number of dead wood *often* observable on heavy pruned gardens.

I have read the remarks about the tea-bush being an evergreen, and I am confident that the so-called cleaning out of tea bushes in the pruning-time is overdone—hence the nourishment, which the bush would gather during night-dews by means of the leaves, is cut off, and the sap not rising at that season, the branches die out. It is all right to clean out thin bánjee branches, but the clearing off *all* the leaves—which is very very often done—should certainly be stopped. All the sap which is required to reclothe the tree with leaves would go to force out new shoots, and give earlier and stronger flushes.

CULTIVATOR.

CURIOUS EFFECT IN PRUNING.

DEAR SIR,—Can you or any of your correspondents enlighten me as to the cause of the branches of Tea-plants dying after pruning? The plants were pruned, as usual, in December and January, and in March and April the branches commenced dying off, *i. e.* a great number of them. The branches that have mostly died off were last year's growth, fresh and vigorous at the time of pruning. Besides the loss in produce, they make the garden look very sickly.

CHITTAGONIAN.

The only way we can account for it is, that you over-pruned, and so drove the sap too suddenly back. Branches of one year's growth won't bear much cutting. Perhaps, however, some of our readers may be able to give another reason.—ED., *I. T. G.*

DEAR SIR,—In answer to "Chittagonian" as to the branches of tea-plants dying off after pruning, I do not agree with your foot-note, that you think it was caused through too heavy pruning, as "Chittagonian" says—"the branches that have mostly died off were last year's growth, fresh and vigorous at the time of pruning." I therefore am inclined to think that had "Chittagonian" paid close attention to the bushes soon after the new flush broke out, he would have found a caterpillar or rather insect covered with a hood, (something similar to the common *cadis worm's* hood or covering) but smaller than the cadis worm; and instead of climbing to new leaves as the cadis worm does, he moves over the bark only, and eats it. They are generally in large quantity on whatever bush they appear, but unless the bush is looked at very closely, they cannot be seen, as they are the same colour as the bark. The general appearance of the bush attacked in February or May is a whole lot of dry pruned branches at the surface, and the leaf flushing out from the bush low down. I believe this to be the very worst blight that affects Tea, and if it was extended over a large area, there would be simply no yield. I had some bushes affected, and as yet they have not given a leaf; but those that I was able to detect, and get the grubs all carefully removed from them and burnt, have got over the harm done.

If it had been over-pruning, I do not think the young wood only would have died off.

J. C. ALLEN.

SECTION XIV.

PLUCKING.

PLUCKING.

One cannot be too careful at the commencement of the Season. The shoots ought to be well developed, *i. e.*, five leaves on each. Pluck only the bud and second leaf, when a vigorous shoot will come on. When the Season is advanced, say from middle of May, then pluck bud, second, and ¾ of 3rd leaf. Should it be a banjy flush, *i e.*, only two leaves developed, pluck only ¾ of the softest leaf. Do not allow lateral shoots to be touched, which would stunt the bush, and leave no surface afterwards. From May, plucking can go on regularly, and nerricks be established.

Col. Money says : The principle of plucking is to leave the bud at the axis of the leaf down to which you pick, intact. He does not recommend heavy plucking till after September, but only so much, before that date, that the wants of the Plant in foliage are never quite attained. He says that this principle will be found to give the largest yield of leaf, and will not injure the plants.

There are, however, very many opinions on the subject, and we subjoin some of them, as follows :—

METHODS OF PLUCKING.

There seems to be some diversity of opinion on the subject of plucking so as to obtain the greatest amount of leaf from one's bushes. The question is, whether it is best to pluck two or three *whole* leaves and the bud, as the case may be, or to pluck two and a *half* or three and a *half*, and half the one below, if soft, leaving the axis of the third and fourth leaves and the interlode or stalk between them. I am an advocate, after years of fair trial of both systems, of the second plan. My reasons are briefly these :—

1st. The rapidity with which the next flush comes on.

2nd. The absence of unsightly stalk in the tea.

3rd. The greater facility in sorting the roll before fermentation, separating the fine from the coarse leaf, so as to be able to treat each according to its requirements.

The first reason is the most important, as the difference in yield I think is very marked. By leaving a whole leaf below, experience shews that leaf must and does fully mature itself before the new shoot breaks away, whereas, by leaving the axis with a small portion of the third leaf, the sap of the plant goes directly to nourish the young shoots, instead of wasting itself maturing the whole leaf left by the other plan. A not uncommon appearance is to see the whole plucking-surface of a bush covered with hard dark-green leaves, which go on maturing, and absorb all the vitality of the bush, and keep back the young flush until they are satisfied, and as hard as leather.

The difference of the two systems is very marked at beginning of the season, when the bush is recovering from its pruning. I have known five weeks to elapse between a first plucking and the second, when bushes plucked two and a half leaves have gone on growing without a check.

If a whole leaf is left, this maturing process goes on repeating itself after each plucking, always delaying the new flush, and retarding the growth of the plant.

The only argument I have ever heard brought forward in favour of leaving the whole leaf is, that it strengthens the bush. This may apply to young gardens being plucked for the first time, but cannot to old-established bushes. Even the most bigoted upholder of this theory ought to be satisfied with the four or five leaves always left on the first shoots after the pruning, and those usually left after each plucking, for the good of the plant.

Reasons two and three are also important.

EXPERIENTIA DOCET.

DEAR SIR,—Your correspondent, "Experientia Docet," I think is entirely wrong in theory, though he says he speaks from experience. He puts forward two methods of plucking,—the one is to pluck two or three *whole* leaves and the bud, and the other to pluck 2 or 3 whole leaves and the bud, and also to take half of the 3rd or 4th leaf, if soft ; and he advocates the latter plan on account of the following reasons :—

1st.—The rapidity with which the next flush comes on.

2nd.—The absence of unsightly stalk in the tea.

3rd.—The greater facility in sorting the roll &c., and separating the coarse leaf from the fine.

Now as to the first, I say he is entirely wrong. Does he mean to say that he has ever paid any attention to the matter ? Five weeks is a very quick time to be able to pluck the second flush after the first, no matter how the first flush has been taken off, (either by cutting a leaf or otherwise). Again, I beg to say that had "Experientia Docet" given the years of trial to both systems he speaks of, he would know or find out that a young shoot does not get all its nourishment from the roots below, for it gets just as much from the leaf he would cut off, and thus deprive it of that supply of nourishment. He ("Experientia Docet") is quite right in saying it strengthens the bush not to pluck half leaves ; but he does not think this is much in its favour.

I should say that the stronger you can make the bush, the oftener it will flush.

Now as to the 2nd reason : I say he is also wrong, for there will be stalk in the tea, no matter which way he plucks ; but by cutting the leaf, he will get a very large percentage of

Broken tea, as it breaks more (*viz.*, the half leaves) in the process of rolling.

As to No. 3 reason, as it does not signify much, it may be right or wrong, and is simply a matter of opinion, but of no moment.

A. C. J.

P.S.—I omitted to say that the main branches from which the first young shoots spring are very rarely as regular in throwing out shoots as I demonstrated, and that only a certain number of these young shoots may be plucked the first time round (*viz.*, those which have grown long enough), and in the next plucking (probably a week or 10 days after) what will then be ready are taken together with what I have illustrated, *viz.*, the flush from the lower-leaf axis of the shoots previously tipped or plucked.

Again, to prove the correctness of this theory as explained, it will be generally admitted that from 8 to 10 flushes are the usual number taken from a garden; and this being so, if we only plucked the garden 8 or 10 times we would finish our plucking (going round once a week) in 8 or 10 weeks; now this is absurd, as we have about 36 to 44 weeks' plucking, which, divided by 5 (as an average time to lapse between each flush) gives us say 8 flushes (40 weeks ÷ 5 weeks = 8) for the season, but of course in cases depending on climate, cultivation, and soil, the pluckings may be more rapidly taken off at longer intervals; but on every garden, as far as I have seen, there is a certain proper time to take the leaf off: if that time is exceeded, the next flush is retarded, and if taken prematurely the bush and subsequent flushings are weakened, (this time of course depends on weather, cultivation, &c.) If you have insufficient pluckers you *can't* pluck in time; but if you have, by carefully watching the growth, experience will teach you what forces you will require, *viz.*, when to increase and when to lessen your hands, and when they want particular careful looking after through bad and careless plucking.

A. C. J.

COARSE *versus* FINE PLUCKING.

Mr. T. N. Christie at a recent meeting of the Maskeliya Planters' Association, Ceylon, spoke as follows:—

The few remarks that I have to make on the subject of tea-plucking, particularly as regards the merits of fine plucking, are based on the experience of one whose name, were I at liberty to mention it, would go far towards carrying conviction to your minds. The question as to which is the best method of plucking is, I suppose, the most important we have to consider in tea cultivation—even more important than the *pros* and *cons* of heavy pruning.

Coarse plucking and fine plucking, in all their degrees, have advocates in Ceylon at the present moment, but the fine pluckers are in the large majority, although many of those who formed that majority have inward qualms as to whether they are doing right or not.

The coarse plucker says:—"You are plucking your bushes to death, your estate will be worked out in no time, and your yield is much less than mine." The fine plucker says:—"My yield is good enough, and my prices are 30 per cent. better than yours, and, as it costs almost as much to land a pound of ten-penny tea in London as it does to land a pound of fourteen-penny tea, my profits per pound are more than twice yours."

I was myself told by many *Indian* planters that the high position which our teas attained last year (and from which I regret they have this year slightly receded) was due to our short-sighted, short-lived policy of fine plucking. Any one, they told me, would make high-priced teas by sacrificing the quality of their yield and the permanency of their plants. I did not, however, consider what plucking I saw in India as being very coarse, and I fancy the Indian planter has of late been plucking finer than he used to do half-a-dozen years ago.

At first sight fine plucking does strike one as being more likely to exhaust our estates than coarse plucking, but when we look more closely into the facts the likelihood is much less apparent. As regards exhaustion of the *soil* it is I think evident that, say, 300 lbs. of tea will take just as much or just as little from the soil, whether the leaves equivalent to that quantity are ten days or 15 days old.

As regards exhaustion of the *plant*, perhaps more might be said in favour of coarse plucking, but even in this respect it may be doubted whether the physique of the plant appreciably benefits by leaving on the immature leaf for a few days longer. The leaves from which we manufacture are all soft, growing leaves—that have not reached the stage of performing the functions of foliage, and their removal a few days sooner or later cannot make much difference to the plant, one way or another. You all understand, gentlemen, that the same leaves are plucked under the two systems which we are considering—only in the one case they are plucked a few days earlier than in the other. What little difference the earlier removal of the flush may cause can easily be made up, if the fine plucker allows his bushes to "run" for an extra week or two before and after his pruning. We should aim at getting foliage below the pruning level, and this can be obtained by lopping back our plants at an early age. The information which I have received shows that the loss in quantity by fine plucking is not nearly so great as the coarse plucker—particularly the Indian coarse plucker—thinks. On an estate where the plucking, although never very coarse, was much coarser than it has been during the past 18 months, one patch has been plucked fine for 2½ crops, one field for 2 crops (and this field has kept up the quantity of its yield from the time it was plucked fine,) and the whole estate plucked fine for 1½ crops. None of the bushes are in any way harmed, and, now that they are being pruned, they look well for the coming crop, having plenty of fine clean "pipes" of young wood to grow new flushes on. From the primary shoots that grew on the wood left after pruning, only the bud and one leaf were taken, and the yield in the beginning fell behind the previous year's yield by about 4,000 lbs. of tea, but since then the yields have run alike, and the yield for the year will not be more than 4,000 lbs. under the previous year's yield,—which was the largest the estate ever gave. Besides, the fine tea made from the first plucking left far more profit than would have occurred from the larger quantity, which would have been obtained had another, but harder, leaf been taken.

In perusing the *Indian Tea Gazette*, I find an article "COARSE PLUCKING *versus* FINE PLUCIKNG." There is a medium in all things, and there must be such in plucking tea-bushes —"a happy medium" which gives the best results, and which cannot, I fancy, well be explained on paper: in which case all one could say is, an ounce of practice is worth a pound of theory.

In the instance mentioned, of plucking bushes to death, in the same article (a dialogue between a coarse and fine plucker), I have no doubt Mr. Christie will agree with me that both methods may be so adopted as to make any tea-bush "very seedy:" let him pluck coarse or fine, and take all the flush off; it is immaterial what course he pursues,—either method will well nigh kill a tea-bush in a few years; and there being no new wood left, each successive pruning will make it smaller yearly.

There is no questioning that a certain amount of good substantial wood must be left at the most vigorous growing season of the year, either in India or Ceylon. This is of vital importance for the current season's crop as well as for wood to prune on for the following season. After this wood is made, the bushes might be handled more heavily in plucking either coarse or fine: but to keep a tea-bush in health, and gain *probably* the best results in either country (as I know only what I read of Ceylon), a full leaf or half a leaf must afterwards be left on the bush after each plucking. I would also say, leave all the flushes which grow horizontally at the edges of the bush till they gain the height of the surface of the bush: then tip them. By this method fine large bushes are made, and the plucking-surface is increased, as well as healthy plants obtained without loss; on the contrary, gain in yield.

This Discussion is most interesting to all engaged in Tea Cultivation, especially now that we are endeavouring to make our Product known elsewhere than in Great Britain, for much will depend upon what quality we send into the markets of the world, with which to drive out the China leaf. If it can be shown that fine plucking, whilst producing a much higher average price in the London market, also allows of *almost* the same quantity being secured, with no greater exhaustion of tree or soil, we shall be great gainers by the Discussion.

SECTION XV.

BUILDINGS.

BUILDINGS.

Time was when Factory Buildings were necessarily built in a very kutcha manner, the transport of permanent building-materials being both difficult and costly. Corrugated iron has, however, of late years come very generally into use; but there still are Factories which have to be built of the material most readily at hand, and in respect to Out-buildings, Thatch has even now largely to be employed. Where the use of iron, also, is difficult, by reason of initial cost and transport, tiled roofing may often be practicable. We therefore have pleasure in reproducing at the end of this Section communications on the subject of Thatch, and Tiles, for Roofing, which appeared some time since in the columns of the *Tea Gazette*.

THE FACTORY, &c.

The walls may be built of reeds (*ekara*), bamboos, planks, mud, sun-dried or *pucca* bricks, stone:—or, best of all, corrugated iron, according to the district and climate.

The timber used should be of two descriptions: one that will not rot or eat if buried in the ground, for posts, &c.; and the other light, and, if possible, impervious to the attacks of borers and other insect pests. The wood used in contact with the ground should previously be well charred, tarred, creosoted, or coated with crude earth-oil or silicated paint. However, tar is a dirty, sticky material to use in a Tea-house. Unless timber is quite dry or seasoned, it will rot or eat if buried or coated with any of the above; and will soon become like sodden tinder.

All nails used should be either *wrought*, or those known as French pins (pointes de Paris):—the former for heavy timber, the latter for planks or battens.

Plank flooring should never be *nailed*, but always *screwed* down, the screws being previously *oiled*. These can be easily removed, while those corroded by damp, or by the sap in the timber itself, are very difficult to remove, and entail destruction of the plank. Unless planks are thoroughly seasoned, it is as well to fasten down the flooring with thin battens running over the pins, screwed down every here and there.

The panes of glass used for doors and windows should be of uniform size, 12″ × 10″ being the one most useful. The putty should be English made, and not the abomination concocted by natives, that soon dries and drops, leaving the panes to follow suit on the first windy day.

Silicate paints are undoubtedly the best and most economical in the long run. Wood-work, previous to being painted, should be washed clean with a little crude soda (*Sájí matí*), warm water, and a stiff brush. Old painted wood, before being repainted, should always be so cleaned, or the new coat is sure to blister off, having no real hold on the smooth surface, but on a blistered coat of old paint, with a layer of dirt between the old and new paint. None but the best English boiled linseed-oil should be used in mixing paints. Never buy *dry* paints. If turpentine is used, it gives the painted surface a dead look, while if only oil is used, the result is a gloss. Bundles of rags used instead of paint-brushes cause waste.

If the Factory is to be built of wood, iron, or masonry, all the materials should be sawn, dressed, ordered or prepared *the year before.* When the actual building is put in hand, the lack of materials should be the last cause of stoppage or even temporary delay.

In planning a Factory a most important consideration is the *site*, with reference to (1) water-power available for driving machinery, (2) proximity to the bungalow and coolie-lines, (3) the soil in which the foundations are to stand. The next point to consider is the *maximum yield* of the Garden. And, lastly, the prevailing winds during the Manufacturing Season, as well as the climate of the District.

Suppose the best available site selected; the climate that of the plains, hot and moist; the prevailing winds during the rainy season S. W., and the maximum outturn expected a thousand maunds. A Factory 150 feet long and 30 feet wide, with one *end* facing S. W., is what is required.

For financial or other weighty reasons it may be convenient to build the Factory by instalments. This can easily be done, as a Factory must be divided into three distinct compartments of equal size for *rolling, firing,* and *packing.*

Commence with the S. W. end first. Mark out a square 50 feet each way. If the walls are to be of masonry, foundations must be dug down to the lower solid stratum, at least three feet. Along the lines marking the square place pegs every 12′ 6″. Round about these pegs, as centres, dig a hole 2′ 6″ square, and at least 3′ deep. Connect these square holes with each other by trenches 1′ 6″ deep and 1′ 6″ wide. Fill up all these holes with masonry, building up to about a foot above the general level of the ground. We have now the *plinth* ready. Run up the pillars, 2′ square, and the connecting walls, 1′ wide, to a height of 10′ all round. The door-frame (*chowkut*) 8′ × 6′ should be placed on the plinth, and built in between two of the pillars of the N. E. wall. A window-frame (6′ 8″ × 4′ 3″) should be put in position, exactly in the middle, when the connecting walls are 1′ 6″ high, between every pair of pillars along the S. E., S. W., and N. W. walls.

On the completion of the pillars and walls, on a uniform height of 10′ being attained, wall-plates of timber, in lengths of 15′ × 10″ × 3″ *halved* into one another, should be laid along the S. E., S. W., and N. W. walls. Care should be taken that these *plates lie exactly in the centre of the walls*, so that the *entire wall supports the weight of the roof.* However, these plates are generally placed on the *outer edge* of the wall, thus throwing the *entire thrust of the roof on the few outside bricks only*,—a most unnecessary and dangerous practice.

Exactly in the centre of the room, to be ascertained by stretching two cords tightly from the opposite corners, make a hole, six inches wider than a good slant (12″) post, 15′ high. Fill the bottom of the hole with 6″ of charcoal, well rammed down, put in the post, and pack it tightly with small charcoal, well rammed all round. A post so secured in the ground is utterly impervious to the attacks of white ants, &c., who cannot bore through well pounded compact charcoal. In fact charring, or surrounding wood with charcoal, is the only efficient method of preserving it from insects and damp.

A cleft $3\frac{1}{2}$″ wide should be made, 9″ deep, at the top, to receive the ridge-pole 26′ × 9″ × 3″. The N. E. wall should be continued up in a triangle, the apex of which should be the exact height of the post in the centre, *viz.*, 15′ above the plinth. On this apex, a corresponding cleft being left in the masonry, the other end of the ridge-pole will rest. Two other ridge-poles, morticed into the head of the post, and resting on the S. and W. angles of the wall-plates, projecting 2′ 6″ beyond the pillars, will complete the outline of the roof, which will have three slopes, facing S. E., S. W., and N. W., respectively. Rafters (9″ × 3″) must next be secured to the ridge-poles, parallel to and 12′ 6″ from one another, and at perfect right angles to the ridge-poles. The rafters should project about 2′ 6″ beyond the walls, to form the eaves.

Fill up the angles formed between these rafters and the wall-plates with triangular blocks of wood, which, being cut to fill the angle exactly, will give a bearing surface of the entire width of the wall-plate. Drill a half-inch hole perpendicularly through the rafter, chock, and wall-plate. Raise the entire mass of timber, slip a half-inch bolt, fitted with a head and nut, up from the under side of the wall-plate, and putting on an inch-and-a-half iron washer, screw down the nut tight, so as to connect rafter, chock, and wall-plate, in one solid mass of timber. Similarly, drill a hole through an opposite pair of rafters and the intervening ridge-pole, and with a bolt and nut bind all three firmly together. Nailing the timbers of roofs together with huge spike-nails is a clumsy, insecure, and destructive device. If bolted together, an entire roof can be tightened up or taken to pieces at pleasnre, with ease. Should posts be used instead of pillars, the hardest wood procurable, ironwood if possible, should be used. The head of the posts should have notches cut in them to hold the rafters, which should be keyed into them with an iron rip,—a piece cut off ½″ rod-iron, not a nail hammered through, generally splitting the cheeks of the notch. Pillar-plates are not necessary, unless the rafters are placed closer together than the posts. These plates should be let into the posts on the outside just below the bottom of the notch. A band of iron should be nailed under the pillar-plate, passed over the rafter, and nailed under the plate. To dig a hole in the side of the rafter and nail it down to the pillar-plate is very clumsy, and affords little or no hold.

The spaces between the posts can be filled in with matting, planks, or, best of all, corrugated iron, fastened on battens, exactly like the roof. This makes a very clean, lasting piece of work.

Beams should seldom or never be let into or nailed to posts: cutting notches in posts weakens them considerably, and can generally be avoided by using *brackets:* these are blocks of wood fitted with a slot or notch a trifle larger than the beam to be rested in them, nailed on to posts or beams. In supporting beams across from one row of posts to another, nail brackets on to the inner face of the posts, with two large spike-nails, and in these brackets place the beams, which should be 1 inch shorter than the exact distance between the posts, to allow them free play. In case of the beams sogging, or bending down into an arc from their own or the superincumbent weight, the floor can be raised sufficiently to allow of the beams being lifted out of the brackets, and reversed. This simple way of correcting a serious fault in a floor could not be possible without much labor and more destruction were the beams and planks nailed down. Tie-rods and sheets are also useful in preventing the rafters sogging. The consequence of this fault in roof-timbers is, gaping of the sheeting or shingles, and leakage. Sheets may be placed under a beam likely to sog, until the fibre of the wood has stiffened. Sheets should have a cleft-head in which the beam rests: otherwise they are apt to fall away when the beam above vibrates from any cause.

When the rafters have been firmly fixed in their places, if 6-inch sheets of iron are to be used, eleven parallel rows of battens (3″ × 3″) should be nailed into notches, half an inch deep, across each slope of the roof.

Commencing with the lowermost row sheets, *screw* down four rows. Then, if thorough ventilation is desired, *bolt* down the topmost row of sheets so as to have them 6″ higher than the other lower sheets. This can be done by using blocks of wood six inches high for the bolts to pass through at the ninth batten, and proportionately high ones at the tenth batten, while the ordinary screw can be used at the topmost row. The sheet so raised must be a foot longer than the others, *i. e.*, it must be a 7′ one. Six sheets on either slope, with an additional one so as to give an overlap on the sides, will, if thus raised, make a very efficient ventilator if one such is placed over each of the three rooms of a factory.

Wrapping a piece of jute-tow dipped in thin lead-paint, round the shank of a screw, below the washer, plugs up the hole punched in the iron, and makes a very water-tight roof. Care should be taken to punch the holes on the ridges, and not in the gullets of the iron, and to use a backing of half-round wood, as the iron gets dented in, and the hole is not a clean one. No amount of cobbling and tinkering will make a badly-put-on roof water-tight, and as a little European superintendence is all that is required to make a tight roof, there can be no excuse for having a leaky one.

The windows, which are frequently left *unbolted*, either from carelessness or design, (for there is a great deal of petty pilfering invariably going on in a factory,) should open inwards, and be guarded by iron-wire netting, inch mesh, such as is used for fences and aviaries at home.

The walls should be well plastered, and painted with silicate paint. Unprotected walls suffer from damp, and the bricks and mortar soon crumble away.

The floor should be beaten solid ; covered with a three-inch layer of concrete, and finished off with Portland cement. In using this cement the following should be observed to ensure good work :—(1) Use the heaviest description of cement procurable, *quite pure*. Mixing and ekeing out with sand is false economy,—in India at least. (2) Use as little water as possible in mixing for use. (3) Lay it on in as thin a layer and as quickly as possible. (4) When dry enough, flood the floor with clean water, and keep it so as long as possible. The slower cement sets under still water the tougher the work done. (5) Cement should not be used in the immediate vicinity of fires, as it invariably blisters and breaks up.

A proper tool and store room, fitted with racks and shelves, should adjoin the factory. This building should be fire-proof, damp-proof, insect-proof, and thief-proof, by being built of iron or masonry, with a concrete floor raised a foot above the general level of the ground. There should be at least two or three small windows, glazed, and protected by wire netting.—SIGMA.

THATCH, FOR ROOFING.

This is still such a heavy item in most Tea Factories, and there seem to be such losses under this heading, quite unwittingly, and due to want of knowledge of the proper "times and seasons" to cut it, that some remarks on thatch-cutting may be of interest to both Planters and Proprietors.

There unfortunately seems to be a general idea that Thatch can be profitably cut at any time during the cold season, when there is "nothing better to do ;" that, whether cut in October, January, or March, it will be equally good and lasting.

This is a great mistake, and partly accounts for the recurrence of this item so steadily year by year, for such large amounts.

Like many other things thatch-cutting should have its times and seasons attended to, or loss is sure to follow.

It is not at all uncommon to see it cut from November, on till March, and depending on other work—often of less moment.

In Assam we have two distinct kinds of grass largely used, *i. e:*, "Borata," which is found in large open spaces, called thence "Bortani," generally a little above the rice-growing level of Potars ; and the other " Ulú," *(Imperata cylindrica)* generally found in the same habitat.

Borata is one of the grasses the seed of which is transported by the wind: hence it is found in the open and not in the forest ; has a tall flower-stalk or culm 12 or 14 feet high, carrying the large spike of minute and down-covered seeds that travel in the air great distances.

Borata also has no underground stem, but rises direct from a stool and roots at the surface. Hence it is easily eradicated by scraping.

The leaves are from 3 to 6 feet long by $\frac{1}{2}$ and $\frac{3}{4}$ of an inch wide, with a stiff white midrib, that tends to keep the end from bending over. Ulú has, on the other hand, many characteristics the reverse of the above, and it has two distinct modes of propagating, *i. e.*, by its minute down-covered seeds on a short culm, and by the stems running underground, and shooting up at frequent intervals.

Being found at from an inch to 2 feet deep, a scraping will not eradicate it : the flower-stalk, again, seldom rises above the level of the leaves, which are from a foot to 6 feet long by $\frac{1}{2}$ to $1\frac{1}{4}$ inch wide, and generally curve over at the ends.

At times these two grasses are found on the same site mixed, and early in the year it is not easy to distinguish between them, especially if the Ulú is well grown and called " Boronga ;" this however does not so much matter, as thatch is not cut till much later.

By September and October, Borata can be easily distinguished by its long flower-stalk rising 5 or 6 feet above the leaves, enabling the wind to sweep freely among the flowers and spikes of seed.

At times patches of this grass may be seen comparatively free from these flower-stalks, and these should be selected by the overseers, as stems are a great drawback, and prevent thatch lying close and flat.

One of the main things to note regarding these grasses is, that if cut too soon, there is an excess of sap and too little fibre, which naturally induces rottenness. Again if cut too late there is too little sap and too much earthy matter, which renders the grass very brittle, (an equally serious fault). The happy medium is generally found when 4 or 5 inches (only) of the tip has withered and turned brown, and if cut then, the thatch will be, as the Assamese say, " likota" or tough. The appearance of the grass is of more value than any date, but as a rule it falls between October and December, depending on season and site. When the Borata or Ulú tips have withered some 4 or 5 inches, is best.

The question of cutting about the right time, is more a matter of profit and loss than is generally supposed ; if cut at the best time, Borata will last 5 and 6 years, and Ulú 8 ; but if not at the best time, and too late or early, the limit is more likely to be 2 for Borata and 3 for Ulú : no light matter in large estates.

In places where grass is not easily obtained, an Ulú bari will be found a great saving,—say a couple of acres of cleared land fenced in and kept free of creepers. The density and rapidity of the growth of Ulú, where cattle and creepers are kept out, is, unfortunately, only too well known to many. By November a fine crop should well repay the little care that is necessary, and by June another one ready, the growth improving yearly. From having it near and dense, the rates also can be greatly increased, and three bundles, each six feet round, quite possible.

In some places Ulú is called " Sun-grass," and grows rather short, say at 2 feet to 3, as on the churs of the Brahmaputra. When kept clean in forest land, or good soil, it will reach 6 or 7 feet in the blade, and $1\frac{1}{2}$ inches wide.

It is found all over South-eastern Asia under various names, but always preferred to Bortani grass on account of its more lasting qualities.

The adaptation of grasses to their surroundings (like all animals and plants) is well seen in Assam, where there are at least four quite distinct modes of propagating the seed.

One large group has the seeds transported by the wind, and we see them flourishing only in the open, not in forest; again, having the seed very minute and covered by fine hairs, also carried high on a long stem, so as to catch the wind.

Another large group depends for transport on animals mainly, and these are generally found in and about forest and scrub, the seeds being covered by spines, hooks, gum, &c., and they become readily attached to anything that touches in passing.

Still another group are edible, and transported by birds, or again, as in water grasses, have large hollow husks, and float by.

The two first named are, however, the most conspicuous, and at times the stems of Kagra and Megella rise to 27 feet high.

In conclusion we may say that in Assam and Eastern Bengal generally there is very little to complain of in regard to the possibility of always having good thatch for our houses, if we only cut it in reasonable time. With our leaf, the proper time is generally a question of days (or less), and with thatch it may be one of weeks; but when it runs to *months*, and at times varies by 4 months, it is expecting a little too much of it to keep equally fit all the time, and wait our convenience; though not at once seen, this is done at a heavy loss, which in these hard times is worth attending to.

S. E. Peal.

TILES FOR ROOFING.

A correspondent has asked for information regarding tiles for roofing coolie-lines. Our correspondent will find the information he requires in the "Roorkee Treatise on Civil Engineering in India," Vol. I., which can be obtained from the Curator of the Thomason Civil Engineering College Book Depôt, Roorkee, N. W. P. The cost of making the tiles *on his factory* can of course only be calculated by himself.

CORRUGATED IRON.

	Nos. 18-	20-	22-	24-gauge.
Weight of 100 square feet ...	2¼	1¾	1½	1¼ cwt.
Square feet per cwt. ...	50	62½	77½	94 feet.

8 sheets of 6 feet long and 2′ 8″ wide cover 100 superficial feet.
6 „ „ 8 „ „ „ 2′ 8″ ditto ditto overlapping and corners being taken into calculation.

SECTION XVI.

STEAM ENGINES IN TEA FACTORIES.*

* Written specially for the *Tea Gazette*, by C. B. FERGUS, Mechanical Engineer, and Tea-factory Mechanician.

ON MACHINERY IN TEA FACTORIES.

Chap. I.—Engines and Boilers.

In India, wherever heavy and expensive machinery is in use, as in a flax or cotton mill, a mechanical engineer, or at least a trained European mechanic, is generally to be found in charge of it; and these establishments possess the additional advantage of being situated in or near such cities as Calcutta and Bombay, so that in case of breakdown the necessary repairs can be readily and speedily effected. But the user of small machinery in the Mofussil is very differently situated, especially in the Tea-districts. Few Estates can afford an engineer of their own; and many are so situated, that much valuable time would be lost before the services of an efficient man could be obtained. It is therefore important, on the principle of prevention being better than cure, that every manager or assistant in charge of a Tea Garden or Indigo Factory, or elsewhere, where steam machinery is in use, and where the services of an engineer or practical mechanic are not readily available, should be so far conversant with the principles and working of the Steam Engine as to, as far as possible, guard against accident or premature decay. Accidents to machinery are in a great measure preventible, and the length of time during which an engine or machine will do efficient work will be greatly increased by the care taken of it.

I therefore propose to give a few plain Instructions for the guidance of steam users who have not the advantage of being able to obtain the services of a mechanic, by which they will be enabled to see to the care and management of their machinery, so as to lessen the risk of accident, and preserve it in good working order with a minimum of deterioration. By attending carefully to the rules laid down, by carefully instructing the enginemen and firemen accordingly, and by strictly enforcing the carrying out of these Instructions, the steam user will find the risk of accident to be greatly obviated, the efficiency of his machinery increased, his fuel economised, and his bills for repairs greatly lessened.

The class of machinery supplied to Tea and Indigo factories, where small power is required, is usually of the simplest construction, almost invariably one or other modification of the non-condensing, or as it is usually but improperly called, the high-pressure engine. Various reasons, such as the greatly increased cost, scarcity of water, difficulty of water-storage, and the absolute necessity of having an engineer, or at least a trained mechanic, in charge, prevent the use of the much more economical condensing engine. The latter engine, with its complicated system of pumps, valves, &c., is quite beyond the comprehension of most people who have not made it their especial study; but the ordinary non-condensing engine is so simple, that the principles of its working may be sufficiently understood by the reader to enable him to carry out the instructions given.

I will therefore proceed to explain as simply as possible, avoiding technicalities, and without going into theoretical matters, what the Steam-engine is, and in the following remarks please note that by the term "engine" I mean the ordinary type of non-condensing engine, as separate from the boiler, although strictly speaking the boiler is part of the "engine," which means all and the whole of an apparatus designed to do work by the pressure or tension of steam.

Steam-engines are either condensing or non-condensing. In both, steam is formed by the action of heat on water in a close vessel, and brought to a certain pressure. It is then, in the ordinary type (for there are other engines than those you usually see, such as rotary engines, &c.) allowed to press on a tightly-fitting disc or piston, which moves in an accurately-bored cylinder. The steam is allowed to act on alternate sides of the piston, pushing it back and forward in the cylinder. Each time that the piston arrives at an end of the cylinder, the steam which has pushed it there is allowed to escape into the atmosphere, in the non-condensing engine, into a vessel called the condenser in the condensing type. It will be remembered that the pressure of the atmosphere at the surface of the earth is about 14·7 pounds on the square inch. The side of the piston in the non-condensing engine, from which the steam is escaping, being in communication with the atmosphere, is of course exposed to this pressure. But suppose we could remove this atmospheric pressure from the exhaust-side of the piston (that is, from the side from which the steam is for the time being escaping), it is, evident that we would have the benefit of 14·7 pounds additional pressure on the steam-side of the piston,—that is, on the side which is being pushed by the steam. This was done in the earlier forms of condensing engines by admitting a jet of cold water into the cylinder after the steam had done its work by pushing the piston to one end. This jet of cold water, mixing with the steam in the cylinder, condensed it, and there being no opening for the admission of either steam or air into the cylinder, a vacuum was formed.

The piston was then pushed by the steam into the space in which there was a vacuum, thus gaining the benefit of the 14·7 pounds above spoken of. A more familiar way of explaining this would be to say, that the piston was *sucked* back by the vacuum as well as pushed back by the steam. This is strictly not a correct explanation, but as the word Suction is used to indicate the effect produced by the removal of atmospheric pressure, it is more familiar to, and will be more readily understood by, the reader. The objection to this method of forming a vacuum was, that the jet of water cooled the inside of the cylinder, which in its turn cooled and condensed the steam admitted for the next stroke of the engine, and thus greatly impaired its efficiency. James Watt conceived that the steam might just as well be brought in contact with the cold water in a vessel separate from the cylinder, which would thus not be cooled by its admission: and thus, by the invention of the separate condenser, he made the Steam-engine the effective machine it is. The steam from the cylinder, after it has done its work, escapes into a separate vessel, where, being brought in contact with cold water, or metallic surfaces cooled by water, it is condensed, and this separate vessel, the condenser, being in communication with the cylinder at that side of the piston from which the steam is escaping, a partial vacuum, with its consequent advantages, is formed without the disadvantage, as in the earlier engines, of cooling the cylinder. The condensed water, with that used for condensing it, are removed from the condenser by pumps. This is the basis of the modern condensing engine, and as it is seldom used for driving small machinery, or where the power required is less than twenty nominal horse power, we may dismiss it from our studies with the remark that in its best-constructed forms it does, *cœteris paribus*, about four times the work of the non-condensing type, with the same consumption of fuel.

The non-condensing engine differs from it in that it allows the steam, on escaping from the cylinder, to blow off at once into the air. Although not nearly so economical as the other type, it is more suitable in situations where a large supply of cold water for condensing purposes cannot be stored or readily obtained. It is also much cheaper, simpler, and has far fewer parts than the condensing engine.

The steam-engine consists of two parts,—the boiler or steam-generator, with its valves and appendages, of which we will henceforth speak as "the Boiler," and the machine by means of which the pressure of steam is converted into motion, commonly called the Engine. As the Boiler requires the greatest share of attention and care to prevent accident or decay, as its parts are less easily accessible, and as it is the most difficult to repair if allowed to get into a bad state through corrosion or otherwise, we will proceed to deal with it before speaking of the Engine.

I do not wish here to enter into a description of the many different kinds of steam boilers in use, but will confine myself to a description of those generally supplied to users of small power, such as Tea-planters. These boilers are mostly one of three descriptions,—flued, upright, and tubular.

The flued boiler is of a cylindrical form, varying from fifteen to thirty feet in length and from five to seven feet in diameter. The ends are flat, and strengthened by stays running the whole length of the boiler, and by gussets, which are triangular plates rivetted to the inside of the cylinder which forms the outside or "shell" of the boiler, and to the ends inside. From end to end of the boiler pass one or more tubes called flues, large enough to contain within them the furnace on which the fuel is burned. These flues are strongly rivetted to the end-plates of the boiler, and assist in strengthening it longitudinally, being in fact large stays. A boiler having one flue is usually called a Cornish boiler; to one with two flues the term Lancashire boiler is applied. The fire is generally placed in the front-end of the flues, which are about two and a half feet in diameter. Sometimes, however, the fire is put underneath the boiler, and the flues only used for the heated gases (which for the sake of simplicity we will henceforth speak of as "the smoke") to pass through on their way to the chimney, so that the water in the boiler may extract from them the greater portion of their caloric. In the former case the boiler is said to be "internally" fired, in the latter case "externally." The flues are strengthened in various ways, to none of which is it necessary to allude here, except, perhaps, the Galloway tubes. These are wrought-iron tubes of an oval cross-section, placed in the flues behind the furnace at an inclination of 45°, and crossing each other, —that is to say, one is placed inclining to the right, and the next to the left-hand side of the flue. They are open at both ends to the water-space surrounding the flue, and serve the treble purpose of giving more heating-surface to the boiler, of allowing the water to circulate more freely, and of strengthening the flue. The flued boiler is generally set in brickwork, and in such a manner that a brick flue passes down each side, which unite and pass along underneath the bottom of the boiler, so as to rob the smoke of the last of its heat before passing into the chimney. The flues, both inside and outside the boiler, are usually arranged so that the lowest level of water in the boiler will be three or four inches above their highest part. This is absolutely necessary in the iron flues, as otherwise they would become red-hot from the heat of the furnace, when the pressure of steam would cause them to collapse, and probably cause an explosion. In the external brick flues, however, this is to a certain extent optional, and some engineers have the top of the flue above the water-level, for the purpose of superheating the steam to a small extent.

Another and more usual form of boiler is that to be seen in the Railway locomotive, or in the various forms of portable engines, where the flues above alluded to are split up into a number of small tubes from two to three inches in diameter, thus sub-dividing the heated gases, and causing them more effectually to part with their caloric. These tubular boilers as they are called, are a modification of the invention of George Stephenson, who first exemplified them in his celebrated engine the "Rocket," now in Kensington Museum. These boilers are not more economical, as far as their evaporative power is concerned, than a well-constructed flued boiler, but are more compact. Some are mounted on wheels, so that they can be easily transported from place to place, in which case they are called portable engines; others are constructed so that wheels may be temporarily attached, in which case they are called semi-portable. Some are separate and distinct from the engine, as that supplied by Marshall of Gainsboro',—an admirable boiler in every respect. Others have the engines on the top ; while another of this tubular class has the engine below it, on an iron sole-plate. Each of these modifications has its advantages and disadvantages, of which I will speak further on. They all consist of, first an upright rectangular chamber surrounded by double metal walls, of which the interior one is sometimes copper. These walls are strongly fastened together by iron or copper stay-bolts. They contain between them a space of three or four inches, which is filled with water. This chamber, which is called the firebox, is pierced on one side with an opening, through which the fuel is delivered to the furnace which is inside of it. To the front end of the fire-box a cylindrical shell is fastened, closed at both the fire-box and front ends by plates pierced by a number of round holes, which receive the ends of the tubes. These plates are called the tube-plates. The tubes pass through the shell of the boiler, and conduct the smoke into a chamber underneath the chimney, called the smoke-box. This is closed by a large circular door which is opened when the tubes require to be cleaned. An apparatus for heating the feed-water is sometimes placed in the smoke-box. This utilises the heat left in the smoke after passing through the tubes, which would otherwise be wasted.

A third description of boiler very commonly used, where under ten-horse power is required, is the upright boiler. It consists of a wrought-iron cylinder with a more or less rounded top, within which is another cylinder with a similar top. The interior cylinder contains the furnace, and is made so much smaller than the outer shell of the boiler as to leave a water-space all round, and so much less in height as to be four inches or so below the surface of the water, and then leave a considerable steam space. The interior cavity containing the furnace is called the fire-box, and usually contains one or more cross tubes, to give, like the Galloway tubes, additional heating-surface, and strength to the boiler. There is generally a small mud-hole door opposite these tubes, through which they may be cleaned.

All boilers are liable to accidents from the same causes, and with slight differences of detail, the same precautions to guard against accidents are to be used. In like manner they are all liable to decay from the same causes, and the remarks as to taking care of and preserving them apply equally to all.

Chap. II.—The Boiler, and how to Care for it.

The principal cause of decay in a steam-boiler is corrosion : this takes place internally and externally. By internal corrosion is meant that which occurs in the inside of the steam or water space, where the boiler is exposed to the action of steam and water at a pressure above that of the atmosphere. External corrosion means the decay by oxidation of any part of the boiler not in contact with steam and water inside : so, a leaky joint or rivet in a flue, or the end of a tube leaking, and causing corrosion in the fire-box, will come under this heading. These leaks often take place, and cause corrosion at the openings into the boiler where the steam or water valves are fastened to it. There are several of these openings,—one at the communication-valve by which the steam is allowed to pass to the engine ; one at the feed-water check-valve through which the water is allowed to pass into the boiler to replace that which is evaporated and goes into the engine as steam. This valve is called the check-valve because it prevents or checks the back-flow of water from the boiler.

There is an opening at the safety-valve, the valve which allows the steam to escape before it rises to a dangerous pressure, at each of the water-gauge glasses, by which the steam and water are admitted to the glass which shows the water in the boiler, and at the test-cocks, by which the height of water is ascertained independently of the gauge-glass, thus being a check on it. The manhole and mudhole doors are large openings for the purpose of getting at the inside of the boiler to clean it, and there is another opening at the blow-off cock, which is used for emptying the boiler, and for another purpose to be alluded to further on. All these valves, cocks, and other "mountings," as they are called, are liable to leak where they are joined to the boiler, and the water lodging about the boiler, especially in places where it is not easily seen, as beneath the wood and felt, or other non-conducting substances with which most boilers are covered, often causes serious corrosion,—the more serious because it is not seen or thought of till the boiler has become badly injured. Besides the above sources of leakage, we often find the joints of the plates or some of the rivets leaking. Sometimes through original weakness in the iron, but more generally through over-heating, we find a plate cracked, and leaking from the crack. The fireman, in cooling his ashes, often throws water into or about the flue or ashpit, and wet ashes are often carelessly allowed to lodge there ; this is a common cause of most destructive corrosion, and should be prevented. The stuffing-boxes of cylinders, &c., in those classes of engines which have the engine placed upon the boiler, are frequently leaky, and the water from them falls on and lodges about the boiler. Tubes and stay-bolts are often found leaky, with the usual corrosion of neighbouring parts ; rain or other water is often carelessly allowed to fall on the boiler ; the drip or drain-cocks from the valves and cylinders often leak, and contribute their quota to the general destruction. All leakages enumerated above are preventible and curable, and, when seen, means should be at once taken to stop them. The boiler should be examined from time to time to detect leakage in the more obscure places where it is liable to be passed over unobserved.

I have used the word stuffing-box, above. The piston-rod, slide-rod, pump-rod, or plunger, and other parts of the engine which work into and out of any space containing water or steam, cannot be made such a good fit in the openings through which they pass as to prevent leakage. Were they made to fit the hole exactly, their expansion by heat would cause them to jam, and become immoveable : they are therefore made to pass through a space which can be filled with hemp or cotton saturated with tallow or some other substance, which, while it can be compressed sufficiently to prevent leakage, is still elastic enough to allow the rod or plunger to work freely through it. This packing, or "stuffing" as it is called, is compressed by means of a *gland*, which is a metal ring, bored inside to accurately fit the rod which slides through it, and outside to fit the inside of the stuffing-box, as the space is called where the packing is put encircling the rod. This metal ring has a flange, through which pass two or more bolts, by means of which it is tightened down on the packing—thus compressing it.

Stuffing-boxes are a fertile source of leakage : when they are allowed to go any length of time without the packing being renewed, no amount of screwing-up will make them tight. When they are observed to leak, the gland should be tightened, care being taken not to tighten it so much that the friction of the packing on the rod will cause the latter to heat, and also that the nuts of the bolts be tightened evenly all round. Should the leakage not cease when the gland is moderately tightened, the packing must be taken out and replaced by fresh packing. Care should be taken that the whole of the packing be removed from time to time. Any pieces that are not much worn may be put in again, but the new pieces should be put in first, so as to be at the bottom of the stuffing-box. Gauge-glasses have a small stuffing-box somewhat differently constructed, and made tight by the gland compressing an India-rubber ring. If the latter rings are not obtainable, a little lamp-cotton soaked in oil may be used. No red-lead or any such substance as putty should be used in packing a gauge-glass, as some native firemen are apt to do.

The spindles of communication-valves, slide-valves, check-valves, piston-rods, valve-rods, pump-rods or plungers, and other parts which pass through stuffing-boxes, blow-off and other large cocks, are sometimes made steam and water tight : in the same way water-gauge glasses, also, as described above.

Be very careful that all stuffing-boxes are properly packed and kept perfectly steam and water tight : you will thus cause one source of corrosion and premature decay to disappear.

The materials with which the stuffing-boxes are packed are many. In a large marine engine, or in the large class of stationary engines used in spinning-mills, &c., many elaborate and expensive kinds of packing are used ; India-rubber, canvas, wire gauze, asbestos, and other substances, entering into their composition. One of the best of these is Tuck's patent packing, which consists of strong linen cloth soaked in India-rubber solution, and rolled spirally round an interior square core of India-rubber into the form of a rope. Packing is also made of hemp or jute, soft rope plaited into a gasket, or lamp-cotton done up in the same way. When being put in, all packing should be cut a little shorter than will go round the rod, so as to allow it to expand lengthways when screwed up. If cut with a bevelled end so that the ends overlap, so much the better. When being placed in the stuffing-box, the cut end should be at opposite sides alternately, so that the steam cannot pass. Rope or cotton packing should be well soaked in, and Tuck's packing well rubbed with tallow or oil.

The duty of attending to the stuffing-box packing belongs to the engineman's work. On Sundays, or other days when the engine is not at work, he can do the necessary packing. Particularly insist on his drawing out *all* the old packing ; and if going to put in some new, and the best of the old, make him put the new in first, so as to be at the bottom of the stuffing-box. The packing is withdrawn by means of steel rods called packing-screws, having a worm at one end like a corkscrew. The new packing is driven in by a piece of wood, concave on the side next the rod, and convex outside, so as to loosely fit a segment of the stuffing-box. The packing should be well driven down by hammering on this packing-stick as it is called, and then the gland screwed down as tightly as possible to compress it. The gland is then removed and more packing put in, and the process of hammering down and squeezing with the gland repeated till the box will hold no more. The gland is finally to be left screwed up, but not too tightly, on the packing.

Nothing looks more untidy and slovenly than leaky glands ; and if the engines are on the top of the boilers, as in portable engines, nothing is more destructive ; therefore I repeat, and wish to impress upon the reader, that it is of great importance to keep the packing in good order.

But sometimes, when the rod or plunger, the gland, or what is called the neck-bush of the stuffing-box, become much worn, it is not possible to keep the packing quite tight. In this case tin drip-pans may be provided to catch the leaking water, and an early opportunity should be taken of sending the rod or plunger to an engineering workshop to be renewed ; or if not very badly worn, to be turned true in a lathe. This involves a new gland and neck-bush if the rod be turned ; but if it be renewed, the old ones may be bored out to fit it.

All valves, cocks, &c., which are attached to a boiler are known by the general term of boiler-mountings. With the exception of the smaller cocks, they are attached to the boiler by means of a flange, which is bolted to the shell of the boiler, the heads of the bolts being in the inside of the boiler. As it would be difficult and expensive to make such an accurate fit as to be steam-tight between the flange and the shell of the boiler, it is usual to introduce some substance which, while compressible while soft and newly introduced, and thus capable of being screwed up so as to fill every crevice, will afterwards harden sufficiently to prevent escape of steam or water, even under very high pressures. One of the most useful substances for this purpose is a putty made with two parts of red to one of white lead, moistened with linseed oil. This is mixed with hemp cut in lengths of about an inch, and teased. The putty is then well beaten with a hammer, and worked by hand as a baker kneads dough, for two or three hours,—the longer the better. It is then spread evenly and thinly on the flange, a little is put round the neck of the bolt, and a little on the ring or washer which goes under the nut. The whole is then screwed up as tightly as possible. Sometimes a piece of canvas or wire gauze is cut the size of the flange, with the centre hole and bolt-holes accurately cut in it. This, if canvas, is first soaked in linseed oil and then smeared with the above putty, without the cut hemp, and thinned considerably with linseed oil so as to be semi-fluid. If wire gauze, the putty can be spread on it as above; with canvas or wire gauze it is necessary to wrap hemp, steeped in the semi-fluid putty, round the neck of the bolt, and also to put a small hemp ring or grummet round the point, under the washer; the grummet also soaked as above. There is a very useful patent cement for the above purpose, superior to red and white-lead putty, called Scott's cement. It is used moistened with linseed oil, &c., as above.

Care should be taken, in tightening up a joint, to screw the bolts evenly up all round. This is best done by tightening them in pairs, taking opposite bolts as pairs.

India-rubber in thin sheets, from one-sixteenth to one-eighth of an inch thick, and also a kind of cloth prepared with solution of India-rubber, are now more generally used than anything else in making joints. They require no red lead or other putty, and should be cut like the canvas or wire-cloth with the centre and bolt-holes accurately in their places. They should then be rubbed on one side with black lead to prevent the joint adhering when reopened, and screwed up as above. Instead of hemp round the heads and points of the bolts, in this case small rings, cut out of the waste parts of the sheet, should be used. The above prepared cloth is called "insertion sheet," and any hardware-merchant can supply it. I recommend it as being the best material for making joints, as well as the cheapest, where the flanges are fairly fitted; but if the flange is very rough, or the part of the boiler to which it is to be attached be very uneven through corrosion, some substance must be used which will squeeze into and fill up the inequalities. In such a case the aforementioned putties, or a piece of thick India-rubber, may be used.

Sometimes, although the joints of the flange be perfect, one or two of the bolts may leak. In this case the bolt may be removed the first time access can be had to the inside of the boiler, and put in again, carefully lapped, as it is called, with hemp and putty, as explained above. If more than one bolt leaks, they may be taken out one by one, care being taken that each one be tightened up before the next is removed. If the joint of the flange be leaking ever so little, the first opportunity must be taken to remake the joint, as the little leak will rapidly increase, corroding both flange and boiler, and becoming more and more difficult to make.

Boilers are generally covered with some non-conducting substance. In this a space of at least one inch clear should be left round all flanges and other mountings, such as cocks, so that if a leak takes place it can be at once seen and attended to. The neglect of this precaution has caused many a good boiler to be ruined by unseen leakage before the persons in charge were aware of it.

We have above considered leakage from stuffing-boxes; we have also seen what destructive leakage may take place from bolts and flanges. You should bear in mind that whenever you see a leak from a flange, a bolt, a cock, or any other part of the boiler-mounting, you should take the earliest opportunity of remedying it. You will thus eradicate another factor from the destructive agencies at work on your boiler, and proportionally increase its durability.

The gauge-glass, cocks, test-cocks, and other small cocks about a boiler, are sometimes fastened in their places by a flange, but more generally by being screwed into the iron boiler-plates; sometimes being made more secure by having a shallow nut on the point of the screw inside the boiler. Should they leak, they should be removed, and fastened with hemp round the neck and point of the screw, soaked in red lead as above described for bolts. The hemp round the neck should be wound round in the opposite direction to that in which the screw will revolve when being screwed in; else it will wind off when the screw is being fastened. The hemp round the point, as in the case of bolts, should be a twisted ring, known as a grummet.

These cocks often leak at the plug,—that is, the conical part which revolves so as to open and close the cock. In this case they should be filed and scraped up, and afterwards ground into their place with a little very fine sharp sand or powdered glass. But this requires the services of a skilled mechanic to do it properly, and if not done properly, it is best not done at all. The best plan, if the services of a mechanic are not to be had at the factory, is to remove the cocks at the beginning of the idle season, and send them to some engineering workshop to be done up.

Copper pipes often leak where the flange is brazed on to the pipe. A good bazar brazier can usually repair this, but he should be made to use hard solder or spelter, which is a composition of equal parts of copper and zinc melted together in an iron ladle by the heat of a forge, and poured out thin on an iron or stone slab to cool.

To braze a copper pipe.—File or scrape the parts to which the solder is to adhere, perfectly clean and bright; powder the spelter with a hammer on an anvil to about the size of coarse salt; cover the parts to be brazed with two-thirds spelter to one-third borax; hold the article over a clear charcoal or coke fire, which will be the better of having a blast from a bellows until melted; then remove the article from the fire, or let it cool gradually on the fire.

The non-conducting material with which most boilers of the Locomotive-shaped description are covered consists of one or more layers of felt, covered and kept in its place by wooden staves bound round with iron or brass hoops, or by sheet-iron fastened in a somewhat similar manner. A flued boiler is sometimes covered on the top with a thick layer of clay and cowdung, or ashes: either of these makes a very good non-conductor. Care should be taken in covering a boiler with a non-conducting substance to leave the space of one inch at least clear round all flanges, cocks, or other mountings. The reason has been stated above. But notwithstanding this precaution, it may happen that a joint or seam or a rivet may leak, and, being below the non-conducting substance, may not be observed until serious corrosion has taken place. Flues of flued boilers are cleaned out from time to time, and the boiler, as far as can *be* seen by the flue, may then be examined for leaks; and in this class of boiler any leak on the top would soon make itself apparent by an escape of steam through the ashes, or other non-conductor. Should such a leak make its appearance, an early opportunity should be taken to cool and empty the boiler, when the leak may be caulked with a caulking-chisel, which is a chisel having, instead of an edge, a blunt face about one-eighth of an inch thick. But in a boiler surrounded by wood and felt, it is possible for such a leak to exist without being apparent; it is therefore necessary that the lagging, as this covering of wood or sheet-iron and felt is called, should be removed from time to time, and the boiler examined for leaks. This should be done at least once every year.

The man-hole door is an opening large enough to admit of a man, or at least a boy, entering the boiler to clean it. The mud-hole doors are similar openings, large enough to admit of a man's hand and arm. These are sometimes jointed with plaited rope-gaskets soaked in the semi-fluid red and white lead above alluded to. Sometimes a ring of Tuck's packing is used, and sometimes with India-rubber. Care should be taken that these joints are well made and water-tight. If made with India-rubber, it should be made to fit rather tightly on the projection on the door. As it is meant to adhere to the door, and come out with it when taken off, as if it were, in one piece with it, the India-rubber should be rubbed with black lead on the side which touches the iron shell of the boiler: this will prevent it from adhering. India-rubber need not to be screwed up tight, as it expands a good deal with heat. As it is very expensive, and there is great waste in cutting these joints out of a sheet, it would be well to get them from England, where they can be obtained ready moulded of any size. Cut a piece of paper the size and shape required, and order direct from the manufacturers, sending them the pattern. The North British India-rubber Company, Edinburgh, can supply you, and being manufacturers, you will get the articles cheaper than where middlemen's profits have to be added. Rubber should be kept from the air, either by being placed in water, or thickly varnished, when not in use: otherwise, it will oxidise and spoil. A good roof will prevent any damage from rain-water, and chimneys ought to be provided with a wrought-iron umbrella.

The boiler-tubes often leak at the end next the fire-box. This is caused by the rivetting of the end of the tube being eaten away by the strong action of the flame in the fire-box acting directly on them. Tubes should not be rivetted over, but simply made tight with a tool called an expander, and an iron ferule driven into the end. The tubes can be re-tightened by any one by means of the expander, which is a useful but rather expensive tool. They are generally made to project half an inch at first into the smoke-box: when leaky, they can be driven back into the fire-box a portion of this spare half-inch, and then made tight by means of the expander.

If mud, scale, or salt, be allowed to accumulate on any part of the plates or tubes exposed to the action of heat, the water, being thus prevented from getting at the plate, and keeping it at a temperature not much higher than itself, the plate will get over-heated, perhaps red-hot; a crack will be the almost certain consequence, extending most likely from a rivet or stay-bolt hole. This crack can be prevented from extending by drilling a small hole in its very extreme end, which can be filled up by screwing an iron pin into it. The crack can then be carefully caulked with a caulking-tool, but will seldom be perfectly tight. As accumulations of scale in a boiler are preventible, as will be seen further on, a crack of this sort is simply the result of bad management and carelessness.

Firemen are often careless, when cooling their ashes, in allowing water and wet ashes to lodge about the ashpits or bottoms of fire-boxes in contact with the iron of the boiler. No ashes, either wet or dry, should be allowed to touch the boiler, and the fireman, when quenching his ashes, should be careful not to let any water touch the boiler. Ashes are sometimes allowed to lodge at the sides and ends of the furnace-bars. These should be removed from time to time, and the iron of the boiler very carfully scraped where they have been.

No bricks, lime, or mason-work, should be allowed to touch the boiler, inside or out. A sheet of thin iron should be interposed between the masonry and the iron of the boiler, where masonry is used ; and if inside a flue, such as the brick wall called the bridge at the back of some furnaces, the iron should further be protected by a layer of putty.

In the lower part of the smoke-box of Locomotive-shaped boilers there will be found a tapered screwed plug, which is removable for the purpose of cleaning the lower part of the boiler-shell. A tapered tap is usually furnished with the boiler, to renew the screw in the plug-hole when it becomes worn and leaky. This must be carefully attended to, as if water be allowed to lodge in the bottom of the smoke-box, it corrodes the tube-plate badly; and in any case a hole should be drilled and always left open in the bottom of the smoke-box, to allow the water to drain out which would otherwise collect there.

The water which is developed in combustion often lodges about the flange by which some funnels are fastened to the boilers,—in upright boilers especially. The chimney should therefore be jointed to the boiler with putty or cement, which will prevent water from lodging there and corroding the surrounding parts, as it often seriously does.

Boilers are corroded internally, but rarely to the extent that external corrosion takes place, except in marine and other large condensing engines, where the steam, after being condensed, is used over again for feed-water after passing through many feet of brass or copper tubing in the condenser and feed-apparatus. This tubing being in electrical communication with the boiler, a galvanic action is set up, assisted by the water being more or less impregnated with salt. The iron of the boiler being more oxidisable than the brass or copper pipes, is at once attacked by the oxygen liberated by the glavanic action ; and this takes place in a peculiar way : the corrosion does not extend evenly all over the surface of the plates and tubes, but attacks them in spots, as if the iron had been scooped out. These spots, or pits as they are called, are from one-eighth to a quarter of an inch deep, and from a quarter to three-quarters of an inch in diameter. Sometimes the corrosion takes the form of a long furrow. These pits and furrows are a dreadful source of annoyance and anxiety to the marine engineer, and speedily ruin a boiler. There is however a partial remedy : Zinc being a metal much more easily oxidisable than Iron, it is usual to hang plates of this metal in the boiler. They are attacked and oxidised before the iron is much touched, and thus the boiler is saved at the expense of a few pounds of zinc yearly. This kind of corrosion takes place, but to a smaller extent, in land boilers, except in those of which the engine is fitted with surface-condensers. As it takes place more or less in all, it is well to hang a sheet of zinc in the boiler, taking care that it does not touch any of the iron ; you are then sure that pitting will not take place. A copper fire-box, as found in some boilers of the Locomotive type, often causes pitting. Water itself. if free from air, will not corrode iron. Fownes says : "Pure water, free from air and carbonic acid, does not tarnish a surface of polished iron, but the combined agency of free oxygen and moisture speedily leads to the production of rust."

Water as we almost always find it in nature, contains a certain amount of air. This however is expelled by boiling, and its absence gives water which has been boiled and cooled the peculiar flat taste which renders it unpalatable. Water also contains a certain amount of carbonic acid, which is also liberated to a great extent by boiling. When water is heated in a steam boiler, the air which it contains is liberated, and parts with its oxygen to the iron of the boiler, forming rust, which is a hydrate of the sesquioxide of iron. As the water is being continually changed, there will always be some air in the boiler ; but its action is not nearly so strong when the water, steam, and air, are hot as when cold, probably because the liberated air is in a greater state of tenuity when at the temperature of the boiling water. When the boiler is not working, and the water cold, bubbles of air and also sometimes of oxygen, separated by the galvanic action alluded to in the last para., are formed, and rise to the surface, or adhere to the side of the boiler. When the water is very still, these bubbles often form clusters on the iron just below the surface of the water all round the boiler ; and thus it is that a row of pits and furrows is often found just about the water level. For this reason care should be taken to empty the boiler when it is to be out of work for any time : no water should be left in it. The little that remains in the bottom should be carefully dried out, a gentle fire kindled,—not in the furnace but the ashpit, to evaporate any remaining moisture ; and when the boiler is thoroughly dried inside, the man and mud-hole doors should be put on, and all other openings carefully closed to exclude damp air. Perhaps the best method of keeping the inside of a boiler free from corrosion when out of work would be to detach all brass and copper pipes and mountings, fill the boiler right up to the very top, boil the air out of the water, and then close the boiler up. I never did this, but the method is theoretically correct, and for boilers in Tea-gardens and Indigo-factories, which are for months out of work, it might be tried with advantage.

Water obtained from wells often holds in solution substances which are injurious to iron. For instance the Karachi water contains saltpetre in solution, and as there is often more or less free nitric acid with this salt, it is very injurious, and the locomotives running on the Scinde Railway used to have their boilers destroyed by it. Should the surface-water in your neighbourhood be brackish, and no river water procurable, it would be as well to save up and use rain water, or sink a well below the saliferous stratum.

Steam as usually found in the class of engines here treated of is seldom superheated. This term is used with regard to steam of which the temperature is higher than the pressure. As the pressure or tension of steam increases, so does its temperature in a nearly regular ratio. Thus steam of one atmosphere, as that formed from water boiling freely in the open air in an open vessel, has a temperature of about 112° Fahrenheit. But steam of two atmospheres, or $29\frac{1}{2}$ pounds on the square inch, that is one atmosphere, or 14-7 pounds above atmospheric pressure, showing 14-7 pounds on the steam gauge, has a temperature of about 249° Fahr. In many marine engines and also in some of the larger land engines, the steam in the boiler is allowed to pass through an apparatus called a *superheater*, in which it is raised to a temperature many degrees above that due to its pressure, for reasons which are beyond the scope of the present Papers to explain, as it involves a theoretical principle difficult to be understood by a lay reader. This superheated steam rapidly corrodes iron with which it comes in contact, probably from the hydrogen and oxygen becoming more easily separated when very hot, or the compound becoming more "unstable," as chemists call this state. In small upright boilers, where the flue leading to the chimney passes through the steam space, it superheats the steam to some extent, but rarely so much so as to be very destructive.

The inside of the fire-box and tubes is usually found covered with a hard black scale. This is composed of carbon, with a small admixture of silica, and is deposited from the smoke. A scraping-tool is usually supplied by the makers, for the tubes, and for the inside of fire-box, &c., scrapers may be made of old files. This scale should be frequently removed, as it is a very bad conductor of heat.

One of the greatest causes of rapid destruction in a steam boiler is the formation of a crust of scale deposited from the water on such parts of the boiler as are in contact with heat. Water obtained from wells or rivers is usually more or less impregnated with sulphate or bicarbonate of lime. These, by the action of heat, are released, from solution in the water, and deposited in a firm white scale on the tubes, fire-box, &c., the parts getting the most heat having the thickest deposit of scale.

More dangerous and destructive than this scale is the deposit formed when river water, carrying a quantity of mud, is used in the boiler. It lodges in the same place as the scale, but in much greater quantities, forming a thicker crust; and the consequence is that the water, being prevented from being in contact with the heated plates, these become heated to redness, and being expanded much more than the other parts of the boiler, they crack, and cause very troublesome leaks, with their consequent corrosive destruction; and this coating of mud may be even so thick as to cause the risk of explosion. The boiler-plates, becoming red-hot, are unable to resist the pressure of steam, and are consequently borne down or crushed by the steam pressure so far out of shape that they ultimately yield altogether, and an explosion follows. The same thing occurs if the water in the boiler be allowed to become too low, so as not to cover the heated plates. It is therefore of the utmost consequence, both for reasons of economy and safety, to prevent this deposition of mud and scale as much as possible, and to remove it when formed, before it has accumulated to a dangerous extent. I stated before that I would afterwards speak of a second use for the blow-off cock. To prevent as much as possible the accumulation of mud and scale, the fireman should be instructed to do as follows :—When the day's work is finished, he ought to pump the water in the boiler up to nearly the top of the gauge-glass, and leave it thus all night. Next morning, when getting up steam, as soon as his pressure-gauge indicates five or six pounds, he ought to open the blow-off cock, and blow the water out until it reaches the ordinary working level. By this means a portion of the mud which has settled at the bottom of the boiler during the night, will be blown out.

In spite of this, however, or any other precaution, some mud or scale will form in the boiler. In boilers of the Locomotive type—such as Ransome's, Robey's, &c., the top of the boiler is strengthened by girders through which stay-bolts pass. Underneath these girders there are spaces left for the water to circulate. If dirty water be used, these spaces soon fill up with mud and scale, and a crack then forms between the stay-bolts. The top of the fire-box, the bottom of the water-space round the fire-box, the tops of the tubes, the narrow space between the side tubes and the shell of the boiler, and other narrow spaces, form convenient lodging-places for scale and mud, which, if allowed to remain, would speedily destroy the boiler. It is consequently necessary from time to time to remove the man-hole and mud-hole doors and the mud plug, and, by means of long iron scrapers, straight or curved as may be necessary, to break up and detach the mud and scale. When loosened, it should be washed down to the bottom of the boiler by copious douches of water, and then raked out through the mud-holes and plugs by long rakes. The frequency of this operation will depend on the cleanness or otherwise of the water supplied to the boiler. Rain-water is the cleanest and freest from impurities, either suspended or in solution. With dirty well or river water, the cleaning-out proeess should take place every week on the usual off-day. If none but very muddy water can be obtained, it should be allowed to settle, as it contains a small quantity of free sulphuric acid, and more will be liberated by the heat in the boiler.

Compositions are sold which help somewhat to soften scale, rendering it more easily removeable by blowing out. These are mostly compounds containing soda or ammonia, which act by combining with the acids of the lime sulphate. Common carbonate of soda is often used for this purpose with good results. A handful may be dissolved three or four times a week in the feed-water. It is by this means pumped into the boiler, where it acts as above.

A boiler should never be exposed to sudden changes of temperature or pressure, as these are apt to loosen the joints, rivets, and tubes. For this reason steam should be got up slowly, and when the day's work is done, should not be blown off, but allowed to cool and condense in the boiler. When necessary to empty the boiler, it should be allowed to cool for a night before the water is run off by the blow-off cock.

When no lagging or non-conducting material is supplied by the makers, the boiler may be covered with a mixture of cowdung and clay, mixed with hair or chopped tow. This may be laid on layer after layer while the boiler is kept at a gentle heat. Felt may be tied on to the boiler with ropes. I have found cooly-blankets a cheap and good substitute for felt.

It must be borne in mind that the economical working of a boiler, and, what is of more importance, its safety, depend mostly on the care and management exercised by the fireman while steam is up. I have written at length above on the prevention of accident or decay arising from corrosion on the deposition of mud and clay ; but no matter how good, or new, or strong, a boiler may be, or how free from scale and dirt, it is liable to be destroyed, perhaps with fatal consequences, by a rash, ignorant, or careless attendant.

This arises from one of two causes,—either pressing the steam to more than the boiler can stand, or letting the water get so low as to cause the parts exposed to the fire to become red-hot.

When the maker supplies the boiler, he usually informs the purchaser at what pressure of steam he may work it in safety. Each boiler is furnished with a steam-pressure-gauge and safety-valve ; of the latter there are sometimes two, one of which is locked up, and so constructed that the pressure cannot be increased by the attendant. An example of this kind of valve is to be seen in the class of boilers supplied by Ransome, Head, and Jeffries, and other makers, where the valve is covered with a small brass casing secured by lock and key. A lever projects from it, by which the safety-valve may be occasionally tested to see if it blow off. Great care should be exercised in seeing that the safety-valves do not become choked up with dirt, or rendered stiff and immoveable from any cause.

Should the steam at any time become too high, through excessive firing or a sudden stoppage of the machinery, the pressure may be lessened by opening the furnace door, and also the smoke-box door if any. This lessens the heat, by stopping the draft in the furnace, and thus deadening the fire, and also by admitting a current of cold air through the fire-box and flues or tubes. This method of counteracting excess pressure causes the sudden contraction of the boiler by admitting a current of cold air, and is therefore injurious, often causing leaks, especially at the ends of tubes and stays ; it is therefore to be avoided as much as possible. Some boilers are provided with means of closing the ash-pit, or with a damper in the chimney, which, when closed, prevents the draft from passing through the burning fuel, and thus, lessening the heat, checks the formation of steam without suddenly cooling the boiler. In urgent cases, as where the machinery is suddenly thrown off the engine, with a heavy fire on, and the steam still rising notwithstanding the above means being taken to prevent it, the safety-valve may be cautiously opened, and the engine started to pump cold water into the boiler, which, should it become too high, may be blown off by the blow-off cock.

By far the most usual cause of accident is, however, insufficiency of water. Inattention to the condition of the gauge-glass, so as to allow the passages leading to the interior of the boiler to become choked up, and thus cause a false level of water to be shown, is by far the commonest cause of this. The gauge-glass is fastened into two brass stands or brackets, which are fixed to the boiler in such a position that the upper one is some few inches above the working level of the water in the boiler. Through each of these brackets there is a passage leading from the interior of the boiler to the parts of the brackets just below and above the ends of the gauge-glass. These passages can be closed by cocks, and when these cocks are open, as they should always be, the inside of the gauge-glass is in free communication, top and bottom, with the inside of the boiler ; and it is therefore evident that the height of water in the boiler will stand at the same level in and be apparent in the gauge-glass as long as the water level is not above the top or below the bottom of the visible part of the glass. Opposite each of these passages, on the front of each bracket, there is a small brass screw-plug, which can be removed in order to allow a piece of stout wire being introduced to the passage, to clear it of mud or any other obstruction. This can be done even when there is steam in the boiler, provided the wire be bent into an L shape, one part of which can be held in such a way that the escaping steam or water will not touch the hand. A third cock is found on the bottom of the lower bracket, and a screw-cap through which the gauge is put in on the top of the upper one. This lowest cock is called the drain-cock.

Now, to test if the gauge-glass is in good order, and clear of mud or other obstruction, first open the cock last alluded to. If both the passages of the other two cocks are clear, a mixture of steam and water will come out,—that is, steam from the top cock mixed with water from the bottom one. Now shut the top cock : water alone should come out. Now open the top cock, and shut the bottom one : steam alone should come out. The top and bottom cocks are then to be left open, and the lowest or drain-cock closed. The water should stand then at about half the height of the glass. If more, the feed should be lessened ; if less, increased. Delay in removing the fire, should the water get too low through the feed-apparatus not working, through leakage in the boiler or through inattention, is another frequent cause of accident. Should the feed-apparatus go wrong, and you are unable to get it to work by the time the water gets down to half an inch from the bottom of the glass, you must remove the fire from the boiler at once. On no account omit this, or run any risk by waiting a little longer to see if the feed will work ; and remember that if at any time your water gets suddenly low through a leaky tube or other leakage, or from any other cause, to draw fires at once without a moment's delay, as lots of accidents and explosions have occurred through shortness of water.

Some feed-apparatus have, and all should have, a cock between the discharge feed-valve and the boiler, and also a cock on the suction-pipe, to shut off the water supply. With these, should the valves cease working, you can shut the supply of water off, and thus stop the pump from working ; and by closing the cock next the boiler, you can prevent any hot water from getting back. The supply of water should be stopped from the pump before the latter cock is closed, or the pipe may burst. This can be done by shutting the cock on the supply-pipe, or if there is none, by slacking back the cover of the lowest feed-valve. The valves can then be taken out and examined. If there is a check-valve on the boiler, and in good order, one of these cocks is not needed, as the check-valve will prevent any back-flow of water ; but people frequently allow the check-valves to become leaky. Sometimes the feed-valves cease to work, through vapour forming in the valve-chest above them, and this is often the case when a feed-heating-apparatus is used. In this case cold water thrown on the pump and valve-chest will condense the vapour inside, and the valves will start again. Sometimes the valves jam inside. A few taps with a hammer on the side of the feed-chest will often start them. Sometimes chips of wood get in with the feed-water, or cinders or other rubbish find their way in, aud jam the valve. The best remedy for this is prevention, by passing all the feed-water through a wire strainer.

The boiler is sometimes said to prime. This is said to occur when the water boils over, as it were, and comes into the engine with the steam. This is not as a rule very dangerous to the boiler, but it is to the engine, as the water getting into the cylinder often causes a break-down.

Priming is caused either by using dirty water, by allowing it to get too high in the boiler, or by irregular firing. The cure is indicated by the causes. Fuel should be supplied a little at a time, and often ; but as this is troublesome to a native fireman, he will, if not watched, pile on a heavy fire so as to have a long spell of rest ; then often go away, and leave the boiler to take care of itself till he thinks it is time to put on another big fire. This is wasteful of fuel, causes the boiler to prime ; and, while the man is away, his water may get low, or some accident take place.

Should a gauge-glass break while steam is on the boiler, it can be replaced in a few minutes by closing the top and bottom cocks, taking off the cap on the top of the upper bracket, taking out the broken glass, and sliding a new one down through the hole in the top. The nuts and ferules which squeeze the packing can be put on the glass in their proper positions as it is being slid on. During the time that the glass is being replaced, the height of water in the boiler may be approximately known by the test-cocks. These are two, or sometimes three small cocks, fastened in the boiler near the gauge-glass. They should be slightly opened, and the height of water in the boiler should stand somewhere between them, in which case steam should come from the upper, and water from the lower one. Should water begin to come from the upper one, the feed should be lessened. If steam make its appearance at the lower one, the FIRE SHOULD AT ONCE BE REMOVED.

I have now concluded my remarks on the Steam Boiler, and will proceed in my next to consider the Engine. I will only say in recapitulation of the first part, that by strict attention to the prevention of corrosion by leakage, by lessening internal corrosion as above directed, and by the prevention, as far as possible, and the frequent removal of, mud and scale, you will keep a boiler in good working order for a much longer period than it would be if these Instructions were neglected. And by careful attention to the Rules laid down for the management of the Boiler while under steam, by selecting a steady fireman, and enforcing on him the observance of these Rules, you will almost entirely obviate the risk of explosion.

LASTLY, REMEMBER, THAT AS LONG AS YOU KEEP THE WATER IN THE BOILER AT A PROPER LEVEL, AND THE STEAM AT A SAFE PRESSURE, THERE CAN BE NO EXPLOSION.

ON MACHINERY IN TEA FACTORIES.

Chap. III.—The Steam Engine.

We will now proceed to consider the Steam-engine. In a former page I glanced cursorily at the principles of both the condensing and non-condensing engine. I will now describe them both at greater length, as it is important that the reader should have some knowledge of the methods of their construction, and working.

When a fire is lit in the furnace of a boiler, the water gradually becomes hotter and hotter, until it boils, and gives off steam. If the boiler be open to the external air, as by the safety-valve being removed, this ebullition will take place at the temperature of 212° of Fahrenheit's thermometer, provided that it is at the level of the sea. But if the water be boiled at a high level above the sea, a marked difference in the temperature of the boiling-point takes place. Thus, owners of steam machinery in the Darjeeling hills will find, if they try the experiment, that their boiler-water is in a state of ebullition at a much lower temperature than 212°. The reason of this is, that the greater the pressure on the water the greater is the resistance to its passing into the form of steam, and as the pressure of the atmosphere decreases the higher we go, so does the resistance to the formation of steam, and consequently the temperature at which it is formed. Following this principle out, we find that it holds good in a closed vessel from which the steam, as it forms, cannot escape. When the steam is accumulating in the boiler, as when steam is being got up in the morning, the pressure gradually increases, as the increasing quantity of steam in the boiler occupies only the same space; and as the pressure increases, so also does the temperature of the boiling-point, so that steam of 70 ℔s. pressure above the atmosphere has a temperature of something like 300° Fahr. Here observe that I have used the term "70° Fahr. *above the atmosphere.*" Steam given off at the boiling-point in the open air just balances the pressure of the atmosphere, and is therefore called "steam of a pressure of one atmosphere," and will thus be, at the level of the sea, equal to a pressure of 14·7 lbs., or in round numbers 15 lbs. on the square inch; and the ordinary steam-pressure-gauge only begins to indicate at this pressure, so that steam showing 15 lbs. on it, is actually at 30 lbs. pressure. But as there is the back-pressure of the atmosphere, in the non-condensing engine, to contend against, only the pressure above the atmosphere, or that shown on the steam-gauge, is effective in the non-condensing engine. In the condensing engine, however, it is different, as the partial vacuum formed removes the greater part of the atmospheric resistance.

We will suppose our fire to be lit, and the water arrived at 212°. Steam is now given off in proportion to the intensity of the fire, and fills all the empty space in the boiler above the water. As the safety and all other valves are closed, there is no escape for it, and so, as ounce after ounce and pound after pound of water are turned into steam, which is confined in this space, so the temperature and pressure increase. If there were no safety-valve or other means of escape for the steam, this would go on until a pressure would be attained which the boiler could not stand, and an explosion would occur; but the safety-valve is so arranged with regard to the strength of the boiler, that it opens, and releases the steam as it forms, at a pressure considerably below that which the boiler could bear. It must be borne in mind, however, that few boilers are fitted with safety-valves capable of allowing the steam to escape as fast as it is formed. This is a defect which should be prevented by legislation in boilers on shore, as it is in the boilers of sea-going steam vessels.

The steam having arrived at a pressure sufficient to drive the machinery, a valve is opened, and it is admitted to the engine. Here it is allowed to press to the piston, which is a disc of metal allowed to move freely in an accurately-bored cylinder. Suppose we were to take a common syringe, strong enough to bear the pressure, and connect the small end with a steam-pipe leading to a boiler. Suppose the piston of the syringe to be steam-tight, that is to say, that the cotton or other material twisted round it to keep it tight was such a good fit in the barrel of the syringe that steam could not pass it. Now, if we admit steam through the small end, the piston would be forced to the other end with a power proportionate to the pressure of steam employed, and to the area of the piston : thus if the piston area equalled one square inch, and the pressure of steam was fifty pounds on the square inch, it is evident that the piston would be pushed with a force equal to fifty pounds ; and if the steam were admitted at the large end, and free egress allowed for that before admitted by the small end, the piston would be pushed back by the same pressure. And this is what takes place in the steam-engine. Steam is admitted to the cylinder, which corresponds to the barrel of the syringe, and pushes the piston from one end to the other with a certain force. As soon as it comes to the end of the cylinder, the steam is allowed to escape, and a fresh supply of steam is admitted on the opposite side, which pushes it back again. This in its turn is allowed to escape, and the same thing is repeated over and over again. The force exerted is, as I said above, proportionate to the area of piston and pressure of steam. Thus a piston of six inches diameter has an area of 27-27, or in round numbers $27\frac{1}{4}$ square inches. Suppose steam is admitted at 50 lbs. pressure, and allowed to continue at this pressure during the whole stroke, it is evident that the piston has been pushed the length of the cylinder with a force of $27\frac{1}{4} \times 50 = 1362\text{-}5$ pounds. Suppose the cylinder to be upright, and a weight be fastened to the bottom of the piston-rod (which we will imagine to project through the bottom-end of the cylinder, as it does in some engines), and that the combined weight of the piston, its rod, and the attached weight, be 1362-5 pounds, it is evident that this will just balance the pressure of steam on the piston, and the piston will consequently remain stationary, or if pushed up in the cylinder, will remain in any position in it. Again, suppose a portion of the weight be removed, the piston will travel upwards ; and the more weight we remove, the quicker it will travel. So that, you see, the power of an engine is in a direct ratio to the area of its piston and the pressure of steam upon it ; and its speed is as the same quantities in a direct ratio, and modified in an inverse ratio by the load on the engine ; and every time the piston moves from one end of the cylinder to the other, it does a certain amount of work, which work is represented by the pressure on the piston. As above, suppose that pressure is 1362 lbs., it is evident that the work consists in moving 1362 lbs. through a certain space ; and the work done in a minute of any other time will be the number of strokes the engine does in that space of time. Thus if the stroke of the engine, *i. e.*, the distance the piston travels in the cylinder, be two feet, and the piston moves backwards and forwards forty times in one minute with the above pressure, the work done in a minute will be 1362 lbs., moved backward 40 times 2 feet, and 1362 lbs. moved forward 2 feet : that is to say, 1362 pounds moved $2 + 2 = 4$ feet 40 times in a minute, or 5448 lbs., moved 1 foot 40 times in a minute, or 217,920 lbs. moved one foot in one minute. Now, engineers use as a unit of power what they call a foot-pound. This compound word signifies one pound moved (you will understand better if I say raised instead of moved) one foot. So in speaking of the power exerted in the above example, an engineer would say that the engine had exerted a force of 217,920 lbs. in one minute. Suppose this power was exerted in raising water to a height of 30 feet, you have only to divide 217,920 by 30 to find 75,964, the number of pounds of water raised. But there is a term doubtless more familiar to you, namely, Horse-power. James Watt made a large number of experiments with horses, to determine an average horse's work ; and the mean of his experiments with many animals gave the average power of a horse as 33,000 foot-pounds per minute. Therefore, to find the actual horse-power of the engine in this example, you have only to divide 217,920 by 33,000, which gives it as $6\frac{20}{33}$ actual horse-power nearly.

But you must here notice that actual horse-power does not mean the H. P. which you generally hear spoken of. You often hear it said "so-and-so is getting a ten-horse engine." In the old days, when the non-condensing engine was hardly used at all, and ordinary pressures were only 4 or 5 pounds above the atmosphere, engine-makers used to calculate their horse-power at such pressures ; but now-a-days, when much higher pressures are used, and the same old rule retained for calculating the H. P., it is evident that the power actually exerted is much greater than the power stated by the maker, and which is called the Nominal Horse-power. Ordinary land-engines are usually capable of exerting from $2\frac{1}{2}$ to 4 times their nominal H. P., the best class of them 5 times, and some of the finer marine engines 6 or 7 times their nominal H. P. Nearly every maker has his own method of calculating the N. H. P. of the engines he turns out, and all their rules are empirical, and of no value to the engineer, who usually indicates the capabilities of an engine by stating the diameter of the cylinder or cylinders, the length of stroke, and the boiler-pressure. But I will give you one of the most common rules for determining the N. H. P.: Multiply the square of the diameter of the cylinder in inches by the cube-root of the stroke in feet, and divide by 47. Result equals nominal horse-power. Of course if you have two cylinders you just double the result.

I have endeavoured to show you that the pressure of steam acting on alternate sides of the piston, and pushing it back and forward in the cylinder, exerts a certain amount of power, and does certain work in a certain time, limited by the conditions above specified. What often puzzles a person unacquainted with the Steam-engine, is how the steam is admitted to and allowed to escape from the alternate sides of the piston automatically, and with such regularity. This is done by the opening and shutting of a valve or valves acted on by the engine itself, and the commonest of which is the slide-valve, as it is also probably the only one with which the reader will have to do. Steam is conveyed from the boiler through a pipe to an oblong box or chamber on the side (sometimes, but seldom in small engines, on the top) of the cylinder. From the inside of this box or chamber, which is known as the valve-casing, three passages lead, one to the external air, the other two to the opposite ends of the cylinder. The flat face in which the openings to these passages are situated is made extremely smooth and straight, so that no steam can pass between its surface and that of a metal valve working on it. This metal valve has a hollow space in its centre, wide enough to cover one of the end openings and the centre one, as also the plane space between them. When the valve is so placed that it covers two openings in this way, it is evident that, as the centre opening communicates with the open air, and as the end one does so with the inside of the cylinder, any steam which may be in the cylinder, if above the pressure of the atmosphere, will rush back through the opening, or port as it is called, leading into the cylinder, thence passing through the hollow space in the valve through the central opening into the open air. At the same time the steam from the boiler passes the outside of the valve, and round its end, into the opening leading to the cylinder at the other end. The end-openings are called the steam ports, the centre one the exhaust port. The steam ports allow the steam to pass from the boiler into the cylinder, and after it has done its work, back again into the inside of the slide-valve, and thence to the exhaust port. The slide-valve is so arranged, that as it slides back and forward on the smooth face containing the ports, it is a little open to the steam for one side and to the exhaust for the other, when the piston is at the end of its stroke. This is effected by connecting it by means of a rod to a wheel called an excentric (usually, but incorrectly spelt eccentric), so called because it has the hole in the centre through which the shaft passes out of its centre; and this excentric is so placed on the shaft, and in connection with the slide-valve, that the latter opens for the admission and release of the steam at the proper time. No description can give you nearly so perfect an idea of the working of this valve as an actual inspection. Take off the cover of the valve-casing, and turn the engine slowly round by hand. You will see that when the piston comes to the end of the stroke, that the valve is very slightly open. Keep turning the engine in the direction it works, you will see that the valve opens more and more for a portion of the stroke, and then begins to close again. In most engines the valve closes long before the stroke is completed, sometimes when only one-third of it has been completed. When the piston has arrived at the opposite end, you will see the valve slightly open at the opposite end, and so on. If you could see the inside of the slide-valve, you would see that the opening through which the steam passes out is brought in communication with each end of the cylinder by means of the hollow space in the slide-valve, so that as the steam is beginning to enter at one end, it is beginning to escape at the other. The valve does not close to the exhaust, however, at an early part of the stroke, as it does to the steam, but continues open nearly for the whole stroke.

We have seen how the piston is forced from end to end alternately of the cylinder, and how the steam is automatically admitted and released. We will now consider how the power which is exerted by the steam on the piston is communicated to the machinery to be driven. A round piece of iron or steel, turned very smooth, is fastened into the piston, and passes out of the cylinder through a stuffing-box at one end. A cross-piece is attached to the outer end, which, moving in guides, keeps the piston-rod, as this is called, rigid. To the end of the piston-rod there is attached, by a sort of hinge arrangement, another iron rod, called the connecting rod. The other end of this grasps the crank-pin. The crank is just a modification of the ordinary crank by which a grindstone is turned. and the connecting rod may be likened to the man's arm and hand which grasps it to turn the grindstone. As the motion of the piston-rod is quite straight, it is evident that when it comes to the end of its stroke the connecting rod and crank are in a direct line with it, and therefore, no matter how much pressure might be applied to it, it cannot of itself turn the crank any further. On the end of the crank-shaft, therefore, there is fastened a wheel having a weighty rim which turns with the shaft. During the time that the piston, through its rods, is acting on the crank and turning the shaft, this wheel acquires a certain amount of impetus, which it in its turn communicates to the shaft and other working parts when the piston is at the end of the stroke and ineffectual, thus carrying the engine and all the machinery attached to it forward until the crank is over the centre, when the piston begins to pull or push it again. Even in engines with two cylinders, which having the cranks set at right angles pull or push each other over the dead points, a fly-wheel is usual to steady and equalise the motion of the engine; Only, in marine engines, or locomotives, it is not used, as the screw or paddles in the one, or the momentum of the moving engine in the other, equalise the motion sufficiently. There are, however, marine engines, those having only one crank, in which a fly-wheel is necessary: the vessels of the well-known Star Line for instance.

The motion to the machinery is usually communicated by means of leather belting. Sometimes this leads direct from the fly-wheel, as where a circular-saw has to be driven, and a high speed attained, or a centrifugal pump; but more generally from a separate pulley on the shaft. A pulley is the technical name for the iron wheel on which the leather belting runs. In large Works, such as Spinning-mills, &c., the power is communicated by toothed wheels, or by pulleys having their edges grooved, round which pass several ropes to the next pulley. Both these systems have their advantages and disadvantages. The first, although entailing a much higher first cost, lasts a very long time without requiring repairs, while the second costs less at first, but entails the expense of keeping up and renewing the ropes.

In our next, after glancing briefly at the condensing engine, we will consider the accidents to which engines are liable, their deterioration, and the means of keeping them in good order and repairing them when out of it.

Chapter IV.—Engines, their Variety and Treatment.

In a former paper I alluded to the great economy of the condensing engine as compared to the non-condensing type. Fuel is yearly becoming scarcer in the tea districts, and although the gradual introduction of tea-drying machinery in which wood is used, thus utilising the gases which are wasted in making charcoal, helps to stave off the evil day, still there is little doubt that before long a time will come when the scarcity of fuel will be much more felt than it is at present, and probably for wood-fuel coal will be substituted to a great extent,—coal probably brought from a great distance and at great expense. This inconvenience is already felt in not a few tea-gardens, and will certainly increase. It is therefore advisable that those who are interested in Tea should turn their attention to the more economical forms of steam-engine, the condensing engine, and the still more economical compound engine. The latter may be either condensing or non-condensing.

The condensing engine can only be used where there is a ready supply of cold water. For every cubic foot of water evaporated in the boiler there are required in India about 30 cubic feet in the condenser to bring it speedily from steam to water, to condense it. As I mentioned before, this used to be effected in the cylinder itself, and the loss of heat, and therefore of work, was very great, as the jet of water used to cool the steam and condense it, cooled at the same time the cylinder, piston, &c., and these were re-heated at the expense of a portion of the steam admitted for the next stroke. It occurred to a young man named James Watt, a mathematical-instrument maker, then employed at this business by the faculty of the University of Glasgow, that the steam might just as well be condensed in a separate vessel. By allowing the steam from the cylinder to escape into a closed chamber separate and detached from the cylinder, and there causing it to meet the jet of water which condensed it, he effected the formation of a vacuum in the cylinder and condenser without the cooling of the cylinder by being brought in contact with water. Some people have supposed Watt to be the inventor of the steam-engine, but this, however, is not the case. He converted what was before a crude and scarcely profitable machine into what is, with a few alterations of detail, the modern steam-engine; and the first beneficial effects of his Invention were seen in the immense impulse he gave to mining. Mines which were before unworkable on account of heavy flooding were easily and economically pumped dry, and thus an immense amount of till then useless property was rendered valuable. But more important results followed. His invention of the crank, (for which he had for a time, owing to his invention having been pirated by a workman, to substitute a contrivance called the "Sun and Planet" motion), enabled people using revolving machinery, such as flour-mills, &c., to use the steam-engine for their "prime mover," as the driving-power is technically called, whether steam, water, or other engine. Several of his other inventions are not only of great utility, but of great mechanical ingenuity and beauty ; such as the governor, the parallel motion, &c. Watt was a man of great and varied attainments. While yet a young man he suggested, if not actually demonstrated, the discovery generally attributed to Cavendish, the composition of water. And his correspondence with the celebrated Dr. Black on the then imperfectly understood doctrine of latent heat is extremely interesting from a scientific point of view. Like many great inventors he did not realise anything like the large fortune which one would suppose the immense value of his invention would have brought him. He made money, however, and with his partner, Mr. Boulton, founded the well-known engineering firm of Boulton and Watt, Soho Foundry, Birmingham, which is still in existence, and retains its reputation as a first-class establishment. Watt hinted at the compound engine (to be explained later) which was subsequently patented by Woolf and Hornblower ; and to the condensing engine we are indebted for the immense fleets of ocean-going steamers, which but for this invention would never have been able to carry coal enough for their voyage. In fact Watt was a man,—one of those who only spring up occasionally in the history of the world, who has left an indelible mark on the page of time ; and if to-morrow another inventor should arise who would show us a method of practically using electricity, hot air, or any other means as a motive power, and the steam-engine were to become a thing of the past, still the name of James Watt would live as one of the greatest benefactors of mankind.

There is a form of condenser which, it is said, Watt suggested, but did not make : I mean the surface condenser. In this vessel the steam is not brought in contact with a jet of water. The water used for condensation is forced by a pump, called the circulating pump, through a large number of brass tubes from five-eighths to seven-eighths of an inch in diameter. These are fastened by their ends in a large air-tight vessel. The steam rushing from the cylinder through the exhaust-pipe into this vessel comes in contact with these pipes, and they being kept cool by the current of water passing through them, condense the steam just as the cold jet of water does in the other condenser. The steam is condensed by being brought in contact with the cold *surface* of the tubes, and this form of condenser is therefore called a *surface* condenser. In another modification of it the steam passes through the tubes, and the water outside them. The surface condenser is useful chiefly in marine engines, where it is not desirable that the salt water used for condensing should be allowed to come in contact with the condensed steam-water, which thus remains fresh, and is used over and over again in the boiler. With the old jet-condenser the condensed steam necessarily mixed with the salt injection-water, and in consequence a great quantity of salt was passed into the boiler with the feed. As a very large quantity of the boiling water had to be blown out of the boiler to remove this salt, a loss of fuel occurred, represented by the quantity of fuel required to bring the water blown out to the boiling point,—a very serious loss. The surface condenser obviated this, as with it little or no water was required to be blown out ; and it was therefore used in the days of 20 and 25 pounds pressures on the boilers from motives of economy alone. But now, when pressures of 100 pounds or even 150 pounds are not uncommon, it is imperatively necessary to use the surface condenser, as it is found that water containing salt or other substances in solution, when brought to the temperature corresponding to these pressures, rapidly deposits the salt, or whatever else it may contain in solution, on the tubes, &c., of the boiler, and thus produces the bad effects alluded to in a former Chapter.

It is evident that in either form of condenser there must be some means of removing the condensed water as well as that used for condensation, or else the condenser would in a few strokes of the engine be full of water. There is also mixed with all water a certain quantity of air, which, as I said above, is separable from it by boiling. This air, passing with the steam through the cylinder, enters the condenser, and if not removed, would soon be in a sufficient quantity to vitiate the vacuum. In the jet condenser the air and water are removed by a large pump driven by the engine and usually called the "air pump," although the "air and water pump" would explain its functions better. In the surface condenser the condensed steam and air are removed in the same way, but the condensing water is forced right through the condenser by the circulating pump, and is pumped out through the ship's side in a marine engine, or into a large pond called a cooler in a land engine, where it is cooled and then used over again.

There are difficulties in the way of the adoption of the condensing engine in most of the Tea-districts. During the rains, when the rivers are swollen, and their surface-level probably only three or four feet below the level of the ground on which the engine stands, the injection-water from the river would rush into the vacuum formed in the condenser without the aid of an extra pump. But we must remember that from the beginning of the season till the beginning or middle of June, there is but little rain, and the level of the river-water is low,—in fact in many rivers passing through tea-gardens there is no water. When the river-water is low, those using a condensing engine would have to use the same means on a smaller scale for storing their water and using it over and over again as is used in many large factories; that is, allowing their injection-water to escape into a pond, where it is cooled sufficiently to be available for use over and again. Of course there will be some loss of water from this pond from evaporation, but this is made up by working from time to time a small pump attached to the engine. The power required to work this pump is not much, and is amply compensated by the great economy of the engine. Should any of your readers take a trip to Calcutta during the cold season, a visit to one of the large jute or cotton factories on the banks of the Hooghly will amply repay them for the time they occupy in going there. A very fine specimen of the compound surface condensing engine is to be seen at the Ganges Mills, of which Messrs. Macneill & Co. are Secretaries, and probably that firm would grant permission to visit the Mills. The large masonry-lined tank at the bank is the "cooler" alluded to above. A visitor will usually find the managers and engineers of these mills extremely obliging in showing everything to be seen, provided those gentlemen are not busy, which however they mostly are.

The reader will probably now look back a few lines and ask, "But if, as is often the case, there is for a couple of months at the beginning of the season no water available, how are we to use a condensing engine?" Of course you cannot; but you can convert it very easily into a non-condensing engine for the nonce by temporarily disconnecting your air-pump from the engine, removing the exhaust-pipe, substituting a plain exhaust-pipe leading through the roof, and let the steam puff out through it. We must not however overlook a certain amount of disadvantage here. With the condensing engine, owing to the increased power of the steam through the vacuum on the other side of the piston, a smaller-sized cylinder, and other parts in proportion, are required for the same power than in the non-condensing engine; whereas if we were obliged to work the condensing engine as a non-condensing one for part of the season, we would require to have the cylinder big enough to give us sufficient power to do this. But notwithstanding this disadvantage the economy of the condensing engine is so great that it would soon repay the additional first cost.

But what of Gardens where during the whole year the supply of water is too scanty or at too great a distance from the engine to be available for a condenser? In this case I would recommend the non-condensing compound engine. In describing the compound engine you will note that the difference between it and the ordinary engine lies in the cylinders, and that the condensing and non-condensing types differ just in the same way as the ordinary engine, that is,—in the use or non-use of the condensing apparatus on the tubes, flues, &c., of the boiler, and thus produces the bad effects alluded to in a former Chapter.

We rarely in these days find an old-fashioned engine in which the steam is allowed to enter the cylinder during the whole length of stroke. I only know of one such rubbishy old engine in India. With the ordinary slide-valve, without a separate expansion-valve, the valve and its gearing can be so fashioned as to cut off the supply of steam to the cylinder at any part of the stroke of the piston more than about one-third. Some engines are made to shut off the steam at half the stroke, some at two-fifths, and at other fractions of the stroke : if, however, the engine be provided with a variable expansion-valve, as all engines should be, the valve may be so altered as to cut off the steam at an earlier period than can be done by the slide valve, even at one-tenth of the stroke, as is sometimes the case in large marine and land engines. But why does not the engine stop when the steam is cut off? Because steam is an elastic vapour, and expands in the cylinder, becoming lower and lower in pressure as its bulk increases, but still exerting power on the piston in proportion to its decreasing pressure. If we used steam kept free from any condensation in the cylinder, we would find that in expanding, it nearly followed the rule of its pressure, decreasing in the same ratio as its bulk expanded,—that is, if steam entered the cylinder at 100 pounds pressure and was cut off at half stroke, it would have expanded into twice its initial volume when it reached the end of the stroke, but would have only half its initial pressure, viz., 50 pounds.* If a cylinder could hold three cubic feet of steam, and steam at 100 pounds was admitted, but cut off when the piston had travelled one-third of its stroke, that is when one cubic foot at 100 pounds had been admitted, the steam would still expand, and the end of the stroke would be found to fill the cylinder, but at one-third the pressure, or 33·33 pounds. During this period of expansion the steam is still driving the piston before it, and consequently the machinery driven by the piston, but with a gradually decreasing power owing to its gradually decreasing pressure. We have thus the benefit of the initial pressure of the steam while passing from the boiler, but we have also the additional benefit of using the steam after the communication with the boiler has been shut. This was lost sight of in the earlier engines partly owing to the engineers depending more on the 14 lbs. pressure of the atmosphere for their motive power than the 4 or 5 lbs. steam pressure they then used. But with improved and stronger boilers came higher pressures, and then the benefits of expansion began to be seen,

Engineers then began to design their engines with regard to the economy obtainable from using steam expansively. Higher pressures were introduced, until gradually the present pressures of from 50 to 150 pounds were attained. The slide cannot be constructed to cut off the steam at a lesser distance than one-third from the beginning of the stroke, as the exhaust begins to open too soon, thus causing a loss of steam, and to close too soon, before all the steam

* This is not strictly correct, but is near enough for practice.

has escaped from the cylinder, thus causing a certain amount of steam left in the cylinder to be compressed between the piston and the end of the cylinder, causing a loss of power by its back pressure. A separate expansion-valve was then introduced, and steam cut off up to very high ratios of expansion, one-tenth of the stroke being quite common.

It was however found that beyond a certain point expansion not only began to cease to be profitable, but that the consumption of fuel increased. This led to an investigation of the causes, and the conclusions arrived at led to further improvements in the Steam-engine, the latest of which we will come to presently. These causes we will now proceed to investigate.

A good deal of heat necessarily radiates from the outside of the cylinder and valve-casing. The effect of this is not so much observed when working the engine at low rates of expansion, but still even then it makes a palpable difference in the consumption of fuel. It was sought to obviate this by covering the cylinders with some non-conducting substance, generally felt covered with wood; and this is the kind of "lagging," as it is called, mostly seen on the cylinders of Tea-garden engines.

But still it was found that there was a practical limit to the profitable expansion of the steam. For the cause of this we must look a little at the nature of Steam itself.

In a former Paper I mentioned that steam, taking a given weight at a high pressure, contains a good deal less heat than the same weight at a lower pressure. The latent heat of steam is not invariable, and therefore, although in the open air at the ordinary boiling temperature of 212° Fahrenheit, it takes five and one-third, in round numbers, the quantity of heat to boil the water all off into steam than the quantity of heat required to raise it from the freezing to the boiling point, yet, as the pressure increases it takes more heat to raise it from the freezing point in proportion to what it takes to boil it off; and if for the sake of simplicity we imagine heat to be a substance, and in combination with water when in a state of steam, that is, if we suppose steam to be a chemical combination of heat and water, we will find that the proportion of heat to water in a pound of steam at one hundred pressure is much less than the proportion at twenty pounds.

Now, therefore, if we admit one pound of steam at one hundred pounds into the cylinder, and expand it to five times its bulk, we would, provided certain precautions which I will describe be not observed, find that although we expected to find it at one-fifth the original pressure, namely twenty pounds, we actually find it much less; because, as steam at twenty pounds requires more heat for a given weight than steam at one hundred pounds, if no external heat has been supplied, a portion of the steam must condense in the cylinder until, the latent heat parted with by this condensing portion being mostly given to the remaining steam, it remains at a pressure somewhat below 20lbs; and the higher the ratio of expansion,—that is, the earlier in proportion to the length of stroke the steam is cut off, the more steam will be condensed in the cylinder.

It was therefore sought to remedy this by two methods. The first, which is in use in every properly-constructed engine of large size, and in many small ones, is to surround the cylinder with an outside cylinder, so as to leave a hollow annular space round the steam cylinder. This space is filled with steam from the boiler direct, being thus at the temperature and pressure of the steam in the boiler. As the steam expands and tends to cool, the steam in the casing parts with a portion of its heat to it through the walls of the cylinder, and thus tends to keep up its pressure and temperature. By the use of the steam-jacket, a much higher ratio of expansion can be obtained than without it.

The second method of attaining this object is by the use of what is known as superheated steam. Confined in a close vessel, and not in contact with water, steam can be heated to a temperature indefinitely higher than that due to its pressure. Steam thus heated is called surcharged or superheated steam. It is evident that a quantity of steam thus surcharged with heat when allowed to expand in a cylinder, contains such a quantity of surplus heat as to maintain the expanding steam at something like the temperature and pressure it would have if it were an incondensible gas. And thus great benefit was obtained and to a certain extent is still obtained by the use of the superheater. It was in fact rare to see a marine engine without one, and that it did not come so much into use in the larger class of land engines is difficult to account for. But in these later days of very high pressures the superheater has fallen somewhat into disuse for a very simple and unfortunate reason : The very high temperature of steam at the high pressures common now-a-days, increased by superheating the steam, burns up and destroys any oil or other lubricating substance with which we are as yet acquainted, and in consequence the piston, slide-valve, inside of cylinder and valve-face, also expansion-valve if any, being deprived of a lubricant, get cut up and rapidly destroyed by friction. Also, the carbonised oil aided by heat unites with the iron of these parts, and destroys it by forming a carburet of iron, a substance chemically identical with black lead. I have found parts of the cylinder near the steam ports, and also the edges of the steam ports in the valve-face, so softened by conversion into this substance that I could pare the quondom iron with a penknife, or even scrape it with my nail. But should any one discover a lubricating substance which would stand a heat of from 400° to 500° Fahr. without carbonising, we should again be enabled to use surcharged steam to the same extent as formerly, with great economical benefit.

But notwithstanding all these useful improvements, all tending to lessen the condensation of steam in the cylinder, there was still a loss from this cause, especially when high rations of expansion were used. For this reason the cylinder, although jacketed, cannot pass the heat through its interior jacket, owing to its thickness, so rapidly as to keep the interior of the cylinder up to the same temperature as the steam entering the cylinder. And as, when using high ratios of expansion, the difference of temperature between the steam on entering and when leaving the cylinder is very great, so it is evident that the cylinder must be at a temperature somewhere between the two, and that the greater the ratio of expansion the greater will be the difference between the initial temperature of the steam and the temperature of the cylinder. And steam rushing into a cylinder of lower temperature than itself, becomes partly condensed.

To obviate this as much as possible the compound engine was designed. In this engine the steam is expanded in *two* cylinders. In is first used in a small cylinder at a higher pressure, where it is expanded in the usual way, and then allowed to pass into a larger cylinder, where it is finally expanded as low as possible. By this means, although the steam is expanded just as much or more than in any engine of the old type, there is not nearly so much loss of heat from difference of temperature, as the cylinders are not cooled nearly so much in proportion to the initial temperatures of the steam entering them, the expansion being as it were divided over two steps. The reason why one cylinder is made larger than the other is in order that the total pressure on the two pistons may be equalised, and as the steam in the second cylinder is at a lower pressure than in the first, it requires a larger piston-area to do this.

One great advantage of both the ordinary condensing engine and also the compound type is that they are so constructed that most non-condensing engines can be converted into either. It is not difficult to add a small condenser and air pump to most garden-engines, nor would it be difficult in many cases to alter them into compound engines. Should your machinery be too much for the engine, it would be well to consult a competent engineer as to whether this could be done or not. Sometimes, through weakness of parts of the engine, or through insufficient steam-pressure in the boiler, or perhaps through some peculiarity in the construction of the engine, it might be difficult or impossible to convert it into a compound engine, but these difficulties would rarely arise in the case of an attempt to convert an engine into an ordinary condensing one.

It is no unusual thing to convert an engine of the ordinary type into a compound engine. The writer has superintended this operation in several large marine engines, where one of the cylinders has been removed, and a smaller high pressure cylinder introduced. Several of the British India Company's steamers, in which Company the writer was formerly chief engineer, were thus converted, and Captain Scott has done the same with several of the steamers of the Company of which he is secretary. I would therefore advise planters, in adding new machinery to their plant, to find out whether it could not be converted by one or other of the methods described above into a more powerful engine.

I think I have now said all I can venture to say to a non-professional reader about the Steam-engine in repair. In the next Chapter we will look at it out of repair, and consider the necessary preventives and remedies.

Chapter V.—On Repairs to Steam Engines.

If a Steam-engine, new from the makers' hands, were to be allowed to remain in a merchant's godown without being worked, a certain amount of decay would take place. Or were an engine worked for a time and then allowed to remain at rest for some months, some decay would take place while the engine was standing still. Damp air is a great producer of rust, and unless all parts of the engine liable to be affected by rust were protected by one or other of the compositions in use for the purpose, corrosion by rust would assuredly take place. And as is the case in the boiler, the most obscure parts are these which suffer first. Of course we see our slide-rod getting rusty, and our piston-rod and connecting-rod, in fact all polished iron about the engine following suit. These are visible, and we put a man on to scour the rust off them. But the more important inside of the cylinder, piston, slide-valve, valve-face, &c., are forgotten, simply because they are not seen.

At the close of the season the planter ought to remove his cylinder cover and valve-casing cover. The latter is the plate which screws on to the back of the slide-valve casing, except in the Robey and one or two other engines, where it is very improperly placed at the end of the casing,—a cheap and nasty method which is to be condemned for several important reasons. On removing them he ought to disconnect his piston and piston-rod. He ought also to disconnect the slide-valve from the eccentric rod and from its spindle, and remove the valve and spindle. If the engine is to be laid up merely from the end of the season till the beginning of the next, he should make a mixture of half tallow and half white-lead and apply it to all parts liable to rust ; the inside of cylinder, the valve-face, the cylinder cover if polished, the piston-rod, connecting-rod, crank, shaft, and every other part liable to rust. The mixture should be applied hot.

If he takes a little further trouble, and disconnects his shaft and takes it out, as also all other working parts where iron is in contact with brass, he will remove another cause of corrosion. A galvanic action takes place between the metals, aided by the fatty acids in the oil, and sometimes serious corrosion takes place. In the Navy, where some of their men-of-war are laid up for months, and even years, they have a crude method of partly reducing the effects of this: they keep one junior engineer on board each vessel with one watch of stokers, whose duty it is to turn the engine *partly* round every day, so that the parts will corrode equally. But it is not a long job in a small engine to disconnect them altogether, and this is by far the best plan.

So you see that even when an engine is laid up, harm will come to it if not attended to. If the machinery is to be laid up for an unknown time, as when it is replaced by newer or more powerful machinery, and put aside to be sold, all the above bright parts should be painted with two or three coats of thin red lead paint laid on *hot*, instead of the white lead and tallow mixture.

But it is when an engine is running that the wear and tear takes place, and the risk exists of breaking down.

If an engine works 27 days per month, 10 hours a day, and runs at the rate of 100 revolutions in a minute, you will find that in the month it has made 1,620,000 revolutions. It is quite evident that some wear must take place when two surfaces are rubbed against each other such a number of times; and this is only for one month's work. Multiply this, again, by the number of months in the tea season, and see the enormous sum it comes to. The only wonder is that the wear and tear is not much more than it is.

But of two engines similarly constructed and doing the same amount of work, one will be found at the end of the season to have worn more, and to be in generally worse order than the other. This points to the neglect of some precautionary measures by the adoption of which this extra wear and tear might have been prevented.

There can be no doubt that bad oil has a good deal to do with this. After a good number of years' experience in machinery the writer has come to the conclusion that there is no oil equal to castor oil for heavy machinery. It is used for all parts of the heaviest marine and stationary engines except the cylinders and slide-valves, where mineral oil is used, as it does not so readily carbonise as castor or other vegetable or animal oils. But for oiling the bearings of a steam-engine, or even for use in the cylinder of a small engine, castor oil is far superior to any other; and since the opening of the Suez Canal its use is spreading very much even in Great Britain. But the ordinary bazar castor oil is often full of grit and other impurities which tend to wear down the working parts of the machinery; and when one considers the millions of times that an engine revolves during the tea season, the importance will at once be seen of keeping the lubricants as free as possible from grit or dust or any foreign substance which can have a grinding effect. Therefore all oil or other substance, such as tallow or melted suet, used for lubricating machinery, should be strained before use through the finest wire gauze procurable.

Dust flying about the engine-room is a still worse cause of destruction. Therefore, the engine-room ought to be separated from other parts of the building by a wall, or wooden partition carefully put together, so as to be dust proof. And in doing this it ought to be carefully separated from the boiler. When the boiler fire is being cleaned or removed, clouds of very gritty dust fly about, and portions of this, settling on the engine and finding their way into the corners and crevices about it, into the oilcups and bearings and small oil-holes in the smaller parts of the machinery, form a deposit ready to begin its destructive grinding work when the engine starts in the morning. A good deal of dust is brought in with the tea leaf,—dust blown on to the bushes on a dry day; and lots of this also finds it way into the engine-room. Just prove this for yourself in a very simple manner. Go into your engine-house and pick up the tin oil-feeder used for oiling your engine. Unless you have an exceptionally clean engine-man, you will find it pretty well covered with a mixture of coal-dust, ashes, sand, &c, and every object in the neighbourhood of the boiler will be just the same. Lay a small clean piece of plank anywhere in the engine-room in the morning, and examine it at knocking-off time. Just see how much dust and grit has collected on it. Surround your engine with a dust-proof wall or partition, reaching right up to the roof, leaving only an aperture for the driving-belt to pass through, and leading your steam, exhaust, and feed pipes through the partition, so as that the whole arrangement will be as nearly as possible dust proof, and repeat the experiment with the plank. You will see scarcely any dust on it after a day's work, and you will find a remarkable difference in your bills for repairs to machinery at the end of the season, as your bearings will not have worn down much, and the engineer may perhaps not need to touch them. Your engine will run a much longer time before having the very disagreeable knocking or thumping noise caused by slack bearings.

When an engine has been badly fitted by the makers, when the working parts are not well adjusted to each other, it is evident that at first a good deal of wear and tear will take place, and sometimes serious and irremediable consequences may take place through the bad fitting of parts. I will endeavour to give a simple illustration. Suppose the bearing-brasses in which the crank-shaft runs have not been set exactly in line,—that, say, the inner end of one of the lower brasses is very slightly lower than it should be. It is evident that the shaft, having been turned in a lathe, and being therefore presumably perfectly straight and round in its journals, will rest on the outer end of the lower brass, which will have to sustain the whole weight of that end of the shaft plus perhaps the weight of the fly-wheel, and all the strain thrown on the bearing by the working of the Engine. This weight and strain, instead of being distributed over the whole bearing, is confined to one end of it: instead of having many square inches of bearing surface, the crank-shaft at that end has only a few, and a difference in the proper adjustment of the brass of less than the thickness of the paper on which this is printed would be sufficient to cause the mischievous consequences I am about to describe. The iron journal on the shaft not having sufficient bearing surface to rest on, soon, by the friction of its working, heats the brass in which it runs, and becomes hot itself. As the brass heats, it expands, and grips the iron journal tighter. This of course increases the friction, and the Engine labours away until, all the oil in the bearing being consumed, the brass becomes red-hot and partially melts, while the iron journal itself becomes deeply scored all round, leaving marks which can never be got out without putting it in the lathe, and reducing its diameter considerably.

Contrast this with the well-fitted machine: the parts have been well adjusted,—friction is consequently equally distributed. In course of time, in a couple or three months' working, the surfaces of the brass and iron have been toughened and hardened instead of destroyed by the constant rubbing, and a "skin is formed," to use the technical term, on both the brass and iron, much harder and tougher than the body of either metal, and which offers a great resistance to wear and tear. Once this skin forms on the metals, with clean oil and guarded from dust, the Engine ought to run perhaps two seasons without the brasses becoming so slack as to cause very much knocking or thumping.

But bad adjustment is not the only cause of hot bearings. Dirty oil, dirt or grit getting in, or the neglect of the engineman to keep up a proper supply of oil, also sometimes the brass being tightened up too tight, are very commons causes of the same thing. I have seen more than once an enormous marine engine brought dead up to a stand-still through one of the bearings getting hot; the friction actually becoming so great as to stop the engine. This occurs through the neglect of the man whose duty it is to oil the engine, and through the neglect of the engineer on watch not seeing that the 'greaser', as the oil-man is called, does his duty. Then is to be seen and heard in the engine-room no end of a row. The chief engineer silent but sulky, the second ditto, giving loud orders (he is the working head of the department) accompanied probably by a considerable amount of unparliamentary language; and the engineer whose watch it is, working hard to repair his error, looking very sheepish all the time. Meanwhile the work is going on, however; the trained firemen, under their engineer's directions, know exactly what to do; and without any noise or talking, except the second engineer swearing, buckets of hot water are brought from the boiler, and poured on the blazing-hot bearing crank-pin, very probably: it oftenest gets hot. As soon as the hot brasses, &c., have been cooled down to about the temperature of the boiling water, or as soon as the water ceases to fizz when thrown on, cold water is supplied by a hose kept for such an emergency, until the hot parts are cooled down to their normal temperature. The reason hot water is first supplied is, that if cold water were suddenly dashed on, it might cause injury by the too sudden contraction; a brass might crack, or even the journal itself, or the frame of the engine might give way wholly or partially. As soon as the parts have been cooled down, the brass is slightly slackened back, and the bearing supplied with a mixture of oil and sulphur. The reason sulphur is supplied is as follows: the brass and bearing have probably been partially destroyed, and their surface roughened by the heating and friction. Of course these two rough surfaces rubbing against each other cause abnormal friction and heat. Now, the capacity for heat of sulphur is very great, and consequently it takes a great deal of this extra heat. It is therefore often supplied with oil when the bearing is *threatening* to become hot, and when it is not desirable to stop.

Now, the above course, as adopted for large Engines, is precisely what should be adopted for small ones. First, when a bearing is becoming or has become hot, stop the engine if it has not stopped itself, cool the parts first with hot and then with cold water, slack off the brass, and start again, using a mixture of oil and sulphur.

At the earliest opportunity take out the shaft, or whatever may have been hot, and file the journal smooth with a smooth file; also file the inside of the brass with a half-round smooth file. The journal and brass must be filed so that the file-marks will be round the shaft, that is, in the direction in which it revolves. If the shaft is very deeply scored, it should be sent to a workshop at the end of the season to be turned smooth. As this will make its diameter somewhat less, the old brasses will be useless, and therefore they ought to be sent to the workshop to have a new set made, off them. On the return of the shaft and brasses from the workshop, the latter will have to be carefully fitted in their places, and the shaft bedded down into them. This can only be done properly by a *very* skilful mechanic. No native or Eurasian fitter should be trusted with it, as these gentry are in the habit of performing what little work they can do about Engines in a very perfunctory manner, the Eurasian or country-bred European fitter being in this respect not a whit better than a native. The late Lieutenant-Governor got a hobby in his head, and founded that Training-school at the Bishop's College, Seebpore, for Civil and Mechanical Engineers. The boys there, especially in the mechanical engineering department, will learn just as much, or less, than they do in private workshops in India. In an engineering workshop at home, whether the apprentice has paid, as in some instances, a heavy premium, or been admitted free, he is subjected to the same rigid discipline. Strict silence at work, a certain amount of work expected, and a stern rebuke if both the quantity and quality of the work is not up to the mark, is the custom there, Besides, the minimum apprenticeship is five years *in the workshop.* The lads in the shops at home are imbued with an honorable spirit of competition, and strive to do their work well and quickly, so as to meet with the approbation of their foremen. Here, taught by native example, the Eurasian lads strive to do as little as possible. They often, after being two or three years, only, in the workshops, obtain situations as junior so-called engineers in some of the inland steamers. We won't have them in seagoing steamers, as we find them useless. The deplorable consequences of employing such men are sometimes to be seen, as in an accident to the "Bengal," by which five men lost their lives. The so-called engineer, Pierrio, is now in jail for the consequences of his ignorance, (not carelessness as the judge seemed to think), and this is the second serious accident which has occurred on board the same steamer through the gross ignorance of a country-bred *soi-disant* engineer. I therefore warn you on no account to let one of these people touch your machinery, unless under the eye of a competent European mechanic. How many instances have I known where irreparable injury has been done to machinery by men of the above country-trained class. If Sir Ashley Eden had known the facts of the case, he would have spent the money wasted on the Seebpore Training School in a School for teaching village blacksmiths and carpenters. A Bengalee, and Oorya, or better still Madrassee, makes a capital blacksmith or carpenter when properly taught. You ought to see some of the mechanics in the Madras Sappers. Just fancy what a comfort it would be if you could get the numerous blacksmith and carpenter jobs needing doing in a Tea-garden, done neatly and well by men from your neighbouring villages.

We now come to the bearings in which the journals have a revolving motion : and the first of these is the crank-pin. All these brasses, crank-pin, and shaft brasses, wear in two ways: first, larger in internal diameter; and second, the ends wear a little, allowing sideways-play to the shaft. When the crank-pin brass begins to get worn slack, it soon makes you acquainted with the fact by knocking at each end of the stroke : in fact, every slack brass knocks, but the crank-pin brass more than any. A slack brass should be removed, and the edges very carefully filed until the two halves of the brass are sufficiently close together to prevent knocking, and yet not so close as, when screwed up, to press tightly upon the pin so as to cause heating. Now, to do this properly it requires a mechanic, and unless I know the man well, I never trust a native fitter to do it. Care should be taken that when the brasses are being filed, they be from time to time applied to a face-plate, so as to keep the two edges "out of twist" as it is called,—that is, in the same plane. Also, the two should be put together from time to time and measured with a pair of callipers, to see that the diameters at the inside of each end are alike. Sometimes brasses are not made so that the edges come close together : the edges are left $\frac{1}{16}$ or $\frac{1}{4}$ of an inch apart ; but to prevent the brass from being screwed too tight on the journal, wooden liners are put in between the cover of the bearing and the block in which the brasses are fitted. When it is required to tighten up the brasses, a little is planed or filed off the wooden liners. In other brasses, again, (and this is the usual plan in large engines) a brass liner called a "distance-piece" is interposed between the edges of the brasses, and when they are to be tightened, these are taken out and filed instead of the brasses, which thus never require touching. The above remarks apply to all brasses, either about an engine, a machine, or a line of shafting in which anything revolves.

The neck-bushes of pumps as well as their glands often wear down. Sometimes there is no neck-bush, but the pump is bored out to the size. In this case the pump may be bored out larger, and a neck-bush fitted ; but if the pump be a small one, it is perhaps better to get a new pump at once. When the gland is much worn, if a small one, a new gland will be required ; but if large, it is generally lined with a bush, which can be renewed. If not, it may, if thick enough, be bored out, and a bush fitted.

Pump-plungers frequently wear down, causing great leakage at the glands,—so much so that sometimes the engine cannot pump sufficient feed-water into the boiler. There is no remedy for this but a new plunger.

The same remarks are applicable to the slide and expansion-valve spindles. They get worn down when they come in contact with their glands, and neck-brasses require to be renewed ; but this wear and tear may be lessened to a very great extent in them by having them case-hardened. The valves of the feed-pumps are generally of the kind called conical or mushroom-valves. They are called conical because the narrow edge which fits water-tight on the seat is a very short truncated cone ; but the term mushroom-valve very much more nearly describes the shape of a valve of this description. After long working, these valves become uneven and leaky. The seat also becomes worn uneven,—perhaps slightly oval. By the aid of the file and scraper a skilful mechanic will be able to get the seat and valve nearly round, trying them from time to time with narrow chalk-marks made across the edge, turning the valve round a few times in its seat, then re-marking where the chalk-marks are off, both in the seat and on the valve. These are the high points, and are to be filed on the valve, and scraped with a steel scraper in the seat, if a file cannot be applied. When the chalk-marks rub off evenly all round in both valve and seat, you proceed to grind them as follows : take some very fine clean sharp sand or very finely-powdered glass, or in the absence of both, a little bath-brick, and mixing it with water apply it to the valve-seat, and seizing the valve with a pair of tongs keep turning it round in the seat, lifting it up from time to time to let the sand and water get in ; thus *grind* it, water and air-tight, into its seat. A familiar example of the effect of this sand-grinding process may be seen in the glass stoppers of bottles, which are thus ground tight. If, however, the valve and seat are very bad, nothing can be done but send them to a workshop to be done up in the lathe. The above remarks all apply to cocks, which are made tight in the same way, and if too bad to be filed or scraped and ground true, have to be put in the lathe. The shell of the cock, if much is taken out of it to bring it true, will become so large that a new plug will require to be made for it.

If the feed or other pump-valves are what are called ball-valves, as is the case in Messrs. Ransome's engines, they cannot be filed up true, but must be turned in the lathe in precisely the same manner as a billiard-ball. I will describe the process, as it may interest some of your billiard-playing readers. The latter is fitted with a wooden chuck, having a recess in the centre, lined with leather, and hemispherical,—rather deeper than half the diameter of the ball. The ball fits pretty tightly into this, and is from time to time shifted round, so as to expose a new surface or portion of the surface to be operated on. The tool, for there is only one, is a portion of a steel pipe somewhat smaller inside than the diameter of the ball. The edges are filed away to a level from the outside, and sharpened on an oilstone, so as to make the inside edge a sharp circular cutting edge. The tool is used without a rest, being firmly grasped by both hands, and moved in all directions over the surface of the ball, which is from time to time shifted round in its leathern seat so as to bring all parts equally in contact with the tool. The ball is thus, by the circular tool, soon brought to a perfect sphere. The seat for the ball-valve being similar to that for the conical valve, is to be treated in the same way.

Unless an engine has been carefully put down at first, it is liable in course of time to work slack on its seat, and no amount of tightening up of foundation-bolts will keep it from moving somewhat, as it works. The foundation may also sink a little on one side more than the other. Should either of these contingencies occur, the services of a competent engineer should be applied for at once. He may be able to suggest some means for temporarily putting the engine to rights, or he will tell you at once whether the movement or the loss of level is so great as to cause any apprehension of breakdown. The earliest opportunity should be taken to take the engine down, and replace the defective foundation by a proper one. There is no foundation like good hewn stone or artificial stone; next to them, good straight well-burned bricks and good mortar,—one-half strong slow-setting lime to one-half *fresh* soorkey: to this add about a quarter of the whole of good sharp well-washed river (not sea) sand. Use your mortar quickly: as you use it, mix it. Use no stale mortar. Steep your bricks well before using them. Lay the mortar as thinly as possible between the bricks.

Never allow on any account your enginemen to do any jobs about the engine. All he has to do with the engine is to start it, stop it, oil it when working, keep it clean, and pack his stuffing-boxes when required. Never allow them to *touch* a file. They very often pretend to be fitters, and attempt work which, although you may not perceive it, they completely botch, laying the seeds of breakdowns and all manner of trouble. Remember that there are *no* Mahomedan fitters in Bengal, or very very few. If anything goes wrong with your engine or machinery, don't try to remedy it yourself unless it is something simple; don't let your engineman nor your amateur engineer-friend touch it, but send for the nearest engineer. It is better to be sure than sorry.

As I mentioned Condensing-engines, and as it is possible that ere long we may see them on Tea-gardens, and where small machinery is required, it is necessary to mention the few additional repairs they take. The valves or the air-pump bucket, and of what are called the foot and discharge valves, are mostly made of India-rubber. India-rubber, like everything else, does not last for ever, and the valves require to be taken out from time to time, and renewed. The pumps are sometimes made with one large valve for each of the above, and sometimes several small ones. These, as well as their seats, become coated with a greasy black substance, which is in fact partly carbonised oil from the cylinder, and this, by preventing the valves from shutting quite airtight, impairs their efficiency, and the vacuum falls. The valves must therefore be removed from time to time, and this dirt removed.

The air-pump bucket resembles a piston, but instead of metallic packing it is generally made tight by twisting very accurately and tightly round it, in a recess made for the purpose, a few turns of hard white Manilla rope. As the rope is twisted into its place, it is beaten well down with a stick and hammer. The rope has previously been well soaked in hot tallow. This rope will run for months, but of course will from time to time require renewal.

I think I have now said all I can say about the repairs required to small engines. Most of these can only be done by a mechanic, but a deal of good will be done by adopting the precautions alluded to above regarding clean oil and the prevention of dust, and by selecting a tidy, clean, engineman. For an engine of eight or ten horses' power one man should be sufficient to fire the boiler and attend to the engine. Above this power, he might be assisted by a boy.

Chapter IV.—Summary and Conclusion.

The reader will perceive from the previous Articles that it is in the power of the non-professional steam-user to greatly extend the time during which his Machinery will last, and greatly decrease his bills for repairs, and the risk of breakdowns or accidents, by attending to certain precautions which I have endeavoured to indicate in as simple a manner as possible, and which can be adopted by any person who gives the matter a little study and attention, without occupying much of his time, and without the necessity of any previous mechanical training. Great care should be exercised in the prevention of corrosion in the boiler, in preventing as much as possible the deposition of scale in it, and in removing such deposits when formed. To prevent burning the boiler, or the risk of explosion, great attention should be paid to the feed-apparatus : so that there will be a constant and regular supply of water to the boiler. When the boiler becomes old, and parts of it are worn, then the working pressure should be reduced. It is, however, for an engineer to ascertain the condition of the boiler, and what its safe working-pressure should be. It is probable that the Government will introduce compulsory inspection of steam-boilers in the Mofussil, in which case an engineer-surveyor would, from time to time, inspect the machinery in Tea and Indigo factories, and grant certificates permitting the owner to use a certain pressure of steam. Such a Law is at present in force in Calcutta and Bombay, and has recently been extended to the Mofussil near Calcutta. Fortunately, explosions of steam-boilers have as yet been very rare in India. This is difficult to account for, as the native fireman or engineman is not too careful. I have given ample instructions as to the care and management of the Steam-engine, as far as this can be done without a mechanic. Cleanliness about the machinery is of great importance to its preservation, and attention should be paid to my remarks on this subject; and it should be remembered that a "stitch in time saves nine :" this proverb is nowhere more applicable than to the Steam-engine. As soon as any slackness or knocking be perceived, a mechanic should be sent for at once, and he may probably put to rights something which, if allowed to go on without repair, would result in a breakdown. The machinery should be all carefully overhauled in the cold season by an experienced mechanic, and these repairs should be done as early after the season closes as possible, so that the mechanic or engineer may have as much time to give to the work as possible. The same remark applies to machinery got out from home. It is too often late of arriving, and turns up when all the available mechanical engineers in the district have their time fully occupied, so that the season has sometimes begun a month or two before the machinery can be put up.

Regarding the machinery in use for the preparation of Tea or Indigo, the same remarks that I made about the care of the Steam-engine apply to it. Brasses will wear and get slack, and other working parts require touching up and repairing, just as in the engine. It is no part of the object of these Papers to enter into detailed descriptions of the different machines used. My desire is simply to give a few Instructions as to the care and management of Steam Machinery. Attention should be paid to my remarks regarding the use of condensing engines, and also of the condensing or non-condensing compound engine. Fuel is getting scarcer and dearer every day, and timber-land less easily procured from Government than formerly. It behoves every planter, therefore, to pay great attention to the means of economising fuel.

Water-power is available in some districts, and should be used if possible. The first cost of machinery in this case is the only cost. The form of water-motor which I invariably recommend is the Turbine. It is cheaper, more compact, and does more work for the quantity of water used, than any other motor.

Unfortunately, the water has sometimes to be brought from a great distance in pipes or wooden troughs, and makes the first cost mount up considerably. When first the plans are under consideration for the position of the Factory, attention should be paid to this, so that when the time comes for the machinery to be erected, it may be close to the water-supply. A great head of water is not required for a Turbine, but it must be remembered that the less the height of fall of the water, the greater will be the quantity required for a certain power, and a larger Turbine will be necessary.

I mentioned, when speaking of Compound Engines, that Capt. Scott of Calcutta had patented one, and also a very meritorious Boiler, which I can highly recommend to steam-users whose supply of feed-water for the boiler is muddy. Full particulars regarding both engines and boilers can be had from Messrs. John King & Co., Victoria Iron Works, Howrah, who make them. The boiler has a mud-receiver underneath it, into which the mud settles, and as this receiver is not exposed to the action of the fire, the danger of burning the boiler, through thick deposits of mud, is obviated.

Amongst the many excellent styles of engines and boilers imported from England, I must give the palm to the C-class Engine and Locomotive Boiler of Messrs. Marshall, of Gainsboro. One of the principal things which recommends this engine is, that the governor works direct on the separate expansion-valve, and not on a throttle-valve, as in all or at least most other small-class engines. This enables the piston to have the full initial pressure of the steam, and thus to derive the fullest benefit from its expansion. Messrs. Balmer, Lawrie, of Calcutta, are the agents for these Engines.

I now bring this series of Articles on the care and management of Steam Machinery to a close. It has been my study in writing these Papers to remember that I was not writing for an engineer, and therefore to put my explanations in a form which would be readily understood by men of education, as the class of gentlemen who are in charge of Tea-factories, are. I hope I have succeeded in this, and that these Papers may have the effect of enabling your subscribers to have a better idea of what Steam Machinery and its requirements are.

C. B. F.

SECTION XVII.

TEA MANUFACTURING MACHINERY.

Machinery: its General Principles.
Green-leaf Cutting Machine.
Drying Machines.
Rolling Machines.
Sorting and Winnowing Machines.
&c. &c. &c.

MACHINERY: ITS GENERAL PRINCIPLES, &c.*

One of the reasons, probably, which delayed for so long the introduction of Machinery on Tea Gardens was the expense, or supposed expense, of skilled supervision; and where this took the form of a highly paid European engineer, no doubt there was good ground for the objection. We believe, however, that, except upon some few very large Gardens possessing a considerable amount of machinery, a native stoker or little better does duty as engineer; and if anything goes wrong, the Factory has to rely upon the services of some practical man in the district whose business it may be to make the round, professionally, of the different Gardens employing machinery. Under such circumstances it is somewhat surprising that managers do not cultivate more a knowledge of elementary engineering and mechanical construction, such as might enable them to supervise efficiently the plant which is now more or less contained in almost every large Factory. Of course it is not to be supposed that every tea-planter should qualify for an engineer, but we mean that he might easily acquire sufficient knowledge to keep his engine and gear in good order, and to be able to direct the remedy of any trifling defect; for with machinery, nothing is too trifling sometimes to set all out of order, and a piece of grit in the wrong place may stop an engine as even the breaking of a crank. We propose now to glance at some of the leading principles which regulate the invention and construction of Machinery.

The powers, then, employed to give motion, through machinery, to any object may generally be considered as "pressure." In the employment of any machine, a certain portion of the power is expended in overcoming the inertia and friction of the materials, and that which remains is the only efficient force by which the useful effect is to be obtained.

The loss of power from inertia is doubled when a reciprocating motion exists in the same machine; for a momentary state of rest takes place between every two contrary directions of the movement, and immediately afterwards a new inertia has to be overcome. The retarding forces above mentioned are evidently greater as the quantity of machinery in an engine is augmented; and hence every machine should be as simple as possible consistently with the requisite relation between the moving power and the opposing resistance.

In the construction of Machinery it is evident that all abrupt variations of velocity should be prevented, on account of the irregularity which they induce in the action. When, for example, one wheel drives another by means of the teeth on their circumference, the pressure of the teeth takes place wholly on one side of the latter, and the movement may be steady if the teeth are well formed; but on a sudden diminution of the velocity of the driving-wheel, that which is driven, continuing for a time to move with its actual velocity, tends further to retard the movement of the other, and the pressure of the teeth against each other takes place on the opposite side. Thus a shaking-motion is

* Written expressly for the *Tea Gazette* by C. B. Fergus, Mechanical Engineer, &c.

produced, which diminishes the efficacy of the machine. The disadvantage attending such variations in the movement of the machinery renders it advisable to gain the required effect by continued pressure,.if possible, rather than by the employment of percussive forces.

It is also a maxim assented to by engineers, that the impelled point of a machine should not be allowed to move with a greater velocity than that with which the motive power can act upon it ; since in this case the excess of velocity in the machine will be employed in accelerating the motion of the power, and thus the general acceleration of the machine will suffer a corresponding diminution. The velocities of the impelled and working points should therefore be properly adjusted to the pressures, the inertia, and the friction, in order that all possible advantage may be derived from the machine.

The motion in machines may be of two kinds. On the application of force to a machine previously at rest, a certain movement is induced, and this movement for a time is accelerative ; but in some machines, after a while the resisting power and the friction of the materials destroy the acceleration, when, unless the machine is subject to variations of force, as is the case with those which are impelled by the wind, or by the force of men or animals, the movement will become uniform. On the other hand, there are machines which are acted on by a constantly accelerative power, as when a weight at one end of a rope passing over a wheel descends from an elevated place, and raises a weight attached to the other extremity.

From the endless modifications of Machinery it must evidently be impossible here to notice all their component parts ; but a few general observations upon wheels, shafts and spindles, cranks and eccentrics, drums and band-wheels, clutches and coupling-gearing, may suffice to call attention to some of the leading principles connected with the composition of Machinery.

Wheelwork, whereby the power is transmitted by means of teeth working into one another, is usually known under the name of gearing, but it may perhaps be worth while to add that wheels are technically subdivided into teethed, trundle, pin, crown, annular, and bevilled wheels, according to the shape, or the position, of the parts gearing, or working, into one another. Sometimes, also, a pinion may be made to revolve in, or upon, a straight piece of gearing, for the purpose of changing a continuous rotary to a horizontal motion, or *vice versâ* ; or, again, the wheels may be susceptible of motion in alternate directions, or they may be intended only to revolve in one, in which case they either are made of such a form as themselves to act as ratchet-wheels, or they are prevented from turning in the wrong direction by such a contrivance. In some cases, also, motion is given by the mere friction of the peripheries of the wheels upon one another ; but evidently this can only be accomplished in very small machinery, or where the force to be transmitted is small.

Spindles, or shafts, are the axes upon which the various wheels are fixed, and the initial motion is distributed as may be desired. They may be of wood, or of metal ; and if of the latter class of materials, either solid or hollow, square, hexagonal, or circular, as may be desired ; the object to be aimed at being, in all cases, to make the shaft as light as possible consistently with the requisite degree of strength, and to reduce the dimension of the bearings to the minimum in order to diminish the friction. When shafts are made to revolve on a vertical axis, they turn on a pivot, or gudgeon ; when horizontal shafts of great length are used, they turn in plummer-blocks, or carriages. As it has been found, practically, that two loaded surfaces work upon one another with the greatest amount of friction when they are of the same material, it is usual to make the bushes or steps in which the shafts or gudgeons work of a different material to those parts of the machinery themselves ; or in fact to make iron work on brass or gun-metal, wood upon iron, &c.

Cranks and eccentrics are the contrivances by means of which, in addition to wheels, the direction, or the nature, of the initial motion of a machine is transmitted to the work ; or in other words, by means of which circular and rectilineal motion are reciprocally converted, or uniform velocity is changed into a variable one. The bell-crank lever is the best illustration of the parts of machinery for transmitting a rectilineal motion in one direction to a shaft working in another direction ; and according as the other end of that shaft may be attached to a crank working on a fixed axle around which it may revolve freely, or be attached to a part of the machine susceptible only of rectilineal motion; it will be able to convert the original rectilineal motion into another one of the same description, or into a curvilinear motion. The rack-and-pinion have been already cited as an illustration of the means of converting circular into rectilineal motion ; and the common bow-drill may be cited as an ordinarily-adopted method of converting alternate rectilineal motion into alternate circular motion. Eccentric wheels are, however, the most generally-adopted means of converting curvilinear into rectilinear motion, and they may be either formed of circular wheels keyed upon shafts, whose axes do not pass through the centre of the former ; or they may be what are called heart-shaped eccentrics ; or they may communicate movement by pins working in slots. The cam is a contrivance frequently used for the purpose of converting continuous circular motion into an alternate vertical one, and this is effected in the case of tilt-hammers by means of a series of eccentrics able to lift a lever, fixed at one end, in a gradual manner through a path corresponding to the highest point of the cam itself, after attaining which, the lever is suddenly released, and of course falls. Varying rectilinear motion may be produced by modification in the shape of the cam in any way which may be required ; and there are countless modifications of the traverses of machinery, whereby continued alternate motion is obtained from wheels or axles revolving in a circle. A reversing motion may be obtained by the use of a sliding-bush working in a groove ; and in the numerous tool-making machines of Mr. Whitworth, every description of change of motion, from circular to horizontal, may be observed. The crank is, it may added, the most important element of Machinery, for the purpose of converting an alternate vertical, or horizontal, motion round a fixed centre, into a circular motion ; and the parallel rods, so universally applied to connect the piston-head to the balance-beams of steam-engines, may be cited as amongst the most important combinations for the conversion of alternate vertical motion into a partial alternate circular motion round a fixed axis.

Drums and band-wheels are contrivances by means of which motion is communicated from one shaft, revolving on its axis, to another able also to revolve in a parallel direction, and either in the same or in opposite directions, through the interposition of straps of leather, gutta-percha, or elastic web. The advantage of this method of transmitting power is, that directly the resistance to be overcome exceeds the adhesion of the strap upon the band-wheel, the former slips, and is unable to produce motion ; whereas when teethed wheels are used, if the resistance should be suddenly increased, there is a danger of producing a rupture, or at least a serious derangement, of the machinery. On the contrary, there is often a practical inconvenience in the use of straps, from the extension of the materials of which they are composed ; and it is not therefore customary to resort to their use in heavy or important machinery. When it is desired to change the direction of motion of the shafts, the bands are crossed ; and it is essential that, whenever it is possible so to do, the faces of the wheels should present slightly convex surfaces, in order to keep the bands steady. Band-wheels, equally with teethed wheels, admit of an infinite variety of velocity combinations, of which the speed-pulleys of the turning-lathe may be cited as characteristic illustrations. Among practical men, the first-motion band-wheel is usually called the *drum*, and the second wheel is called the *pulley* ; and the pulleys, where more than one are used, may either be fixed or loose, and made to work, by means of ratchets or of clutches, in any way that may be required.

Clutches, or the other varieties of loose coupling-gearing, are used for the purpose of connecting or disconnecting parts of a machine when it may be desired to start its motion at will, or to arrest the same ; whilst boxed couplings, or fixed connections, are used when the respective parts are intended to revolve continuously. The fast-and-loose pulley, the friction-clutch, and the conical friction and reversing-gear, have been introduced in order to obviate the danger which attends the abrupt connection of moving gear with portions of a machine in repose ; but in spite of the inconvenience arising from this cause, and of the danger of stripping the teeth of cog-wheels when suddenly connected, through the inertia of the materials themselves, it is almost constantly the practice to allow the follower to fall upon and to fit into the driver by means of a series of projections and recesses. Clutches or couplings should be placed as near to bearings or plummer-blocks as possible, in order to secure the greatest possible amount of rigidity in the portions of the shafts connected.

The following are "Notes" of the Machinery now more or less employed in Tea Factories:—

GREIG'S GREEN-LEAF CUTTING MACHINE.

The Green-leaf Cutting-machine is so entirely novel and successful an idea, that we feel justified in drawing very special attention to it. By its use there is no doubt that a very great saving can be yearly effected. The size of leaf being rendered equal by this machine, the after rolling becomes equal in effect also. There is thus a prevention of "dust." Ceylon, we see, is adopting this machinery, and the local Paper speaks very highly of it.

Messrs. Greig & Co. say of this machine, that it is intended for several purposes, and for cutting up into squares and triangular pieces the large succulent leaf of the Assam and hybrid leaf, particularly at the first of the flushing-season, when the leaf has grown rapidly, and is soft enough to roll up into tea. This saves an enormous amount of broken tea and dust compared to the present barbarous method.

Greig's Green-leaf Machine, as exhibited in the late Calcutta Exhibition, consisted of two rollers mounted in a cast-iron frame, and driven by either hand, steam, or other power. The rollers are grooved, and the edges of the square grooves fit close to each other, like scissors. The leaf is fed into the machine through a hopper, and rapidly *clipped* into little squares, the points of the leaves being little triangles; and as the stems are clipped, the tip is free and separated from the rest. The leaf being thus equalised and sized before being dried, can be much more easily separated, without taking the bloom off, than if the separating process took place when the tea is dry. Of course the tea will have to be sifted after being dried, but one passage through the sieves will be sufficient to separate it. No equalising or breaking machine will be needed, and no hand-breaking through the sieves; consequently the bloom of the tea is not destroyed, and a larger portion of fine tea and a much smaller quantity of dust are obtained.

Speaking of this Machine, Mr. C. B. Fergus says :—

Now if the theory be correct that we as a rule do not sufficiently roll our leaf, in fact simply roll it to give it the necessary twist requisite for appearance-sake, and forget, neglect, or do not know that the strength of the liquor is improved to a very great extent by rolling to a pitch quite unusual in tea manufacture ; if it be admitted that the leaf-cells should be more broken than they usually are, and that it would be desirable to avoid this in the tip, rolling it to a less extent than the other leaf, so as not to darken it and destroy its appearance, the value of the sifting process when the leaf is half rolled will be admitted. Then as a natural sequence to this the value of a machine to cut the leaf just before being rolled will be at once seen.

GREIG'S XL-ALL DRYING AND WITHERING MACHINE.

This is a very compact Machine, and stands in a space of 8 ft, by 3 ft. It is divided into two working parts, the *Machine proper* and the brick-built *choolah*, containing the globulous pipes, the former being connected with the latter by an iron pipe thrown out from the Machine itself, in the form of an arm. The *Machine proper* is stated to require no foundation, with the exception of two planks of wood sunk into the ground, to stand level upon ; and when working, is said to do so without any appreciable noise. The rolled leaf when ready is fed into a capacious drum, which is divided into four wire-cloth boxes, with wire-cloth doors, together with the divisions between each box, also composed of wire-cloth. The drum itself revolves slowly in an opposite direction to that taken by the exhaust and force-fan, which latter is worked at the rate of 1,200 revolutions per minute, thus showing the great exhaustive power available for drawing heated air through the globulous pipes into the drum of the machine. The hot air when so drawn into the drum is caught by the fan, which in shape resembles somewhat the propeller of a steam-ship, and whirled round into and through the boxes in which is deposited the rolled leaf. The fan itself is protected from contact with the leaf by a concentric circle of No. 14-mesh wire-cloth. The great principle claimed in this Machine appears to be, that leaf in motion can stand a greater degree of heat than leaf laid on motionless trays, with the result that they are enabled to use air heated to a temperature of over 600°, and the out-turn is necessarily larger.

GREIG'S PATENT GLOBULOUS PIPES.

Bearing fully in mind that most small estates are unable to use machinery, on the ground of the high rate of original cost, Messrs. Greig & Co. have "struck oil" in making these Pipes serve for an efficient, and, at the same time, a very economic drying-stove. We will quote their own words—" A splendid stove can be made by merely taking eight of these Pipes, and placing them in rows, in the form of the letter X, four at each side, and building them into brickwork. By having a long grating between the legs, the heat acts directly on the Pipes, and as there is a splendid draught, any number of sections or Driers can be heated by the same fire. Wooden hot-air chambers and trays could be made by the local mistree, the same as used in Assam over charcoal fires."

ALLEN'S PATENT DRYING MACHINE.

The Inventor states of this Machine, that it can dry one maund of tea per hour, or about equivalent to 4 maunds of leaf.

It cannot burn the tea as in other machines, yet it thoroughly dries it, at one fill of the Machine

It takes $\frac{1}{2}$ md. tea at each fill, and every leaf of this is done in exactly the same time; no turning over, changing of trays, or further looking after the tea, after the roll has been placed in the Machine on the trays.

Temperature can be lowered from 300° to one 100° in 2 or 3 seconds, and run up again in 5 to 7 minutes.

It will burn any fuel. Fireplace $2\frac{1}{2}' + 3'$, when kept regularly $\frac{3}{4}$ full of firewood or coal about 6 to 8 inches thick, while Machine is drying, will suffice—($\frac{1}{2}$ md. of fuel to a maund of tea should be ample.) The appearance and fine flavour of tea dried in this machine by fan beats charcoal; no gloss is lost on the tea from shaking up and turning over, and the tea is black, with glossy appearance and good flavour.

JACKSON'S NEW COMPOUND DRYER.

Messrs. W. & J. Jackson's new Self-acting Tea Dryer consists of an iron frame and casing about 9 feet long, 3 feet 6 inches wide, about 8 feet high, and inside this casing on a light foundation of brickwork is placed an air-heating stove of an improved type and construction, and over this stove is carried an inclined lead-coated iron compound concentric cylinder, which is composed of a number of cylinders fixed within each other on the same shaft, leaving an annular space between each cylinder throughout the length. These annular spaces are again subdivided by peculiarly T-serrated carriers or racks, which carry the tea well round on the top side, and when it falls, it does not go to the bottom of the cylinders, but only on to the serrated carriers on the outside of the next cylinder within it: thus, therefore, the tea-leaf is spread out over the whole area of the cylinder, and is slowly but steadily turned over, disentangled, and individually presented to the action of the heated air, ensuring a regularity in desiccation that cannot possibly be obtained from any tray-system of drying.

In working the machine, the fermented leaf has simply to be fed into a hopper at the higher end, by a boy, after which it requires no more attention till it is discharged dry.

The speed of the cylinder can be varied to bring the leaf through quickly or slowly, and it is estimated that the machine will dry four maunds of green leaf per hour, with one maund of firewood. There is no fan whatever about the apparatus, and the cylinder can be turned by one man, when the Engine is stopped, if required.

The advantages of this Self-acting Dryer, therefore, are—

(*i.*) After the leaf is fed into the machine, it requires no more attention till it is discharged dry.

(*ii.*) Every individual leaf is simultaneously exposed in precisely a similar manner to the action of the heated air, thus producing an unvaried and perfectly even-dried leaf.

(*iii.*) The tea is steadily but very slowly kept in motion, thereby dispensing with the tedious and tiring watchfulness of attendants, and the loss of heat and fuel hitherto required in tea-drying on the tray-system.

(*iv.*) There are no trays or woodwork about the machine whatever: it is therefore thoroughly durable, and cannot get out of order.

DAVIDSON'S SIROCCO.

This Machine has recently been very considerably altered and improved, and the Inventor asks attention to the following points :—

1. The new machine, at no greater cost, turns out double the quantity the old one did.

2. The ironwork will not now burn : a coating of fire-clay tiles all round the stove, besides improvements in ribs of stove, and double metal sides with air between, all round the machine, makes it impossible.

3. The tea was apt to burn formerly, because the lowest tray was too near the fire, and because no arrangement existed for diffusing the heat equally. Only two trays are now above the stove, and the lowest is 6 feet above it instead of 3 feet as formerly. An excellent arrangement for diffusing the currents of hot air now exists.

4. The machine being constructed on entirely new lines, the iron does not heat as it did formerly, and the tea is dried by the current of hot air *alone*.

5. The smoke-chimney is now attached to the bottom of the machine. It takes away *none* of the waste hot air ; and going out through the side wall of the factory, it has not the objections to it which the old chimney had.

A Ceylon Paper thus describes in detail the nature of the improvements :—

The castings of the Stove have been improved in construction very materially. The Diaphragm-plates do their work best when of *thin* metal, but where heat is transmitted to air through metal there must always be wear and tear by scaling, but the new castings now hold these plates so well that they cannot buckle or part company from one another.

The smoke-chimney is now at the *middle* of the horizontal flue, and this arrangement not only removes its heat from the coolie, but also does away with the smoke-bend and box, which interfered with draught at times, and are certainly better left out.

The base of the vertical air-duct is now made same width as the stove-casing, and the sides come up at an angle, forming hopper-shoots at each side under the two middle trays and part of each end one. Any dust falling on same gets delivered out at once into the receiving-pans, now carried on brackets *outside* the tea iron frame, and quite clear and apart from the stove-cashing, that they cannot receive much heat therefrom, and have not the remotest chance of being charred. There is a flap-door on each end of the horizontal flue, through which a brush can be introduced, so that occasionally the dust that lies on the flat piece of sheeting, may be swept down the sloping hopper without interfering with the working of the trays in any way. It may however lie there without any danger of scorching, being so far off from the stove. The new shape of the machine also obviates the necessity for a web travelling the length of the horizontal flue, as suggested by one or two Ceylon planters.

The new trays are much improved :—the slips of mahogany at each end *run solid* across, and the handle is a flat brass stamping over a small half-round finger-hole instead of handles let in, and dividing the cross slips. The new trays are quite rigid, and they will have iron angle-plates on the 4 *under* corners of the trays, so that they bear only on these points, and iron to iron slips along quite easily. One man can push 8 loaded trays as easily as he did 4 when bearing all along the wood slips. If this plan be not found sufficiently satisfactory, Messrs. Davidson intend to put on rollers; but they try as far as possible to avoid anything that weakens construction in its application, whereas the things they have now added vastly *increase* the strength of the trays, and serve the purpose, we believe, generally as well.

The question of a hopper at each end of the horizontal flue to receive dust from the trays when being turned on the projecting slides, had consideration, but the Patentees came to the conclusion that it was an impediment to the man working the trays, by preventing his getting close up to the end when pushing in the trays, and thought that if the dust were allowed to fall on to a clean cloth or platform, it would sufficiently answer the requirement However, hoppers could easily be applied to a machine if a person specially wished it. We may point out, in passing, that the distribution of the hot air under the trays is, in the new machine, more evenly and better effected by means of deflecting plates ; and also as it has only half the distance to travel to each end of the horizontal flue, and the sloping sides of the air-duct facilitate the distribution.

BARRY'S NEW DRYING MACHINE.

We paid a visit to Chowkidingi, the head-quarters of the Debroo' Combination Company's estate, on purpose to see Barry's new Drying Machine, lately erected here, at work. We think it a great success, and capable of great things in the way of Tea-drying. A huge cylinder, in which are innumerable cells, is made to revolve slowly round a tube containing hot air, forced thereinto by means of a fan erected over a furnace. This fan is driven by the same engine that drives the Drying and Rolling Machines at work in the Factory, and revolves with great rapidity. The cylinder is slightly elevated, and the withered leaf is put in at the higher end, which falls, as the machine revolves, from one cell into another until it reaches the lower portion, from whence it drops into trays placed ready for its reception. The tea is then placed for a short time on an ordinary chula, to finish it off. The consumption of fuel is very small, two or three maunds of coke being sufficient for about twenty maunds of leaf.

ROBERTSON'S TYPHOON.

Mr. J M. Robertson, manager of the Arcuttipore Tea Company's Gardens, has invented a new Tea-drying apparatus which he has named the Typhoon. A number of the planters of his district met at his Garden, by invitation, to test the merits of his machine. We quote the verdict recorded by them on the teas which were manufactured in their presence during the trial :—

The "Typhoon" is a simple and inexpensive construction of brick and iron, which can be erected without skilled labor. The heating material used is coke, and the quantity of coke required for a maund of tea is stated to be one quarter of a maund.

The out-turn from the "Typhoon" we found to be at the rate of one-half maund of thoroughly dried Tea per hour, and the manner in which the work was done was to our entire satisfaction, some of us thinking that the apparatus was capable of doing more.

The inventor leads us to understand that the entire cost of construction and material will not be over Rs. 300, and we do not see that this sum need be exceeded.

SHAND'S NEW TEA DRYER.

As this machine can be made any length and width, the quantity of leaf which can be manufactured is only limited by the extent of drying surface. One, five feet wide, and fifteen feet long, will admit of about forty pounds of tea being spread as thinly as on Sirocco trays, and, if heated to 150° Fahrenheit, would dry a maund per hour. The steam for heating the thin galvanized iron drying-surface is generated in the space (3 inches) between it and the thin boiler-plate bottom.

The machine, which is made steam-tight, is partially filled with water, and placed on a fire-stove. It is evident that a comparatively small quantity of fuel will generate sufficient steam to heat a large surface, especially if the smoke-flue is placed under the whole length of the machine.

BICKNELL'S SELF-ACTING TEA DRYER.

This appears to be the cheapest Dryer yet introduced. Including the royalty charged by the inventor, and the cost of erection, with all the appurtenances, it is stated that a sum-total of Rs. 175 will not be exceeded. The Dryer turns out 20lbs. of tea an hour. For small Gardens this Patent seems to offer a great advantage.

NELSON'S ROLLING MACHINE.

There is, or was (for we do not know whether any are now in use) a Roller introduced by Mr. Nelson, who was the first to introduce a Machine for Rolling. Necessarily, since that time, great improvements have been made. In Nelson's machine, the *Bag* was used ; and the same principle has been subsequently adopted, with many improvements, by Greig ; but to Mr. Nelson belongs the credit of the first initiation, we believe, of the Bag system, which has now been perfected by Greig.

JACKSON'S ROLLER.

This machine will be well recollected as being the cause of a heavy law-suit, in which Mr. Kinmond sought, and successfully, to prove that the machine was an infringement on his Patent. In the result, parties using Jackson's Machine had to pay a royalty, we believe, to Mr. Kinmond. Subsequently an arrangement was come to between Jackson and Kinmond. The object of the Invention was to imitate as nearly as possible the motion of hand-rolling, and it proved very successful, the peculiar motion given to the ball of leaf rendering it very effective for hard leaf.

It is not necessary to enter into any detailed description of Jackson's machine, as a reference to that of Kinmond will almost suffice. Some planters, however, still prefer Jackson's Roller to Kinmond's, as they say it is more simple. There will always be differences of opinion on such matters, but there is no doubt that the simpler the construction of a machine, the less liable it is to get out of order. Price has necessarily, also, much to do with the selection of any machine—especially for small factories. In this respect Greig's Roller carries off the palm. In selecting a machine, regard should, of course, be had to the extent of work it is required to perform, for it is not every Estate that can afford or requires the large and expensive machines of Jackson and Kinmond.

KINMOND'S CENTRIFUGAL ROLLING MACHINE.

The inventor has very wisely made small sizes of this machine, to roll as little as a maund at a time, and we do not see why he should not make them even smaller, so as to be worked by hand. This would meet the requirements of very small estates.

The inventor claims that his No. 1 size (the machine we are speaking of (cost f.o.b. £100), will roll $6\frac{1}{2}$ maunds of leaf per hour ; but seeing that 6 fillings and dischargings have to take place,—there being space for only a little over a maund at a time—we should be inclined to put the capability down at not more than 5 maunds an hour. The motive power required to work the machine is a 2-horse power engine, but of course it would be well to have at least a 3-horse power engine, as there would doubtless be shifters, &c., to drive, from the shafting. The principle of the machine is centrifugal force, the leaf being thrown and re-thrown perpetually from the centre by the effect of carefully-regulated set wooden flanges on the two opposite discs. The discs revolve in the same direction, but apparently at different rates of speed, and the pressure is regulated by a delicately-threaded screw, working against a spiral spring, under the most perfect control, the action of which, in separating or drawing the discs together, can be regulated by a boy. It is as well to have two sets of springs of different strength, as although the springs are guaranteed not to break, they *may* compress *hard up* before the full pressure is exerted on the leaf being rolled ; and the springs should never be hard up, although they may be *very near*. Every part of the machine is simple, and extra strong. It is easily erected, and has a neat, compact Machine-like look about it.

The driving-pulley on the Rolling-machine is 20 inches in diameter, and should be driven at a speed of 150 revolutions per minute. This causes the plates of the rolling machine to have a speed of 60 revolutions per minute, which is attained with a *minimum of noise* (no small advantage).

Owing to the short time in which the rolling process is completed, the leaf comes out specially green and fresh, while from its being so thoroughly shaken up and turned over and over in the process of rolling, the leaf is softened, and prevented from being bruised or broken.

The machine is fed from above, and the inside of the discs in contact with the tea is entirely of wood.

LYLE'S IMPROVED TEA ROLLER.

The present machine is stronger in make than the original one, and can roll off a larger quantity of leaf. Eight maunds of leaf can be double-rolled in an hour, or 12 maunds single-rolled in the same time. This is very rapid work, but the leaf has a good twist, and those who have used the machine say that the outturn in the cup is always of a very even colour.

The machine is remarkably simple in construction, and cannot well get out of order. The pressure can be regulated at will, by a ratchet movement. This is a great desideratum, as the tendency of some machines is to smash the young leaf, or insufficiently twist the hard pluckings of the finish of the Season.

Although the model we were shown is for steam power, the machine can be readily fitted with a fly-wheel for hand-driving ; and as no foundation is required, its erection is simple and cheap enough.

As to working capabilities, the machine can roll 100 maunds of leaf daily, and no hand finishing is said to be required.

THOMPSON'S CHALLENGE ROLLER.

The cry is "Still they come." Mr. Thompson has invented a new Roller.

The special features of the "Challenge." are; *firstly*, free contact of the leaf throughout the roll with the outer air; cheapness; simplicity of mechanism; perfection of feed, discharge, and pressure; minimum of power required.

GREIG'S LINK-AND-LEVER ROLLING-MACHINE.

A correspondent writes as follows :—

I have just seen the drawings and description of a new Rolling-machine invented by John Greig & Co., of Regent Works, Regent Road, Edinburgh, that can be worked by either bullocks, water, or steam. It is called "Greig's Patent Link-and-Lever Tea Roller," and rolls from 10 to 20 maunds per hour. It can be worked by one man, and *rolls easily 2 bags at once*, and these cost less than one anna per maund of dry tea. It is somewhat on Haworth's principle, and is a *capital machine*, which I can *strongly recommend.* It is also cheap.

GREIG'S SIFTING MACHINE.

For the sorting of the dried leaves the inventors have provided an unique circular-motion Sifting-machine, which, while it occupies less room than any of the existing machines, possesses the advantage of being self-delivering, and of separating the tea into the various qualities. There are four sieves. The tea, after being rubbed over the upper sieve by hand, falls, by the action of the machine, into No. 2 sieve, where the souchong is deposited, while on the two lower sieves respectively pekoe souchong and pekoe and tips remain, the dust falling through beneath. After having been again dried, the tea is packed for the market. The inventors claim for their Patent, originality, combined with simplicity and cheapness, and that both space and motive power are economised.

Mr. Fergus, Tea Factory Engineer, thus speaks of Greig's machine :—

"Another machine which is well spoken of by those who use it, is Mr. Greig's improved circular-motion machine. In it he uses sieves twenty-seven inches in diameter, but, as they are placed above each other, the objection to the sieves in the Jackson's machine does not apply, as the tea falls from the one to the other. It consists of a cast-iron frame-work, on the top of which runs a horizontal shaft driven in the usual way by a belt and pulleys. From this cast-iron framing there project two flexible springs something like fishing-rods, to the ends of which are suspended by chains a box with a semi-circular back, something like a cupboard with four shelves. On these shelves are placed four sieves made of Nos. 5, 8, 10, and 16 meshes respectively. The shelves of course are open in the centre to let the tea fall through. Attached to the cast-iron framing are two small upright shafts, which are driven by mitre-wheels from the shaft formerly spoken of. At the bottoms of these shafts there are cranks which are connected to strong wrought-iron brackets attached to each side of the box or cupboard, or sieve-holder, or whatever we may call it. When these cranks are set in motion they communicate a horizontal circular motion to the box, and consequently to the circular sieves inside of it; and as it is intended that the machine be driven at from 80 to 100 revolutions per minute, there can be no doubt that it will pass through a good deal of tea. The inventor claims for this machine that the nibs (dried tip) pass through it without being broken, as they fall "end on" to the next sieve. How far this is the case I don't know, but I do know that it would be very desirable to have the nibs fall perpendicularly from sieve to sieve, as there would be a much less percentage of broken nibs, which means a higher price for the tea. I have not seen Mr. Greig's machine at work, but see no reason why it should not be as good a Sifter as any. I saw it in the late Calcutta Exhibition, and can vouch for its being well made, strong, and very compact. The inventor says that it can put through about 800lbs. per day.

Its price is £28 F. O. B. at Glasgow. This should render it a favourite in small factories where a larger machine is not required.

N. B.—The Agents in India for Messrs. Greig & Co.'s various machines are the TEA PLANTERS' AGENCY, 10, Hare Street, Calcutta, from whom Prices, and further particulars, can be obtained, and who, we believe, keep some of the machines in stock.

ANSELL'S PATENT TEA SORTING AND WINNOWING MACHINE.

A correspondent, writing of this machine, says :—" I consider it a most useful machine, and a great saver of labour. With 4 men, I do with it in one day an amount of work which, without it, I would have to employ from 20 to 25 men to accomplish."

DALGARNO'S SIEVING MACHINE.

We have no hesitation in pronouncing this the simplest contrivance we have seen. The action is the closest possible imitation of hand motion, and by an ingenious cradle-arrangement connecting the sieves, the gradient can be altered at pleasure. There are two sets of sieves, the first fitted with Nos. 6 and 8 mesh, and the second with Nos. 10 and 12 mesh. One further advantage is, that the whole can be easily put together at the Factory.

SIFTING MACHINE.

Colonel Money states as follows :—

" I see a Sifting-machine is now being advertised—' Jackson's Sifting-machine.' I have seen drawings of it, but not the machine itself. In the one respect that it is much larger than anything used hitherto, it is more likely to succeed.

There is a machine for sifting and fanning Tea at one and the same time. I know not who invented it. It is a simple winnowing-machine, with sieves placed in front of the fan. By means of a rod and crank attached to the axle of the revolving fan the sieves are made to shake from side to side when the fanners are turned. The Tea is put into the upper sieve, a coarse one, and passing successively through finer ones, is thus sorted into different Teas. The open leaf at the same time is blown out by the fan.

I purchased one, but I do not find it does the work well. Sifting Tea is a nice process, and I did not find it sorted the Teas with any nicety. I have taken out the sieves, and use it now only for fanning, which it does very well, though no better than an apparatus which could be constructed at one-third the cost."

TEA SIEVES,

A Ceylon planter writes as follows :—

" Reading the local papers some days ago, I noticed some tea-men found it a difficulty to separate the large from the small leaves : I mean the pekoe from souchong ones. I got my carpenter to make two large sieves, (one for each of my estates) 8 by 3, with a depth of say six inches, meshes $\frac{5}{8}$ of an inch square, made out of the strands of an old wire rope : a simple contrivance. So I suppose many tea planters have the same sort of thing—*cheap, but not nasty*. The sieve is slung from the four corners with a wire from the floor above. One man can sift 300lbs. leaf per hour just as it arrives from the field. Pekoe leaves, of course, go through, leaving Souchong ones in the sieve. Leaves being thus separated enables me to get even withering : as the small leaves will be ready before the large, if put together to wither, I do not see how a man can get even or proper withering. Leaves will be ready for rolling, and will have more white tips, of course, than if the large and small ones were all rolled of a heap ; tips will not be discoloured by the juice from the large leaves. Common-sense tells us all that. My sieves have been in use with me between two and three years, and they *are a great help indeed.* 60 to 70 per cent. of Pekoe leaves pass through. When leaves come in wet, several of the leaves will be found clinging together ; the sieve shakes them adrift."

TEA-BREAKING MACHINES.

Mr. Ansell, of Kurseong, has invented a very good BREAKER, simple, and easy to work; and another TEA BREAKER is that of Mr. Geo. Reid's invention. The principal is that of cutting the leaf between toothed rollers. It is spoken well of by planters in Assam, and the price is moderate.

SECTION XVIII.

MANUFACTURE.

PART I.—Leaf-Weighing, Withering, and Rolling.

PART II.—FERMENTATION :—

Chemical Process of Fermentation.

Phases of Fermentation.

As to the right degree of Fermentation.

Discussion regarding Fermentation.

PART III.—FIRING :—

Firing.

Panning.

PART IV.—MISCELLANEOUS :—

Generally-admitted facts.

Causes from which different Results arise.

Jottings from a Planter's Note Book.

Tea Manufacture in Dehra Doon.

Manufacture of Green Tea.

Tea Tasting.

MANUFACTURE.—PART I.

LEAF-WEIGHING.

When leaf is brought in from the Garden, the Tea-house Assistant must see to the weighing of it, and should carefully examine the contents of each picker's basket, before weighment, to see that shoots have not been plucked off, or coarse and hard leaf gathered. The rate for plucking in different districts varies, but a full rate for each woman may be taken as 8 seers per day; and over that, 1 pice per seer. Where there is a lack of surveillance in taking in leaf, pluckers may, and are ever ready to, make money at the expense of the Estate.

The leaf being weighed, is to be laid thinly on trays, and placed in the rack for withering.

TEA WITHERING.

We are all aware that to make good Tea a good "wither" is a *sine quâ non*, and we are all equally aware that it is a department in the manufacture that has not yet been touched by the machinist, or thoroughly mastered by the tea-planter. Rolling and firing are under control at the present day ; and fermentation, the result of study and experience, may be said to be quite mastered by many in Ceylon ; but "withering" is still at the caprice of climates and seasons. Our distinguished machinist, Jackson, is said to have been pertinently addressed at the late Kandy Show by a no less experienced tea-planter, somewhat as follows :—"Mr. Jackson,—We are under obligations to you for the facilities afforded in tea-making, now: when are you going to give us a machine for withering ?" His equally pointed and suggestive answer was : "I leave that to my successors." This, therefore, is a branch of the art that has baffled planters, both in Ceylon and India, and which is still, more or less, left at the mercy of the elements.

According to one of the best Indian authorities, Col. Money, "the agents are sun, light, heat, and air. Light is a powerful agent, for, if some leaf be placed in a partially dark room, and some in a well-lighted verandah, the latter will wither in half the time the former will take." In fact, Col. Money was so satisfied as regards light, that in his note to the third edition he says : "I am now sending out the glass necessary for a glass withering-house." In Ceylon, with its monsoon and heavy rainfall, Withering is one of the subjects that should engage our best attention : and there is no season like the present to fully appreciate the question in all its intensity. To such of our readers as have Siroccos, our advice is to make timely arrangements to conserve the heat rising from the Driers. If the withering-rooms are above the Drier or Driers, the plan would be to make the rooms as airtight as possible on the sides by means of ceiling-cloth, lime, washed thickly. The top should also be ceiled, leaving small openings only to allow the moist air to escape without too rapid an escape of heat. To those about to build withering-sheds we would suggest large windows to admit abundance of light. As for air, atmosphere laden with moisture is hardly to be courted as a favorable agent for withering. It is all good and well at a milder period of the year. The sun, whenever it is possible to catch a glimpse of his face, may safely be employed for a few minutes to expel moisture, and start withering; after which the leaf should be allowed to wither in the lofts; or, if sufficiently withered, rolled off.

One word in conclusion. We would recommend our friends not to try withering in Driers unless they have the labour and the patience to do so at a maximum of 100 or so. For, if they do so at a high temperature, a light liquor and an out-of-the-ordinary flavor will be the result. It is better to wait patiently till the leaf withers than to hasten it, and spoil the tea to a certainty. Perhaps a fan would prove one of the best auxiliaries in a Tea-house to expedite withering.

To exhaust the air of a well-ceiled room, a small stove may be placed at one end of it, and a fan at the other.—*Ceylon Advertiser.*

One of the important processes of tea-making is the *withering.* It is of not little consequence that this process should be under control so that it may arrive at completion at a convenient hour, not too late nor too soon. It is inconvenient to have all the machinery waiting for the withering, and not quite consonant with either convenience or comfort that a planter may get up at one, two, or three in the morning to call his coolies to work to suit the withering. This process is one that may be well under control, where a planter has got tea-drier-heated air, or other heated air at command. The quickness of the process depends on the *dryness* of the air,—not merely on the temperature, though that has something to do with it: the *dryness* of the air is the chief thing. With a clerithew arrangement and fan, the speed of the fan could be regulated to regulate the withering; or by turning on the heated air from the tea-drier, the process might be expedited; and by turning it off, and if need be saturating the air with a chinchona-waterer or other spray-producer, the process could be delayed. But to do any of these with anything approaching to accuracy some implement to *measure* the *dryness* of the air must be used. Mere temperature is no measure of dryness. Air at 60° may be very dry, while air at 100° may be at the point of saturation. Some hygrometer must therefore be used to detect the *dryness* of the air used for withering the leaf. Perhaps no simpler or better can be got than *the wet-and-dry-bulb thermometer.* These can easily be constructed by using two thermometers that are fairly accurate. Wrap a piece of rag round the bulb of one, and keep the other end of the rag in water, in a small cup fixed to the thermometer, and kept full of water; as the air, when dry, allows of rapid evaporation from the rag on the bulb, and this evaporation cools the bulb of the thermometer, the mercury in the wet bulb tube descends, so that the difference of the reading of the two thermometers shows the dryness of the air. Some calculations are needed for great accuracy, but for withering purposes the observation of the difference will probably be enough.

A few experiments with such an Instrument, and comparison of its indications with the withering of the leaf, would enable the planter to have a pretty accurate idea of how to regulate his withering.—*Cor. Ceylon Observer.*

In very wet weather, it may be desirable to turn out the contents of the basket, and allow the surface-water to be driven off before weighing. Care, however, should be taken that green leaf is as little knocked about as possible.

After the leaf is weighed, it should at once be spread thinly over bamboo trays. Avoid pressing on the leaf with the hand; forenoon's leaf to be laid out where it is not so hot; afternoon's leaf to be placed where heat is to be obtained. Next day, if the leaf is perfectly withered and soft for rolling, it should be put into the rolling-machine.—*Tea Gazette.*

The agents for withering leaf are sun, light, heat, and air. Of these the most powerful is sun, for it combines all the others with it. Light is a powerful agent, for if some leaf be placed in a partially-dark room, and some in a well-lighted verandah, the latter will wither in half the time the former will take. If light and moderate ventilation be present, heat is a great accessory to rapid withering.

There is often great difficulty in withering leaf in the rain. It *can* be withered in Tea-pans, but 'the out-turn' is then more or less injured, for after infusion the out-turn comes out green instead of the proper 'new penny' colour. Withering in dholes is also objectionable for the same reason, though if the heat is moderate, the green effect is less. It is further a long and tedious operation.

Space and light are the great wants for withering leaf in wet weather. Bamboo mechans, tier above tier, should be constructed in every available space. Large frames, covered with wire mesh, may also be made (by means of weights running over pulleys) to run up to the roof of any Tea building. The leaf withers well in such frames, as heat ascends, and much heat is given out by dholes.

It signifies not where leaf is spread, as long as there is space and light.

In dry weather, when leaf comes in from the garden, spread it thinly anywhere, and turn it once early in the night. It will generally be withered and ready to roll next morning. If not quite ready, then put it outside in the sun. Half an hour's sunning will probably finish it.

In wet weather, if there is any sun when it comes in, or any time that day, take advantage of the sun to wither the leaf *partly*, so much that, with the after withering all night under cover, it will be ready next morning. If not ready next morning, put it out in the sun, if there is any, till it is ready.

In very wet and cloudy weather, when there is no sun, and continual rain, so that the leaf *cannot* be put outside (for remember that outside, when there is no sun, the light alone will wither it) artificial withering of some kind must be resorted to.

Unwithered or under-withered leaves break in the rolling, and give out large quantities of a light-green-coloured juice during the same process. The Tea is much broken, and of a reddish grey-colour. The liquor is very pale in colour,—cloudy weak, soft, and tasteless.

Over-withered leaf, on the other hand, takes a good twist in the rolling, gives out but little juice, which is of a thick kind, and of reddish-yellow colour. The tea is well twisted, 'chubby' in appearance, and blacker than ordinary · the liquor of an ordinary depth of colour,—clear, with a mawkish taste,—*Col. Money.*

Tea-leaves commence to decay shortly after they have been removed from the bushes, sooner or later dependent upon the state of the weather and their condition of moisture, and this is accelerated or retarded by the temperature of the withering house, amount of air and light they are exposed to, degree of thickness spread on machans, and finally, though the most important of all, to the number of hours that have elapsed prior to rolling. To make tea of really good quality, strength, and flavour, all the conditions being similar, the leaves should be plucked and manufactured separately, and as soon as practicable after being brought in.

The application of artificial heat to raise the temperature of the "leaf-house" has often been tried, and in many quarters this is now done at the height of the rainy season. Almost all planters, however, are agreed that this is not conducive to high-class quality, and is only resorted to as a last resource. Several machines and processes have been invented and tried for the artificial withering of the leaf, and although it is possible that some suitable system for drying the air without absolutely heating it may yet be found, yet, so far, no satisfactory method has been discovered. It is, however, of course, fully recognised that the Withering-process is the most crucial one in Manufacture.

Excepting in very fine warm weather it is next to an impossibility to "wither" the leaf in the way best suited for preserving its "active principle" in the subsequent operations of manufacture. The humidity of the atmosphere is such during the greater part of the season in the province of Assam, the Terai, and the Dooars, that the evaporation of moisture from the larger quantities of leaf now produced cannot be effected without some change in the present method of dealing with the process of Withering. Some means must be adopted for "drying the air" to be used for this purpose. Air, we repeat, when saturated with moisture, cannot take up any more, and till it is dried at a high temperature, and cooled and distributed at a lower one, it is out of a planter's power (do what he will) to oxidise and subsequently manufacture evenly. Proper withering is indispensably necessary to the preparation of black tea, and there is art in the management of the process.

It is impossible to make good tea from badly-withered leaf, and although this is an universally-recognised axiom, still a good many planters do not calculate beforehand what is the largest space they are likely to need in the Season—while perhaps in August a great rush of leaf comes with a long-continued spell of wet weather, and tea-houses get filled with leaf that will not wither, and which has to be manufactured anyhow. A poor invoice of tea is the result.

Withering-space of 600 square feet to the maund is required to dry leaf in perforated Bamboo trays in damp weather, or say 67 trays of 3×3 with a spread of $1\frac{1}{4}$ lb. per tray In dry weather a seer of leaf per tray, or 40 trays per maund, will be found sufficient.

Withering in the sun is objectionable, but in bad weather wet leaf is better withered in the sun or in the wind than by artificial heat. The operation should not be hurried, as dried leaf is not necessarily withered leaf.

Under-withered leaf breaks in the roll, and gives a green out-turn. Over-withered leaf gives tips, but a dark out-turn. Leaf withered in the sun gives a reddish tea, A bright coppery out-turn can only be obtained from properly-withered leaf.

Leaf is best withered when there is free supply of light, and cool air.
Wet leaf is better withered in the sun or in the wind than by artificial heat.
Dried leaf is not necessarily withered leaf.
Under-withered leaf breaks in the roll.
Over-withered leaf gives most Pekoe tips.
Leaf withered in the sun gives red tea.
Under-withered leaf gives a green, and over-withered leaf a dark, out-turn.
A bright-coppery out-turn can only be obtained from well-withered leaf.
Under-withered leaf will take longer to fire than well-withered leaf.

Withering should be done rather slowly, and avoid exposing the leaves to artificial heat.

There are several tests to show when leaf is withered. Fresh leaf squeezed in the hand, held near the ear, crackles, but no sound should be heard from withered leaf.

WITHERING.

By Percy Swinburne, late of Sylhet, Cachar, and Assam.

The old method of withering was to spread the leaf 2 to 3 inches thick on a mychan, and to turn it over several times during the night to prevent its heating too much. In wet and cold weather it was placed in small quantities at one time, on a mychan, over the firing-dhools, where the heat quickly softens and prepares it for rolling. But now great improvements have been made in the factory buildings and accommodation. It is generally recognised that the leaf must be thinly spread out, and the withering-process most carefully conducted, to turn out good tea. Withering, sheds admitting air and light freely, and fitted with tier upon tier of bamboo trays, are made. Large pucka iron-roofed tea-houses are fitted with lofts for withering, and arrangements are made for regulating the heat and admitting or shutting out the air.

Natural withering, as generally understood, means that the leaf is placed in open or closed houses in which the draught of air may be regulated; while artificial withering includes the use of heated air, or of machinery.

A large proportion of the best tea which is sent to the market is now made from artificially-withered leaf, that is to say, from leaf which has been withered by heated air. The lofts of the pucka tea-houses are heated by the sun, to a temperature of over 100 degrees, and are often intolerably and suffocatingly warm. In dull and wet weather, also, the temperature in these places is still considerably higher than that of the surrounding atmosphere, as they are heated by Siroccos or other firing-machines, the chimneys of which pass through them.

There has for a long time been a strong prejudice against artificial withering. Closed hot-houses were used because the weather so often proved unfavourable, but natural withering, under favourable circumstances, is always supposed to give the best results.

In natural withering, the faster the process the better the result, so we may conclude that perfect withering would consist in removing all superfluous water from the leaf instantaneously, without disturbing the oils, juice, &c., while sufficient heat was applied to reduce the fibre to the soft condition required for rolling.

The finest tea was made from leaf withered in 3 hours, at a temperature of 140 degrees. The tea was on several occasions carefully assorted, and true samples of the bulk were sent down to Calcutta to be valued, and the quality of the liquor, as well as the appearance, were pronounced excellent. The average valuations were about 14 annas, and the leaf was good, but not finer than that plucked on most estates in Darjeeling, or Sylhet, or Cachar, being two leaves and a bud. The market at the time was depressed, and the average price of the teas of the districts named was, at that time, between 9 and 10 annas.

In 1883 the entire crop of the Kainagar Estate, Sylhet, just under 900 mds., was withered in hot-houses, heated by smoke-flues, and realized 11 annas per lb. average. The houses were "kutcha" ones, built of bamboo and plastered ekur. They were 14 feet high in the roof, 7 feet high walls—breadth 20 feet. Two four-feet wide passages, and 4 rows of chalnies 3 feet wide.

The pipes were 9 inches in diameter, and $\frac{1}{8}$ inch thick, and ran along both sides of the house underneath the outer row of chalnies. The heat was much greater near the furnaces than at a distance from them, and the house gets thoroughly heated for a distance of about 15 to 20 feet only from the furnace.

The heat is also uneven; and the greater it is, the more difficult it becomes to equalize the withering. The leaf must be thinly spread and carefully watched. One part of the house withers much more quickly than another, and if the leaf is left for an hour only, after it has reached the right stage, much quality is lost.

These houses, defective as they are, are preferred to those of the old style.

When the men have learnt how to arrange the leaf, and work the fires, the rolling can be commenced at 5 A. M. every day in all weathers.

The leaf does not turn red unless it is bruised in some way during the withering process, and its juices become exposed to the air. This may happen from the leaf being gathered up a second time, and removed from one place to another.

If it is once established beyond dispute that the best tea can be made from artificially-withered leaf, there should be no difficulty in making a hot chamber in which the leaf could be very thinly spread out, and the heat equalized and regulated, and the moisture removed.

One of the great disadvantages of open houses is, that the damp cold air which checks the withering is admitted, as well as the warm air which favours it. Withered leaf absorbs moisture, and is refreshed by it—as a bouquet of faded flowers is revived by sprinkled water. But when the leaf has withered a second time, it loses its freshness, and when the flowers have again faded, they begin to give out an offensive smell; the first stages of decomposition having set in in both cases. Leaf which has once lost its volatile freshness and delicacy, never recovers it, and can never be converted into fine tea.

The fine qualities in the leaf may be chemically altered in the hot withering process, but they not are lost altogether, as is proved by the quality of the tea produced by it.

In the same way, however, as the flavour of the tea is affected by different firing processes, so it is probably also affected by the degree of heat applied in the withering as well as by the manner in which it is applied.

Good tea can be made of leaf which is carefully withered, rolled, fermented, and finally baked ; but although strong, it is peculiar, and has not the delicate flavour and smell of tea which is roasted over charcoal in the usual way, and this again is not so aromatic in flavour as that which is dried by the rapid hot-air draught of the "Sirocco."

It would appear that the best withering would be accomplished by a strong draught of moderately warm and quite dry air passing over the whole surface of the leaf.

If the juices can be kept uninjured, the more the leaf is withered the better the quality of the tea. The presence of water in the rolled leaf appears to affect the fermentation injuriously. It is not accurately known at present what chemical changes take place in the various systems of manufacture, but we know that we are more or less dependent on the weather, and that the changes which take place satisfactorily one day, will not do so on another, under apparently exactly the same condition. Lightly-withered leaf makes tea without strength or body, and this is probably due to the presence of too much water in the rolled leaf, which causes an injurious fermentation. On the other hand, over withering, or bad withering, by which the juices have been injured or destroyed, have the same effect, and produce weak pale-liquored tea.

ROLLING.

We object to heavy rolling, either by hand or machine, unless the leaves have been gathered *during* very rainy weather, and they are themselves also over-charged with moisture, in which case it must be resorted to, but merely to expel the superfluous water. In all other conditions we maintain that the less pressure is exerted upon them, the better and stronger will be the teas. The operation of rolling is simply for the purpose of breaking or bruising the numerous diminutive cells of which the leaves are constructed, in order to induce chemical action to take place, the resultant of which is the product called Sea ; but how this arises we are unable to state, neither is it of the slightest practical importance to the manufacturer. Old tea-planters believed that the rolling was solely for the purpose of extracting the acrid juices from the leaves, but a moment's reflection should convince any one that it is these very juices which are contained in the cells and their interstices that make the tea. To look at the matter in an extreme point of view, supposing the entire fluids were removed from the leaves during manufacture, there would remain nothing but the bare skeleton to be put into the pot, and consequently the boiling water could extract no tea from these suitable for the table. Rolling for a longer time than experience dictates, although lightly, is as detrimental as the converse.

One of the oldest planters in India thus advises, as regards Rolling :—

If you roll lightly, you will have a better show of tips, but then on the other hand you stand a chance of not getting all the juice-cells in the leaf bruised ; and the consequence is, want of strength in the tea. I think, as the market stands at present, liquor is the test, and there is nothing like heavy rolling to bring out the strength. I am inclined to think that, provided the first roll has been thoroughly done, there is no advantage in giving a second ; besides, with a single roll you can easier attain the much-desired salmon-colour in the infused leaf.

Another experienced planter says :—

I have often made the experiment against lightly-rolled leaf, and find that the heavier the leaf is rolled the stronger is the tea. I am referring to hand-rolling. The latter process, however, discolours the tips, and gives a larger proportion of broken. I think the mass should not be re-rolled or in any way disturbed during the process of fermentation. I spoilt my teas for a time by heavy re-rolling before firing, but now I merely open out the balls to spread on the firing-chalnies.

Colonel Money, in his latest Work, says :—

Hard rolling gives darker coloured and stronger liquor than light rolling. Hard rolling destroys Pekoe tips, inasmuch as the juice expressed stains them black.

Light-rolled Tea has therefore many more Pekoe tips than hard-rolled.

Hard-rolled Tea is somewhat blacker than light-rolled.

In all, therefore, but the point of Pekoe tips, hard rolling is better.

Lightly-rolled leaf does not make strong Tea.

MANUFACTURE—PART II.

FERMENTATION.

Chemical Process of Fermentation.

Fermentation is a chemical process which is by no means popularly understood. To the dairyman it is a bugbear of no small proportions, the more so because he has been taught something of its destructive properties, and has learned to consider it something in the same light as children think of, and fear, the bugaboo of the nursery. But there is nothing connected with the business of dairying in all its branches that should be better understood. Fermentation is a chemical change which varies as the substances affected by it differ. Generally it may be considered as a change of organic substances, in which their elements are broken up and combined in new compounds. Particularly: it may be distinguished as saccharine, when starch and gum are changed into sugar; vinous, when sugar is changed into alcohol; acetous, when alcohol is changed into acetic acid; lactic, when lactose, or milk-sugar, and glucose, or grape-sugar, are converted into lactic acid; viscous, when sugar is converted into mucilagenous substances; and putrefactive, when nitrogenous matters are decomposed into substances containing ammonia, nitric acid, and other gases. There is also a butyric fermentation, which may be produced in milk or cheese by the addition of chalk, or may go on under the presence of certain germs, but this sort of fermentation is generally included under the generic name of Putrefaction. All these changes are caused by the development of special forms of fungi, which, however, have a somewhat close relationship, and have been considered as all varieties of each other. Hollier maintains that the forms which accompany mildew also induce fermentation and putrefaction, and common experience in the dairy corroborates this belief. Fermentations, under whatever conditions and character they may occur, are all purely chemical reactions, and do not all necessarily destroy or cause the destructive decomposition of the substances affected. It is necessary to realise this fact in considering the chemical changes which occur in fermenting substances, especially those which enter into consumption as animal or human food.

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1. The out-turn of over-fermented tea will more or less approach in colour an old penny, rather than the new penny,—"THE DESIRABLE LIGHT SALMON-COLOUR."
2. In the liquor, the grip, like taking alum-water for a gargle (especially in the case of a well-fermented pekoe or broken pekoe), will have disappeared.
3. A sweet smell, the result of the change from the incipient stage of fermentation to the stage of true fermentation, will emanate from the tasting-cup, and follow the tasting.
4. The liquor on being cooled will not cloud, as will the correctly-fermented tea, from the broken pekoe down to the pekoe souchong in good teas.

A correspondent of the *Ceylon Observer* remarks as follows:—

There has been much disputation upon whether "oxidization" should not be substituted for the term we usually use as "fermentation" in the manufacture of Tea. Under any circumstances I should say that ferments would be discovered as present in this process, and it is furthermore undoubtedly the first stage towards decay, unless we may consider decay as beginning with the wither. There is a great deal in the term "decay," and this appears to be more implied by the expression "ferment" than by oxidization, although some are very much inclined to believe the change in our Tea is as much owing to the former as the latter. Whenever mere water, saying nothing of decomposing compounds, such as tea after rolling, has first been boiled to destroy animal and vegetable life, and then exposed to the normal atmosphere, it has always succeeded in filling it in a very short time with life, and, as far as I have studied the subject, this is even the case with tobacco-water, a very certain destroyer of insect, and I may say all vegetable, matter.

Inorganic compounds never of themselves ferment, as far as the correct meaning of that word applies. Chemical change may take place, heat may be produced, and oxygen very frequently comes into active play. With organic compounds oxidization of course takes place, but this most probably in conjunction with ferments. I should think the germs of fermentation are usually first contracted during the wither, and develop themselves after the roll. Fermentation and decay of course mean the absorption of a deal of oxygen from the air, and are very much affected by the slight addition of water. Excessively-fermented tea becomes sour, indicating, I suppose, the change of some of the sugar, starch, or tannin, into active acid. The production of acetic acid has, however, recently been called oxidization, and not fermentation.

Fermentation, I conclude, correctly means the presence of another influence acting upon the tea, or whatever the substance be, as yeast upon beer, or gluten upon sugar. In organic properties, however, it must be very difficult to determine how far the germs of the atmosphere act upon our decomposing tea, consisting as it does of all the necessary elements to produce fermentation quite as much as oxidization, both gluten and sugar being present.

Phases of Fermentation.

The process in the manufacture of Tea which we rightly or wrongly call Fermentation is so important, and demands so much of the planter's care and attention, that we are sure a few Remarks will be read with interest.

We propose, in the first place, considering what real fermentation is ; and in the second, whether it is either possible or probable that real fermentation can take place in the manufacture of Tea.

The researches of the eminent French chemist Pasteur lead to the following conclusions regarding Fermentation :—

Fermentation is produced by the action of living germs or cells on the substance to be fermented. These cells or germs may be of three kinds :—

1st.—The living cells which exist inside fruits.

2nd.—The germs or seeds of plants.

3rd.—The germs of animalculæ.

In the first instance what takes place is this : The cells take oxygen from the saccharine juices of the fruit, throwing off carbonic acid, and producing alcohol. If these cells are broken or injured by gushing or other means, they are powerless to effect this. Everybody knows the unpleasant hot flavor of a pine-apple that has been kept too long. It has lost its sweetness, and has acquired instead a peculiar burning taste. What has taken place is neither more nor less than "fermentation". The living cells which exist in the pulp of the fruit have absorbed oxygen from the sweet saccharine juices, and have by doing so produced alcohol, which is the cause of the burning taste.

The second instance arises from a very different cause. We now have the germs or seeds (as they really are) of a plant acting exactly in the manner we have described, in a foreign substance. This is the sort of fermentation that comes into play in the manufacture of Beer and Wine. The brewer first steeps his barley for a certain time in water, then drains and subjects it to a gentle temperature sufficient to cause it to germinate ; he then dries it on a kiln, and calls it *Malt*. He now grinds and mashes it up with warm water, boils it with hops until all the soluble parts have been extracted, and obtains an infusion which is called *Wort*. He has now got to ferment this, and for the purpose uses the seed of a minute plant called *Torula cerensiæ*. Yeast is a fluid containing these seeds in suspension, and the admixture of the yeast with the wort is simply the sowing of the seeds of the Torula in a congenial soil. These seeds sprout and grow, but in order to do so they require oxygen. They accordingly take it from the sugar contained in the wort, turning it (the sugar) at the same time into alcohol, and acting just in the same way as the life-cells did in the case of the pine-apple. In the manufacture of wine, yeast is not required, simply because the seeds of the Torula are found on the outer surface of the ripe grape ready to hand. Break the skin, and the seed is sown, and 48 hours afterwards we find it sprouting into growth with all the usual phenomena of real fermentation. The result of fermenting *wort* with Torula is the glori ous beverage called *Beer*. The result of fermenting the *Must* of the grape with the seed of the same plant is *Wine*. Were germs of other ferments sown in the wort or *must*, fermentation would ensue, but the results would not be palatable. The maladies of beer are owing to its being contaminated by germs floating in the air which are not those of the Torula. The plants which spring from these objectionable seeds are not nourished in the same way as the Torula, and consequently the result is not *Beer*.

The third instance is that in which the germs or eggs of animalcul as are sown; in short when animal and not vegetable life is the fermenting power. When milk turns sour or putrefies, the cause is to be sought in the presence in it of curious eel-shaped organisms; the sourness being due to an animalcula called *Vibiro*, and the putridity to a different one called *Bacterium*. These animalculæ float in the air, and are the direct cause of milk going bad. Keep your milk in air free from them, and it will never go sour or putrefy. Take a common tin of soup, open it and leave it exposed to the air in your room; it will putrefy in a certain period, which will be longer or shorter according to the temperature of the atmosphere. Now open a similar tin in air which you have freed from such germs, and it will remain for ever perfectly pure. The Bacterial eggs which float in the air of your room fall into and are hatched in the soup. They then breed and multiply at a marvellous rate, totally altering the composition of the soup; and the result is Putrefaction as it is commonly called, which is really due to Fermentation.

We thus have three phases of Fermentation. In all three the casual force is to be found in the *life* existing in cells or seeds or eggs, and the question is—Does any such process take place in the manufacture of Tea?

The process of rolling expresses the juices of a leaf, and among them appears *Tannic acid*. Fire your leaf immediately after it is rolled, and after infusion note flavour of liquor and colour of out-turn. The liquor tastes harsh, pungent, and raspy, and is quite unpalatable. It further wants "body." Compare this with leaf that has been fired after being just sufficiently "*fermented*," and then with leaf that has been allowed to "over-ferment" before being laid on the trays. It is quite unnecessary to enter into particulars, as they are familiar to everyone.

As to the Right Degree of Fermentation.

To hit the right degree of Fermentation requires more study and discrimination than are generally given to it; and failure at this point is, beyond doubt, one of the most prolific causes of *poor teas of weak liquor*. It is no unusual thing to meet with two samples which, having as nearly as possible the same appearance in the dry state, show such a marked difference in the infusion as to make one worth from 3*d*. to 6*d*. per ℔. more than the other—a difference generally traceable to an error in fermentation, though it may also occur in the firing—more frequently from insufficient than over firing—or from the tea being allowed to lie about, and become more or less musty before packing.

While the two extremes of *over* and *under* fermentation have to be avoided, the general tendency is to err on the side of excess. This sometimes occurs from inability to recognise the true indications of sufficient fermentation; sometimes from a want of appreciation of the importance of the point, and allowing it to be treated in a haphazard routine fashion by the tea-makers. One cause of over-fermentation may be found in the habit, prevailing in many tea-houses, of allowing the leaf to lie about in heaps too long before firing, waiting for space to be available on the dholes or trays, there being a tendency, more especially in factories where steam is employed for the purpose, to push on the rolling of the leaf without giving any consideration to the adequacy of the accommodation for firing it off while at the right stage of fermentation. Another fertile cause of over-fermentation, producing dull, weak, and sour teas, is want of care in seeing that the fires are kept brisk and bright, and that no more leaf is put on each *chalnee* or tray than can be quickly fired off. When a thick mass of leaf is put over a slow fire, fermentation of course goes on even more rapidly than before, stimulated by the gentle heat, and a dull sourish tea is the certain result. Rolled leaf is in a fit state for firing off just as the original green colour is turning to pink. The out-turn of the infused leaf should be a *bright salman-brown.*

DISCUSSION REGARDING FERMENTATION.

I was listening to a conversation on tea matters between three worthies. One was a man who had had 7 years' experience, and was assistant on a Garden ; the next, a man of 8 years' experience, and was manager ; the third was never either manager or assistant, but had been inspecting Tea-Gardens for a number of years, and was a tea proprietor to a large extent. Tasting-cups were brought, the tea infused, which was "bulk," and when five minutes had expired, up goes C., (we will call them in order A., B., and C., *viz.*, A. the Assistant, B. the Manager, and C. the Proprietor,) pours out the liquor, turns up the out-turn, shakes his head, and remarks, "What do you think of this B. ?" B. takes the out-turn to the light, smells it, turns it over, and remarks—"Too green : more fermentation wanted." A , who had had two years' experience as solely tea-house assistant, and five years of both tea-house and out-door work combined, had made the tea. He winked at me, and then said, "With many bhánjee leaves amongst your leaf it is better to fire off rather green ; now, you see, one-half or nearly so, of this leaf is bhánjee, and many of these bhánjee leaves are hard." B , who had general experience, but never was a *tea-house* assistant. asked the reason why it was better to fire off green, and C. could *not see* why more fermentation was not given. A. winked again at me, and said, "I'll do as you desire, but my experience goes to prove that bhánjee leaves take longer to ferment than Pekoe leaf, and when your bhánjee leaves are green, your Pekoe should be fired." C. remarks, "Well B., what do you say ?"

B.—"I do not agree entirely with A. My plan of manufacture is different from his : I therefore trust he will adopt my plan, and give the proper fermentation. His tea no doubt tastes pungent, with fair flavour.

C. (*interrupting*)—"I think so too, but as there should be more fermentation, A. must change his system." A had risen, and he and I went into the Bungalow to have a peg. "Well," said A., "and have I spent my time for nothing, trying various ways of manufacture to produce the best profit for the garden ? I have under-fermented and I have over-fermented; I have sifted the roll, I have fired it without sifting; I have rolled the leaf right off, and I have rolled it 2, 3, and 4 times, and I know what qualities a good tea requires by taste, appearance, colour of out turn and liquor, &c. ; and I know how, in manufacture, these qualities are all produced—in fact I would be a fool if I did not, after such experience ; and I am not consulted how tea should be made, but told to change my system by fermenting more. *Now* my tea will be reduced in price all round, but later on I could with advantage ferment more."

(*Enter B and C*)—C. speaking to A. says, "You will have to get more of a salmon-colour in your out-turn ; this is done by carefully watching the roll while under fermentation, and firing it off at the proper time : when once you see how long it takes to ferment, there will be no furth r bother."

A. is grieved to see that C. thinks him such a novice, and begins to say, "Yes, but"—when C. interrupts him, and says ; "You just do as B. desires, and you won't be far wrong."

A. (turning to B.) says: "Well, what way shall I make your tea ?"

B. explains, and lays down the system, *viz* , how many hours' fermentation he thought quite enough ; how many men to roll, and how many to fire off ; how many to wither leaf, &c., &c., ; and he hoped his system would be carried out.

A. replies, "Your system is a good one, I have no doubt ; but fermentation"—

C. (*interrupting A.*)—" On what do you chiefly depend for making good teas?"

A.—" On proper fermentation being given."

C —" And still you do not give it ; why ?"

A.—" Because there are exceptions to the rule, which makes it better sometimes to sacrifice our colour for our liquor, but rarely *vice versâ.*

B.—" I always give $2\frac{1}{2}$ hours to ferment my roll, and I find it answers very well. I'd advise you, A., to do the same."

" All right," says A., for A. was fully well aware that people who hold a high position get to think that they must know more than those below them,—though, really, those below them may be more experienced than themselves ; but high position makes people forget all this, and it is only natural, (so thought A) ; and as his opinion was not asked for, (it being no doubt thought worthless, he being an assistant), he thought it best not to dispute the matter, and so avoid his Manager's displeasure for shewing up his ignorance. (Exit B. and C.) So said A. to me after B. and C. had departed.

After some conversation I remarked to A. that he did not seem to agree quite with B. and C.'s mode of manufacture.

A.—" Well, I was about to explain my ideas on fermentation, when I was interrupted by C."

(After asking for his ideas, he said) " that no stated time could be given for fermentation, as far as his experience went." He said (and truly) " that some days are hotter than others ; that morning and evening was cooler than 12 at noon ; that some tea-houses were hotter than others ; that some were drafty and cold ; also that March was cooler than May or June ; that April was generally subject to great varieties of temperature through the day ; that June, July, and August, were damp, &c. &c. ; and he found that it was very rarely the same length of time for fermentation could be given day after day to produce the best tea. His experience also went to show him that it did not pay a Garden to leave bhánjee leaves on the bushes, and that the length of time for fermentation greatly depended on the description of leaf (coarse or fine) plucked ; "but," said he, " what is the use of all this experience ? and it grieves me that I should simply be made a tool or a machine of, instead of being able to apply my knowledge to the Company's and my own welfare."

I did not venture to offer an opinion on the subject, as I was not well up in these matters. At the same time I thought there was something in what A. said.—Dyapa. [Note by the Editor.—A.'s statements are correct.]

Sir,—We are asked to believe that the process in our manufacture which we cáll "fermentation" is the result and the proof of the active presence and motion, amongst the mass of tea-leaves, of innumerable microscopic beings so low in the scale of life that one hesitates to call them *animals*, though M. Pasteur and other learned authorities have definitely settled that they really are such, if living and breathing entitles them to be so classed ; and it seems to be implied that these little creatures are always present on the outside of the leaf, waiting for an opportunity of entrance by any fissure, to commence the discharge of their natural functions, which opportunity is afforded them when the tissue of the leaf is bruised and broken by the rolling process. I cannot very clearly or satisfactorily understand or account for the heating and discoloring of the fermenting leaf, but every one knows that it does become heated and discolored during the process. In fact I think it is by the *color* that the tea-brokers or tasters, who are learned in these things, affect to judge whether the fermentation has been sufficient or otherwise. Personally I am inclined to think that it is safer to be guided by the sense of *smell* than of *sight*, but this does not bear very particularly upon the points of the matter which I have immediately in mind. The question that occurs to me just now is this—If fermentation cannot commence before the tissue of the leaf is broken, and if heat is a sign that it *has* commenced, how are we to account for the leaf heating and getting discolored too, (may I say *fermenting*) as it not unfrequently does, in the pickers' baskets out in the field, if they press it down at all freely, as they are sometimes obliged to do. This is one of a few things that I want to ask you, Sir, or any of your learned contributors, to enlighten me about. I don't aver that heating and discoloration are sure signs of the presence or action (I really hardly know which is the best word here) of fermentation, but I think they invariably accompany the process in tea-making.

Sibris.

[One of the promoting causes of fermentation is heat, and it is not therefore surprising that leaf in the pickers' baskets lying below pressed-down leaf, above t, commences to discolor, or in other words to enter the first stage of fermentation. The whole subject however is one requiring such close examination and chemical investigation and inquiry, that we shall be glad to have the opinions of those who have studied the subject attentively.—ED., *I. Tea Gazette.*]

SIR,—The only practical information on the exact point when fermentation should be stoped, is the following, from the *Tea Cyclopædia*, p. 224 :—

"Rolled leaf is in a fit state for firing-off just as the original green colour is turning to pink."

Coming from Messrs. George Williamson & Co., this hint is no doubt a right one. But even then this is not definite enough. Every tea-house man knows that leaf that would make Pekoe and Broken Pekoe, ferments some time before the harder leaf. What is one to do in the latter case?

AD TAT.

DEAR SIR,—A simple and practical way to make *all* your leaf ferment evenly, is to sift it with a half-inch mesh sieve immediately after the final rolling, and it will be found that about 40 per cent. of ordinarily-rolled leaf will have fallen through. Put this into your fermenting trays, but in a separate line to the coarser leaf, which has not gone through the sieve, and when ready for opening out (which will vary from a quarter to three-quarters of an hour before the other) keep and dry it separate, as it will also take less time to dry than the other. One man can easily sift 12 mds. per hour, *i. e.* by having the sieve suspended from some support to enable him to use it somewhat after the motion or action of Jackson's Sifting-machine,

TEA HOUSE.

DEAR SIR,—I have found the easiest way to have the rolled leaf fermented rapidly is to have the table on which it ferments close by the fire. One must of course take care to cover the leaf well, as otherwise the leaf, on the surface, will slowly dry and become dark.

NATHANIEL.

FERMENTING MACHINES.

SIR,—In reply to an enquiry about a Fermenting Machine, I beg to state that we have had one in use here for the last two years. It was made on the factory, and has been found very beneficial, as in the Dehra Doon districts, owing to deficiency of sap in the leaf. and moisture in the atmosphere, the "roll" fails to colour properly. By its use the desired colour can be obtained at once without difficulty, at the same time both the pungency and aroma of the "out-turn" being considerably increased.

One of its advantages is, that by its means "roll" may be safely kept for at least six hours without heating or deteriorating in the least, but remaining perfectly sweet and fresh.

I may add that this process, in reality, does not cause the tea to *ferment* at all, but *oxidises* it, the chief agents being water and a powerful blast of cold air.

"ARBOR."

MANUFACTURE.—PART III.

FIRING.

The leaf, after having arrived at the proper state of fermentation, should be quickly fired and well dried, which process ought not to exceed one hour. There is no doubt that quick packing after manufacture tends to keep a rich aroma in the teas, which it very soon loses on exposure, even in a good Factory. In many Concerns it may be difficult to completely fire off the teas on the day of manufacture, but in all such cases they should be so far dried that there will be no danger of their getting so damp and soft as to risk the chance of sourness, which is apt to set in, if proper care is not taken.

The day's manufacture should be finished during daylight. With proper arrangements there should be no difficulty in doing this. Manufacture carried on at night is always inferior. Of course there are times when this cannot be avoided, but this should be exceptional.

The roll should be spread less than 1 inch thick on the trays, and half an hour should be taken for firing. The malty quality in tea is imported by brisk sharp firing. Teas should always have a final firing or hot sunning before packing.

The secrets of high-class Manufacture are multifarious; they consist in a most careful attention to every component part of the process, from the moment it commences till the time the tea is finally fired off. As regards, however, the duration of the process, and the temperature at which it should be done, this is a point which at this juncture deserves the attention of all planters, and is well worthy of full discussion. Since the introduction of machinery, there has undoubtedly been a tendency to too rapid firing at an extreme temperature. More recently, however, the more intelligent planters are reverting to slower firing at a lower temperature. The question, however, as between the two methods is a matter which is still *sub judice.*

About this operation there appear to be mistaken views. Tea must not be calcined. That is the whole secret. The leaf when in its withered state—properly withered, that is—contains most delicate chemical products, to be dealt with very differently from what on many Estates it now is. The process too prevalent is to "fire off" quickly, and such a process at the high temperatures now used really burns out its active principle.

Analytical experts declare that when the tea is properly dried, the tannin, or astringent principle of Tea, remains undisturbed. The aroma of the leaf is dependent on the careful application of heat at a certain maintained degree of temperature. Then, too, with a very high temperature the process of firing destroys the gum and the theine, leaving the almost charred woody product behind, which, when infused, gives such unsatisfactory results, and leads to so many complaints of quality.

It is to be feared that many planters follow precedent, and fail to understand why they do so. At home, manufacturers have definite reasons for every process,—reasons arrived at after a multiplicity of costly and extended experiments. A few more practical experiments with regard to Indian tea manufacture may lead to some far better results than any yet achieved, and we recommend the suggestion to the notice of our readers. There is no doubt machinery has gone a long way to cheapen Manufacture, but the Chemistry of Tea is, we imagine, scarcely understood as it should be.

PANNING.

The following are the views of two "fathers" of the Tea Enterprise, on the question of Panning :—

Panning was a dirty, troublesome, dangerous process, but it is quite possible we may have to return to a modified form of Panning, under which, by the assistance of mechanical appliances, the old disadvantages of the process may be overcome. In any case, I should very much like to see 50 maunds of tea manufactured under the panning system alongside of 50 maunds under the present system, sent home as a trial ; as, upon these, reports could be obtained which would do much to assist us in forming an initial opinion as to the desirability of further experiments in that direction. For myself, I think that many advantages resulted from panning, which we have lost by discontinuing the process.

Mr Haworth, the Inventor of one of the first Rolling-machines, is in favour of a return to "panning," but under an improved method, by which any risk of burning, from over heated pans, would be avoided. He thus sums up his idea of a perfect system of manufacturing :—Withering as at present ; a first light rolling; a partial panning ; *oxydize* ; then a full fermentation, final roll, and final fire. The object of a first partial panning is explained to be the getting rid of a portion of the moisture to begin with, so that at the final firing there would be less to evaporate ; but it seems to us that this partial firing would unduly check fermentation.

MANUFACTURE.—PART IV.

MISCELLANEOUS.

THE SCIENCE OF TEA PREPARATION.

Whenever the leaf is detached from the shoot, a difference of temperature is the immediate result. Water is given off in the form of vapour by evaporation, which causes a reduction of temperature in the leaf. In the process of rolling, the epidermis is broken up, and the substances forming the cell-walls of the cellular and vascular tissues are *mashed* up with the vegetable juices of the cells. Chemical decomposition of the organic structure at once takes place: oxygen is absorbed, and carbonic acid gas is given off, generating spontaneous heat amongst the particles of the mass. The rise in temperature increases, as the roll is squeezed together, and would go on until the spores of putrefactive fermentation became developed. This is prevented by breaking up the bulk at the proper moment, spreading out the leaf, and exposing it to atmospheric evaporation, which again reduces the temperature. What is now required is a vacuous atmosphere to promote speedy evaporation, for the greater the force of evaporation, the greater will be the degree of cold on the surface of the leaf. What I mean by a vacuous atmosphere is an atmosphere deprived of its own vapour.

The object in squeezing the leaf into balls is to suspend evaporation, and submit it to the influence of *sweating* caused by the absorption of oxygen and the expulsion of an equivalent volume of carbonic-acid gas. This removes the sourness of the leaf by changing a portion of the organic acids into glucose or grape-sugar. It may be called a process of insensible fermentation, although it is in reality simple oxidation. True fermentation is caused by the sporules or seeds of living bodies which always float about in the air, and, in entering into the mass of leaf, propagate themselves, and in the act of development cause putrefactive fermentation. If the air of the compartment in which the roll is made could be filtered before passing into it, these sporules would be prevented from entering, and the tea could be preserved for any length of time without the slightest chance of putrefaction. But, on breaking up the rolls, even although they should happen to be over-sweated, if the leaf could at once be exposed to vacuous air, the temperature would be so suddenly reduced by the force of evaporation that any germs of true fermentation which might have been propagated would be instantly killed.

In the process of rolling and sweating, or so-called fermentation, the leaf undergoes a state of oxidation, and becomes darker and darker in color the longer it is exposed to the air previous to firing. This discoloration is caused by the influence of the light and air acting upon the tannin or tannic acid of the leaf. Tannin, which is the astringent principle of the leaf, differs from the active principle—theine—in chemical composition: the former consists of carbon, hydrogen, and oxygen only, while the latter contains a large proportion of nitrogen in addition.

Tannin in a state of solution rapidly absorbs oxygen, and its astringency becomes weakened the longer it is exposed to the air by resolution into glucose and gallic acid. In the process of firing, the gallic acid is again split up into carbonic acid gas and pyrogallic acid, or what is termed *trihydroxyl benzene*. Tannic acid is also formed into pyrogallic acid when heated to 215 degrees Cent. The former has the property of forming a permanently black oxide with rust, or any *ferric* substance, and care should be taken that the leaf, from the time that it is picked until it has been fired, is never allowed to come into contact with iron, not even with the head of a nail in the rolling table, as it will leave a black mark on the leaf, which, after infusion, would make the out-turn present the appearance of the tea having been burnt in firing, though that should not be the case.

Tannin is very soluble in water, and in the process of infusion becomes completely dissolved, and should leave the out-turn of the leaf a uniform fresh copper-colour.

The secret of success in the manufacture of good tea, I think, lies in expedition —I mean in the processes of withering, rolling, and sweating; for if these are prolonged, the active principle—theine, consisting largely of nitrogen—volatilizes and flies off as ammonia gas. Strength, pungency, and flavor, can only be preserved by expediting these processes.

Rapid firing is, in my opinion, detrimental if the heat is obtained directly from fuel or from hot air as it commonly exists in the atmosphere, for the simple reason that the astringent principle is burnt out of it by being suddenly exposed to a temperature of 215 degrees, changing the tannin into pyrogallic acid ; and for the same reason I consider it is injurious to attempt firing more than two or three trays at a time, for the steam arising from the lower trays dissolves a portion of the tannin before it has become *fixed*, and, besides, the firing of each tray throughout cannot be accomplished under a uniform degree of temperature.

Speedy fermentation, or sweating of the leaf, depends upon a proper condition of the withering, and this depends upon the hygrometrical condition of the soil and of the atmosphere at the time the leaf is picked. In seasons of drought great attention should be paid to the withering process, for at that time there will be much less sap in the leaf, and less moisture to evaporate than would be the case during, or immediately after, rain. Consequently, if the leaf is over-withered, the juice becomes so thick by the time it is ready for fementation that it will not ferment properly, no matter what the condition of the atmosphere may be. If the rolling and fermenting operations could be conducted in chambers of dessicated atmospheric air, I do not think it would be necessary to wither leaf more than just enough to prevent it from breaking in rolling, but, until we have special compartments for withering leaf in dry atmospheric air, in wet or dry weather, it is impossible to lay down any precise rule for guidance. The best test can only at present be obtained from experience.

For the processes of withering and fermentation, thermometers placed in the tea-house, or anywhere, are of no practical use, for the degree of *thermal* heat indicated by them is no criterion of the general conditions of vapour heat, which exercises the greatest influence on these operations. With an apparatus to absorb moisture as quickly as it forms, every operation could be carried on with mathematical precision in any kind of weather, but common atmospheric air contains at all times from 50 to 70 per cent. of the quantity of vapour necessary to saturate it, and if this proportion does not exist within these limits, the atmosphere is either uncomfortably hot, or stewy.—*Correspondent, Ceylon Paper.*

Generally-admitted Facts with regard to the Manufacture of Tea.

1. Leaf is best withered when there is free supply of light and cool air.
2. Wet leaf is better withered in the sun or in the wind than by artificial heat.
3. Dried leaf is not necessarily withered leaf.
4. Under-withered leaf breaks in the roll.
5. Over-withered leaf gives most Pekoe tips.
6. Leaf withered in the sun gives red tea.
7. Under-withered leaf gives a green, and over-withered leaf, a dark, out-turn.
8. A bright-coppery out-turn can only be obtained from well-withered leaf.
9. Under-withered leaf will take longer to fire than well-withered leaf.
10. Low rolling-tables cause the leaf to get broken. Anything under 3 feet high is objectionable.
11. If sap comes too quickly in the roll, it shows that the leaf required more withering.
12. Too much sap makes a knobby tea, from the leaf getting into lumps.
13. Small leaf cannot be successfully separated from the large before rolling.
14. Heavy rolling destroys the flavour of the small leaf, but improves the strength of the large leaf.
15. Heavy rolling discolors the Pekoe tips.
16. Coarse leaf requires all the rolling it can get.
17. Contact with iron blackens the roll.
18. The roll will color in any temperature, be it higher than, equal to, or lower than, that of the tea-house.

19. In a higher temperature than that of the tea-house, the color comes quickly; in a lower temperature, much slower.

20. At some period of so-called "fermentation" the roll gets warm. In the present state of our knowledge there is no certainty whether to check or encourage that warmth.

21. The roll gets blackened by contact with the air, and colors more evenly covered up.

22. Coloring in balls is uneven. Roll spread out over three inches to color gets mawkish.

23. The fermentation proper cannot be brought about without heat. Teas coloured in a temperature below that of the tea-house are not "fermented" in the real sense of the word. "Oxidation" or "colouring" express the process more correctly.

24. There is no fixed time for colouring; the proper point is determined by the eye.

25. There is no chemical or other test in use to determine the point at which to stop the colouring.

26. The color of the roll immediately before brisk firing is about the color of the out-turn which will be found in the cup.

27. Pungency or rasp and a light liquor accompany a green out-turn.

28 Thickness and a dull liquor attend a good out-turn.

29. Over-coloring produces a soft tea.

30. Care given to the withering ensures good colour; care given to the roll ensures strength, but care will not ensure flavour.

31. In the present state of our knowledge, there is no method by which flavour can be fixed.

32. Leaf opens out during the colouring, and requires re-rolling.

33. Heavy re-rolling before firing softens the tea. A light pressure to excite a little moisture gives the twist and the polish required.

34. Drying in the sun gives a black and tippy tea.

35. Tea dried in the sun cups out with a metallic taste.

36. Colouring and softening go on rapidly over slow fires, and are checked by all-aglow fires.

37. Quick firing gives a brisker tea than slow firing.

38. The roll spread thick on firing-trays gets stewed and dull.

39. The roll has been spread too thickly when the fire cannot be seen through the contents of trays.

40. When three-quarter fired about half an hour, trays can be safely filled up four deep, and the curing finished over slow fires.

41. Choolas can be constructed to consume one maund of charcoal, or less, to one maund of tea.

42. Pucka-battying developes nose or aroma.

43. Drying in the sun before packing completely dessicates the tea, but gives it a peculiar flavour.

44. Bulking is better before than after pucka-battying, to ensure the teas being packed hot.

45. Iron-wire, brass-wire, or bamboo trays, are all good for firing, but the two former are better conductors of heat than the bamboo ones, and not liable to get out of mesh.

Causes from which the different Results of Manufacture arise.

Dark infusion.

From Over fermentation.
,, Burnt tea.
,, Draft of wind on roll while fermenting.
From Uneven and over-withering.
,, Compressing leaf in baskets.
,, Firing too slowly when fermented, &c. &c.

Thin liquor.

Fine pekoe.
Under-withering.
Too light rolling.
Under-fermentation.
Coarse leaf, &c. &c.

Darkness of liquor.

From too hard rolling.
,, good leaf and over-withering.
,, proper fermentation.
,, much broken tea, &c. &c.

Flat and soft.

From exposure to damp.
,, too slow firing.
,, bad bhánji leaf.
,, insufficient manipulation, &c.

Pungency.

From good leaf.
,, proper fermentation and hard rolling.
,, good withering and good leaf.
,, every stage of manufacture well performed.

Flavor.

Very even plucking.
Light rolling, and many others.

Much tip.

Over-withering.
Fine plucking.
Light rolling, &c. &c.
China leaf.

Black.

Under-fermentation and withering.
Careful sifting.
Quick firing,—especially machine-fired teas, &c.

Irregular.

Under-withering (insufficient).
Irregular leaf.
Much breaking-up in sifting or packing.
Bhánji leaves, &c. &c.

Curly.

Hand rolling.
China tea bushes.

Well twisted or open.

Depends upon withering.
Description of leaf.
Mode of firing.
And of course good careful rolling.

Showy, handsome, &c.

Under-fermentation.
Careful sifting.
Sifting the leaf before firing.
And many others.

Leafy and chaffy.

Much bhánji leaf.
Coarse leaf.
Insufficient withering.
Too much sifting, &c. &c.

Brown.

Over-withering.
,, fermentation, and others.

Common.

Much Red leaf.
Dusty, &c. &c.

—*A. Dowling and A. F. Bruce.*

JOTTINGS FROM A PLANTER'S NOTE-BOOK.

How to obtain Tip.—(I.) Silver Tip.—*Pluck* the tip separately, then spread out very thin on *dollahs* or mats, and *wither* as high as possible without allowing the tips to turn crisp or black. *Roll* with a very light hand, giving just sufficient "roll" for the gum to exude: in other words, for "the roll" to have a gummy feeling. *Ball* tightly. *Ferment* rather lightly. *Firing.*—If sun, break up the balls carefully, spread the tips very thin on *dollahs*, or zinc sheets (which are preferable), and after firing "twelve annas" in the sun, put over slow but brisk (glowing) fires. If no sun, break up balls carefully, and put very thin on *chalnies*, over bright but slow fires. When about "twelve annas" fired, double or treble the quantity of leaf on the chalnies for final firing off over glowing but slow fires.

(II.) Golden Tip.—*Plucking.* The best plan is to pluck the bud and Pekoe leaf in one, and half the Pekoe Souchong leaf along with it. The bud and two leaves may be plucked on one shoot, but this plan is not recommended. *Wither* high, but be careful not to allow the least redness. *Roll* as ordinarily, but not heavy : too much pressure is injurious. *Ball* tightly for twist. *Ferment* for rich bright salmon-colour.* *Fire* in the same way as for Silver Tip.

(III.) Orange Tip.—This is the dead-bronze-coloured tip obtained in the ordinary process of manufacture. No special instructions are required.

* Resembling somewhat the colour of new bronze before it has got tarnished.

To obtain Pungency, Aroma, and Flavour.—Spread the "roll" as thin as possible on the *chalnies* or drying-trays, so that the fires may always be seen *through* the "spread."* See that the fires are always brisk, glowing (live charcoal) fires, *before* you allow any *chalnies* to be placed on the *chulahs*. Make the *garbwallahs* (fire-men) keep *continually* turning over the leaf† every few minutes, to prevent burning or scorching. Allow the tea to dry over these fires till the leaf has thrown off *all* moisture, and begins to turn black. Then double two trays into one, over the same fires, and keep thereon till a black appearance is obtained, after which the tea may be put on three or four fingers thick, according to the amount of accommodation available, and put over slow but bright fires. Keep the tea over these fires until *thoroughly* fired, *i. e.*, until *all moisture is completely expelled*, and the tea is perfectly dry and crisp.

Some planters, just at the finish of the spring, cover the trays over with *dollahs*, in order to further retain the aroma, but this should not on any account be done till *all* the moisture is out of the tea.

How to Manufacture Green Tea.—The leaves, when plucked, are placed on open-work bamboo *chalnies* or trays, and placed in the sun until they become sufficiently flaccid or withered to allow of them being manipulated or rolled without breaking. After manipulation of about 2 to 3 minutes, the leaf is again put in the sun in the open trays as formerly for about 2 or 3 minutes, after which, when the leaves have become sufficiently heated, it is again rolled. The leaves are again placed in the sun, and rolled as formerly. This process is continued until the leaves are thoroughly rolled. When ready, they are placed in bags made of fine canvas or stout American drill of two feet in length and one foot in breadth, the mouths of which are firmly tied with cord. On each of these bags a cooly stands, supported by a pole or stick, and rolls them with his feet backwards or forwards, as the case may be As the leaves become compressed in a smaller space and the bags become slack, they are refastened and again rolled by the feet, until they become more compressed, when they are again fastened. This process is continued until the leaves cannot be compressed any more, and the bags become quite hard. The bags are then put by with the leaf in them (they must not be opened) on *changs* until the following morning, when they are opened and the leaf taken out and well separated to prevent its being in lumps. It is next put into an iron tea-pan (in small quantities) moderately heated by a charcoal fire underneath, and kept as near the same temperature as possible, and pressed and rubbed slowly against the pan by the hand ; this is continued until the leaves get quite crisp, as if they had been fired over the dholes or drums, when it is finally finished and ready for packing. Wood could be used in the place of charcoal for burning under the pan, but as it cannot be regulated so well as charcoal, the latter is used in preference, so as to keep an even temperature in the pan. The notion that a copper pan is requisite to give the tea a bright-green color is absurd, and has long since been condemned. The tea, after having been rubbed in the pan, will turn a very good pale-green color, and quite equal in strength and quantity, if properly rolled and manufactured, to any China variety ; and will possess one great advantage over China tea, in that it is not adulterated.

How to make Namoonah Tea.—To obtain a good sample of *Namoonah* tea, be very careful as to the leaf which is plucked, as only the finest leaf, say the first and second of the shoots, will make it ; if it is in any way hard, it will turn a dirty-greenish kind of open leaf, which cannot be made useful in any way, as in Black teas, but has to be thrown away, thereby curtailing any profit that may accrue, by the making of Namoonah, in comparison with the manufacture of Black Teas. After the leaf has been plucked, it is placed in open worked *chalnies* or trays, and allowed to remain until the following morning, when, if sufficiently flaccid to admit of manipulation, or rolling, it is placed in the pan and slightly roasted, or rather heated, and then rolled. It is then again put into the pan, treated similarly as above, and rolled very slightly.

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* A lazy or negligent fire-man should be turned out at once. No lazy or negligent men or women, in fact, should be allowed to work in a tea-house, as they are at the root of a lot of evil. We doubt whether the system adopted on some gardens, of putting weak and sickly coolies to tea-house work, is a wise one. In the long run it does *not pay*.

† This turning over the leaf must be kept on *continually*, every few minutes, *throughout* the whole process of firing. When turning over the leaf, see that the men always lift the *chalnies* off the *chulahs*. On no account should leaf ever be turned over when *on* the fires.

After rolling, the leaves are separated, so as to prevent the leaf being knotted together, and getting into little balls. After being separated, it is placed on *chalnies* and put over the *dholes* or drums, and fired off over charcoal fires,—by some at once, and by others three quarters, and finally finished the following day. The latter is thought to be the best method, as it prevents the Tea having a too acrid taste and giving it a horny appearance, which is preferred in the market instead of that greenish tinge which it otherwise would have if fired off at once. The same result would also occur if it was only panned once instead of twice, as many do.

Thin Liquor.—Thin liquor in tea arises from—

(1) Allowing the leaf to remain too long on the bush (especially on the *China* jât).

(2) Tea that has turned sour even in the slightest degree.

(3) Over-firing, from its changing the nature of the juices, or from the burnt flavour over-riding all the other qualities.

Tea made from hard, tough, leathery leaf, that will not roll, inevitably gives a weak thin liquor. As a rule, tea made from the fourth leaf gives a weak thin liquor.

To produce a *strong, highly flavoured* tea, it is essential that the leaf should be in a *still growing state* when it is picked, as it is then receiving a plentiful and rich supply of sap, charged with all the elements for producing a highly favoured, strong tea, which cannot be the case if the leaf is left on until matured.

Sour Tea.—Tea leaf in the rolled state while quite *cold and moist* can be kept in balls, in a heap, or loosely packed in boxes, for a period of hours depending on the hot or cold state of the weather at the time. As long as the leaf does not become *heated*, no tendency to sourness will take place. But if the leaf is in the least degree *warm and damp*, such treatment will cause it to become hotter, quick fermentation and decomposition will set in, and *sourness* will be the result.

A tendency to sourness is often engendered at an early stage, when the green leaf is brought packed tight in the plucking-baskets by the pluckers. This is a common occurrence, and often done by coolies for convenience of carriage when their baskets are of too small a size, and if a whole day's leaf is brought in at one time, from outlying gardens some distance from the Factory. Examine, therefore, all baskets carefully when brought in for weighment, throw away all leaf that has turned red, and punish all coolies who persist in cramming too much leaf into their baskets.

By packing leaf tight into a basket, spontaneous heat is generated, decomposition takes places, the leaf turns red, and eventually emits an offensive and foul smell. It is needless to say that tea made from such leaf is bound to be sour, and give a *thin* and *weak liquor*. Tea very frequently turns sour after the first firing. When there is a great press of leaf, and not sufficient firing accommodation, the leaf is given a slight firing, or is half fired, and is then laid aside *hot and damp*, either in heaps, or else in a thick layer on a table, or on *dollahs* or mats, to await final firing. It is sometimes kept like this for hours. Meanwhile fermentation continues, decomposition sets in, and the leaf turns sour. *Heat and moisture* engender *sourness*, and produce *sour* tea.

All *sour* tea may be traced to one or other of the following causes :—

(*i*)—Leaf too tightly packed into baskets.

(*ii*)—Allowing leaf when sufficiently withered to stand, instead of rolling off at once.

(*iii*)—Allowing leaf, when sufficiently fermented, to remain fermenting longer on account of insufficient accommodation, either by pressing into bags or baskets, or lying in heaps. Thus, want of accommodation, labour, and apparatus, is oftentimes a cause of sour tea. The only remedies in such case, are ample accommodation, sufficient labour, sufficient apparatus, and means for working off the leaf from the very first operation to the last, so as to allow the needful work to be got through with comfort and ease to all concerned.

TEA MANUFACTURE IN DEHRA DUN.

With your permission, I will offer to my fellow-planters in the Doon a description of a method of making Black tea, which I venture to think they will find it advantageons to follow.

I will not at present enter into an explanation of the reasoning which led me to take to this way, but give shortly the way itself.

First. Your leaf being withered, roll, but after rolling do *not* ball.

Take care of the rolled leaf—*nurse* it, keep it warm. Keep it away from the cold floor—keep it away from cold draughts. Wrap the rolled leaf in a good-sized heap in a *dry* blanket.

Put the bundle on the top of the choolas, in which in the early morning there is sure to be some remains of the past evening's fire. If there is not, you must light a little more, taking care to temper the heat so that it should be gentle.

The contents of the bundle will gradually turn to a fine rich-brown colour, with a warm, fragrant aroma.

When the largest flattest leaves have turned brown, or near it, (they change colour the last) then pan off sharp. *Pan well,* keeping the pan itself at a proper heat, of course. Pan till the tea smokes, and sends out its hot fragrance. Roll on the table again smartly. Now, if you have sun, out with the rolled leaf sharp as the next step, spreading it thinly.

And here, believe an old hand : if you *will* do off your tea *in the Doon* entirely over charcoal, you will, no matter how careful you are, be apt—almost *certain*—to give it an undesirable taste of the fire : even in the rains you will. Only do off entirely over charcoal when there is no sun.

When the tea is something more than half dried, sweep it up carefully, and roll it again, but lightly.

Then finish off over the gentlest, easiest charcoal heat.

This plan may not be perfect ; but it will give a " decent" tea—a tea with a fullish liquor ; not the ghost of a trace of the fire ; and a beautiful out-turn of infused leaf—bright, uniform.

If any one will tell me how to get a deeper colour *from China plant* in the cup, I will feel most grateful ; but I am afraid that this is not to be got in combination with the other essentials,—freedom from a "scorched" taste, fine out-turn, and nice liquor.

What we may be able to do from the Hybrid plant is still an unsolved matter, and years must elapse ere the question can be fully answered ; because we must wait to see how the course of time affects the plant in this climate, and the character of its produce, whether (granted always *good* cultivation) it will fall back to a mere China, or will always shew the Assam stain.

To revert to our Tea making : I offer this method, and can recommend it ; and I am glad to say that our agents in London have telegraphed out to me approval of a sample of tea made after this fashion.

F.

P. S.—Three words more.

1. One *must* have plenty of accommodation for withering leaf and firing off tea ; and plank floors for spreading out half-done tea in, are very suitable things—over the firing-rooms or places.

2. In future I shall wither the leaf as much as I can in chupper or thatched houses, and bamboo trays substantially bound in wooden frames, and ranged tier above tier in substantial rows of machans, arranged to admit the free play of the air about the leaf above and below (lattice-work walls of kutcha brick very good.)

3. I shall try the effect of plucking the leaf " a thought" young.

F.

MANUFACTURE OF GREEN TEA,

AS PRACTISED IN DEHRA DOON FOR THE CENTRAL ASIAN MARKET.

Manufacture can be commenced as soon as the leaf is plucked, but as it is more convenient to manufacture a day's plucking at once, the leaf plucked during the day is allowed to be all night in the leaf-shed, spread out from two to four inches deep, and is constantly turned over to prevent heating

The manufacturing process is as follows: A large iron *karai* or pan, 36″ in diameter by 12″ deep, is heated almost red-hot, and when ready is filled with green leaf, which is rapidly turned about to prevent burning, until it has become quite soft, and the mass reduced to about half its former size. This process takes about three minutes. It is then thrown on the rolling-table, and while the next panful is being prepared, is rolled by the tea-makers. As the leaf is perfectly soft and flaccid, the rolling is done in the same time as the panning takes. If there is any sun, the rolled leaf is then thinly spread out in it until it becomes a blackish green, and is very sticky to the touch; or if cloudy, is put in *chalnees* over charcoal fires until in the same condition. It is then put into smaller iron pans 25″ in diameter by 12″ deep, which are heated to such a degree that the hand cannot be kept on the iron. These pans are about half filled, and the leaf is kept turning over until it has become quite soft again, when it is again rolled. When the day's batch has all been rolled a second time, the small pans are filled to the brim, the heat being gradually lowered, and the leaf is cooked, being constantly turned about as before for about four hours, when it is almost dry to the touch. If a large quantity of the two classes of Gunpowder are required, it is then screwed up in bags, but this is not necessary nor indeed advisable at present, as the Gunpowders do not bring the same prices as Young Hyson and Hyson, a quantity of which classes become Gunpowder in the screwing. The tea may now be left for weeks in the bins before being classed and coloured; but we will suppose that the next process takes place next morning. The small pans should be heated to the extent of burning the hand if kept on the iron for a short time, and about half filled with the tea, which is worked rapidly from side to side until it assumes a light-greenish tint, which will take about an hour and-a-half. It should then be classed, fanned, and picked. Before being bagged for market, about the same quantity is put into the pans, heated to the same degree as before, and is again worked rapidly to and fro for about two hours, until it has assumed all the bloom it will take,—usually a whitish green; but if the leaf is hard and old when plucked, the colour will turn out yellow-green and will require colouring-matter, usually pounded soapstone. It is in this last panning that the colouring-matter is put in, but I believe the Europeans in this district do not use it unless requested to do so by the native buyers. It is easily detected by taking a handful of unadulterated tea, and breathing onit, when it will be found that as the damp dries off, the bloom will return, but will entirely disappear in adulterated tea. The tea is then packed hot in 200-lb. bags composed of an inner cloth and an outer gunny-bag, and is despatched in this state to market. In heating the pans, wood is always used, as it is quite as efficient as, and much cheaper than, charcoal.

TEA TASTING.

A correspondent of the *Tea Gazette* asks for information on the subject of Tea-tasting. Our correspondent has not expressed himself very clearly, but we surmise that the question he wishes answered is the following: is it necessary for a tea-taster to have the three senses—sight, taste, and smell, *jointly* exercised, to form a correct judgment; or, can he dispense with any one of them, as for instance sight, and yet arrive at a correct conclusion?

We are of opinion that a Tea-taster cannot do justice to his profession unless he possesses the three senses above mentioned unimpaired.

In valuing tea for the market, the chief characteristics which a tea-taster looks to, are—

(1) its liquor.
(2) „ infusion.
(3) „ leaf.
(4) any distinctive characteristics it may possess.

In deciding as to its intrinsic value, he has to consider the following qualities with regard to—

(*i*) its liquor : whether strong, rasping, pungent, brisk, flavoury, full, thick, malty, dark ; or, wanting in strength, dull, insipid, thin, burnt, soft, &c.

(*ii*) its infusion ; whether of bright or dull color ; or mixed with green, or any dark or burnt leaves ; over or under-fermented, &c.

(*iii*) its leaf : its make and appearance ; whether black, wiry, even, regular, good, well twisted, flaky, bold, tippy ; or grey, brown, dusty, little or badly open-twisted, irregular, wanting in tips, &c.

(*iv*) any distinctive characteristics it may possess : as *e. g.*, its "nose," *i. e.*, the character of its aroma ; whether of a strong rich scent, or musty, burnt, highly fired, dull, &c.

In testing the qualities of a tea, therefore, the mind exercises the following faculties :

(i) the taste. (iii) the sight.
(ii) „ sight. (iv) „ smell.

Thus the faculty of Sight bears an important part in the process of tea-tasting when valuing for the market.

Our correspondent perhaps thinks that by the sense of sight being used, the mind exercises a certain amount of prejudice, either in favour of, or against the tea—according to its make and appearance, before the sense of taste comes into play : in other words, before it is tasted. But this is an erroneous notion, as is well known by any planter of experience. Teas which would be condemned were they to be judged of and valued by their appearance, often fetch the best prices. If the liquor and infusion of tea are good, its appearance and make will in very few instances tell against it, or lower it in value ; if, however, in addition to the above good qualities it possesses a good appearance and make, the fact may increase its intrinsic value considerably. Thus the faculty of Sight, though in itself important when placed in comparison with that of Taste, holds a subordinate position.

To judge, therefore, of the real merits of a tea, and to enable one to arrive at its intrinsic value, it is essential that the three senses should be used *conjointly*. But, in addition, the senses of touch and hearing are also brought into play. A tea-taster as a rule, whenever the sample permits, takes up a portion of the tea he is tasting, to *feel* whether it is crisp ; and, moreover, generally puts his hand to his ear to *hear* whether it crackles when pressure is exerted. By so doing he is enabled to report whether the tea has been efficiently fired or not. A tea-taster, therefore, in order to be an adept at his work, requires the full and unimpaired use of all his *five* senses. None of the senses can be rightly used by themselves without the aid of the others ; each requires the help of the other in action, to enable one to form a true and correct judgment of the merits and value of a tea.

SECTION XIX.

SORTING AND BULKING.

Sorting.

Bulking.

Bulking in London and in India.

SORTING.

It is the custom in the London market to postpone the sale of Breaks under eight chests, eight half-chests, or twenty boxes, until the conclusion of the general sales, when the majority of buyers have already left the sale-room. In addition to this objection, the Trade have not the same facilities for obtaining samples of these "small breaks." We would therefore impress on managers, especially of small Gardens, the desirability of sorting into as few grades as possible. In our opinion four grades are sufficient, viz.,—One fine tea, two mediums, and one lower class, with, when necessary, an occasional Dust.

BULKING.

"An Old Planter" writes to the *Home and Colonial Mail*, protesting against the treatment which Indian Tea receives in London, at the Custom House, in the process of "bulking;" but really the origin of the evil lies at our own doors. The Trade at home do not desire to bulk where invoices of each kind are sufficiently large, and equal in quality; but where little peddling lots are sent home of classes quite unnecessarily multiplied, the man who is anything like a large buyer will not look at the lots unless they are turned out and "bulked." This process, in the damp climate of England, it need hardly be said, is fatal to Tea so treated, where, with fog and mist coming in at the windows and doors, the Tea turned out lies on the floor of the Warehouse perhaps for many hours.

The cause of this bulking at home, with all its concomitant evils, is because of the persistence of many Gardens here in sending home breaks of tea too small in quantity, and too numerously divided. Many say they cannot afford to wait till they have accumulated a large break of any one quality; but they had much better lose a little interest on their produce on this side than send it forward practically in retail lots, as is too often the case. Looking, like a fond parent, on one or two chests of really fine tea, sorted with every nicety, they say to themselves: how *can* we allow this choice lot to be mingled with its inferior brother? And so we often see an invoice of say 50 chests divided into five assortments, where perhaps, at the most, two would have been sufficient. The planter too often seems to think that the buyer of his Teas at home is the retail grocer, and he may, in this belief, study to meet his wants by offering small parcels. But the thing is a fallacy. The Tea-trade in London is controlled by large buyers, who will only deal with large lots of any particular kind. They have their travellers in all directions to create and foster dealings with retailers, and they must always be in possession of sufficiently large lots of particular kinds in order to keep up their trade with the retailer. The Tea they purchase at the mart, and vend to the retailer, must be as uniform in quality from time to time as possible. People at home who drink tea may not know the actual merit of the different kinds; but they know perfectly well what they are used to: and it is no use giving them to-day one thing, and to-morrow another; and it will not do for the wholesale merchant to say to the retailer, "We regret just now we are out of stock of that particular article, but we have some very fine orange pekoe—a small lot—which we will let you have at a slight rise of price, only, on a lower quality that we last supplied." The grocer, knowing his customers' tastes, says: "No. I want what my customers are used to, and have learned to like. They cannot be always forming new tastes."

Thus it is essential that the wholesale dealer, if he is to maintain a regular and steady trade with the retailer, should be able to supply the latter with goods of a fairly equal standard at all times. This he cannot do if planters, for fancied convenience and profit's sake, keep on disturbing the market with a multiplicity of varieties and qualities.

BULKING IN LONDON.

By the new Customs' Regulations for weighing nett, the old system of turning out and repacking each chest in London, by which the Tea was frequently injured, can be avoided when the Bulking has been effectively performed upon the Garden. We give these Regulations as published by the Tea Districts' Association, which must be strictly adhered to:—

1. The packages on arrival to be weighed to ascertain the gross weight of each package.
2. With each entry the importer to give an endorsement or statement of the nett contents of each package.
3. To test the accuracy of the endorsement of the nett contents, ten per cent. of each Break to be turned out and weighed nett, but in no case should less than three chests be turned out.
4. If the variation in weight of the test packages be found to exceed one lb., the whole parcel to be weighed out. When the averages of the packages weighed nett amount to so many pounds, and a half or more, the half or more will be charged as a full pound; when the fraction is less than half-a-pound, it is to be rejected and disregarded.

THE EAST AND WEST INDIA DOCK CO.'S NEW METHOD.

For several years Mr. Wm. Roberts (Managing Director of the Jorehaut Tea Company, Limited,) has been endeavouring to persuade one or other of the London Tea Warehouses to adopt machinery in place of the "DIRTY" manual system in vogue, and we append a Memorandum with a few rough notes he gave to Mr. Alex. Lawrie, who recently joined the Board of the East and West India Dock Company:

"The methods employed for bulking and refilling Indian teas in London have been always condemned as being "dirty," "inefficient," and "disgusting," and reform is urgently required to remedy those defects. Instead of emptying out the teas upon a dirty floor, shovelling it about in the effort to thoroughly mix the teas together, allowing the teas to come into contact with dirty boots and shoes, and then shovelling up the teas into the box again, it is suggested that a cleaner and more mechancial method might be devised and adopted. At present there are bulking-machines driven by hand, or machinery, capable of thoroughly bulking the contents of 15 chests. The teas are enclosed in a circular chamber, the leaf is not injured, the aroma is not dissipated: there is no dust, and great cleanliness, as the teas are not touched by the hand.

"It is suggested that a large machine constructed upon this principle, and capable of bulking the contents of say 50 chests, might be made, or might be modified and improved by some ingenious engineer.

"The objectionable, if not disgusting, method of pressing down the teas in the chests, when refilling, by workmen's feet, clad with dirty boots or shoes, ought to be at once done away with. But little pressure is required,—say the weight of a man of 12 stone: and a mechanical contrivance could be readily invented for pressing down the teas in the chests by means of lever presses, quick screw presses, or hydraulic presses. Everything, now-a-days, is done by machinery and not by manual power, and no difficulty would be found in improving the system of refilling teas into chests."

From the foregoing it will be seen that Mr. Roberts seized the weak points of the old system. It is most absurd that managers should be asked to carefully manipulate their tea, and that, on arrival at home, the contents of the chests should be subjected to such "dirty" treatment. We now learn that Mr. Lawrie procured the sanction of his colleagues to meet Mr. Roberts' suggestion, with the result that the first experiment has resulted with every promise of success ; machinery has been invented and is already now in use, enabling the warehouse operators to empty the chests direct into a revolving cylinder ; and after bulking, to refill the chests without exposure either to the atmosphere or to the "dirty" boot system.

BULKING IN INDIA.

As we have remarked elsewhere, careful Bulking at the Factory as a rule will save the Teas being turned out at home, and it were better to delay forwardals, so as to accumulate sufficiently large breaks of one amalgamated quality, than to send forward, as is so often the case, small quantities too much classified. The Trade will not look at these, and low bids are the result.

When the contents of each chest in a break are of uniform weight and quality, though the tares may be irregular, the concession made by her Majesty's Customs regarding the new system of weighing net has received the approval of the Trade ; but when Teas have to be bulked in London, the old method of taring is preferred.

Bulking at the Gardens, both in India and Ceylon, is becoming more general, and is very much in favour with the Trade when carefully done, as the tea keeps better, and is sent into the hands of retailers in a much more merchantable condition than if turned out in the London warehouses ; and what is often of importance, it can be got ready for sale with greater despatch after arrival, besides saving expense and loss in value,—sometimes pence per lb. on finest teas,—from the process to which it is subjected, to enable it to be catalogued as "bulked."

The necessity for bulking Teas in India becomes more manifest yearly, and as the matter is one which affects every branch of the Trade, it must be grappled with, if business is to be carried on in a manner commensurate with the importance of this branch of commerce.

In the case of teas sold in Calcutta, the need seems even more apparent than for direct shipments, as the samples on which the former are purchased cannot always represent the break if the teas have to be bulked on arrival in London. This is a matter which demands the serious consideration of Calcutta buyers, as it may partially account for the discrepancies between cost, and sale price in London.

SECTION XX.

TIMBERS FOR TEA BOXES, &C.

PART I.—AS TO INJURIOUS WOODS FOR TEA BOXES:—

INJURY TO TEA FROM THE USE OF IMPROPER WOODS FOR TEA BOXES.

MEMORANDUM BY DR. WATT.

CORRESPONDENCE ON THE SUBJECT.

PART II.—INDIAN TIMBERS:—

TIMBERS OF UPPER ASSAM.

INDIAN TIMBERS FOR GENERAL PURPOSES.

INDIAN TIMBERS FOR TEA BOXES.

CRYPTOMERIA JAPONICA AS A TIMBER FOR TEA BOXES.

SECTION XX.—PART I.

INJURY TO TEA FROM THE USE OF IMPROPER WOODS FOR TEA CHESTS.

An important case tried in London before Sir R. Phillimore, wherein certain Mincing Lane buyers proceeded against the owners of the *Asia* for damages in respect to a large quantity of Tea shipped in that vessel, has resulted in a verdict for the defendants. The case for the plaintiffs was, that owing to the foul state of the ship, or owing to the nature of the cargo she carried, the teas had become tainted, or impregnated with a flavour which rendered them unsaleable. After many days' hearing, during which experts were called on both sides (who, of course, as experts always do, gave directly contrary and conflicting scientific evidence), the judge held that the damage to the Tea had been caused *by the wood in which it had been packed.* It was found that the lead lining of the chests was coated thinly with white-lead, and the surface of the lead itself had become perforated as if it had been pricked all over with a needle. It was chemically demonstrated that this white-lead (carbonate of lead) was formed by the action of carbonic acid upon the sheet-lead, assisted by some volatile acid, which had been given off either from the wood of the chests, or from some adjoining packages ; but seeing that the chests were in perfect external condition, the inference necessarily becomes, that the state of the tea-lead was due to chemical action induced by an acidity in the wood enclosing the Tea. Further, the analysts said that the damage was greatly aggravated by the newness of the wood, which was in far too green a condition, and gave forth a strong aromatic smell.

Now, so long as toon and teak were plentiful in this country, we ran no risk of making our chests of undesirable woods, but of late years the use of other woods has been largely resorted to, and planks obtained from almost any *jât* of tree have been used locally on Gardens, for the manufacture of Tea-chests. Even assuming these woods possessed no tainting properties, there is one thing with which we are all unfortunately only too familiar, and that is, soft woods put together, as they too often are, in an almost green state, absorb a large amount of moisture ; and when the chests dry, they split up in a most undesirable manner. But this would be nothing compared to what we now find may happen by the use of improper woods,—that is, woods having any strong aromatic principle in them, and giving forth benzoic or any of the allied acids, which, becoming oxidized, are almost certain to produce such results as were found to have accrued in respect to the tea-cargo of the *Asia.*

Fortunately, it is not too late to sound a note of warning, for we have hitherto escaped the great danger of injury to our Teas through the use of what may be termed "poisonous woods;" but the fear is, that as wood becomes more and more scarce, other woods than those now in use (many of which are not in many respects at all desirable), may be selected, and a calamity such as occurred with the cargo of the *Asia* may take place, to the serious injury of tea-owners in this Country, and perhaps, also, to the reputation of Indian Tea itself.

DR. WATT, on special duty with the Revenue and Agricultural Department, Government of India, writes, that his views on the subject of Woods suitable for Tea Boxes are at variance with the popular outcry against our Indian Timbers as injuring Indian Teas. He says:—"It seems to me that the fault may not improbably rest, in some part, with the planter himself, or rather with some imperfection in the system adopted by him to cure his teas." This gentleman has evidently taken an interest in his subject, but we must be pardoned for differing considerably with some of his statements made. Perhaps Dr. Watt is not aware of the different processes through which Tea goes before it is ultimately packed. The tea being dessicated, and packed "hot," whereby anything like moisture is prevented from getting into it, we have no hesitation in saying that the fault does not lie at that stage. He states: "My opportunities of examining tea-chests, and of chemically working out the questions connected with the subject, have been too imperfect, and too limited, however, to authorize my doing more than to suggest that *it may be the tea itself which corrodes the metal, and not the wood.*" This is really a very bold suggestion, and an idea which is not borne out by actual experience. We ourselves have known tea which has been packed for 2 years, found, on opening, to be in perfect condition, and to have had no injurious effects on the lead-lining. It is possible, as the injury to the lead-lining is generally noticed in boxes which have been opened for sampling in Calcutta, that the Tea may have been exposed to a damp atmosphere, and a portion of it consequently been affected thereby; but this would only be in a small proportion. Then, again, when these teas are shipped, the intense heat of the "hold" of a ship might cause secondary fermentation, and act on the inside of the lead-lining; but even then it could be only to a minimum extent, which would not have any very material result on prices obtained. What we have, therefore, to deal with, is the chemical action of the wood on the lead-lining; and we are still of opinion, notwithstanding Dr. Watt's experiments to the contrary, that there are certain Woods which have a corrosive and damaging effect on the lead-lining.

Several cases of damage caused by improper wood for chests have come before the Trade, and no amount of care or trouble has been sufficient to effect a satisfactory sale of such teas. We believe the wood comes principally from Cachar or Sylhet, and we would advise great care in avoiding it, as it possesses a disagreeable smell; and when in contact with the lead, an acid is formed which eats through the latter, and so the Tea becomes tainted. The Break so damaged cannot generally be sold on a sale sample, as bulking will not make it run even, and the depreciation in value, when offered "With all Faults," is often as much as 20 per cent.

WOOD FOR TEA BOXES.

Memorandum by Dr. Watt.

My views on the subjects of Woods suitable for Tea Boxes are at variance with the popular outcry against our Indian Timbers as injuring Indian Teas. I may therefore be pardoned the liberty of briefly indicating the results of a few personal experiments.

1*st*.—It seems to me that the fault may not improbably rest in some part with the planter himself, or rather with some imperfection in the system adopted by him to cure his tea. The climate of India, and more particularly of Assam, in point of humidity is utterly unlike that of the Tea-districts of China. The introduction of machinery to lessen the expense of labour would seem to augment the climatic influences upon the manufactured article. The result of a few chemical experiments have led me to the conclusion that the Chinese tea differs from the Indian tea materially, and that this difference is the result in all probability of the system of preparing the tea, combined with the climatic condition under which the tea is prepared.

2*nd*.—I have been, through the kindness of one or two tea-merchants, permitted to inspect samples of tea, and also chests, in an injured condition, and I feel confident that more extensive experiments, and an extended inspection and chemical examination of injured tea and tea-chests would lead to a solution of the difficulty. I have observed the following curious facts:—

(*a.*) The tea may be completely destroyed, and yet upon the most careful scrutiny not a single opening can be detected in the lead. It is obvious that until the lead is corroded through or perforated, any injurious influence which the timber might exert upon the tea could not take place. If the lead-lining through carelessness be imperfectly soldered, then the tea might be injured by the wood; but this would be but a just punishment, and the planter would have himself to blame. I am confident, however, that this is rarely, if ever, the case.

(*b.*) I have on several occasions had the pleasure of inspecting lead said to have been corroded through the action of the wood. I have not seen a lead-lining completely perforated, but it is curious that the fact that the action seems to commence on the inside of the lead instead of on the outside, or on the surface in contact with the wood (the supposed acid influence which decomposes the metal), has not been apparently observed. This fact alone should have suggested a very different conclusion from that which generally prevails. My opportunity of examining tea-chests, and of chemically working out the questions connected with this subject, have been too imperfect and too limited, however, to authorize me doing more than to suggest that *it may be the Tea itself which corrodes the metal, and not the wood.*

(*c.*) In favour of this suggestion, I may mention that there are one or two double organic (chemical) compounds which are well known to chemists to have the power to act as acids to metals, and thereby produce salts, thus corroding metals. This fact, as an established principle of his art, is well known to the planter. It is some time now since the action of iron nails, screws, &c, was perceived by the planter to be injurious, and in his tables and machinery these are, by the experienced planter, carefully covered over or protected.

3rd.—While I am unable to establish the conclusions I have arrived at upon a definite and chemical basis, I think I have said enough to give a new turn to this enquiry. The fact is, tea-planting, including the out-door work, as well as the curing, at the present date seems to be in the same position as brewing was in Europe half a century ago. The process of fermentation and curing of tea is a purely chemical one, and it may be suggested that, instead of feeling, smelling, and judging entirely by colour, the planter might also employ scientific apparatus to determine for him when the process (in each stage) has been carried to the correct extent. It would seem at first sight quite impossible for the tea to get damp, presuming it to be carefully dried and carefully soldered down. Still, however, experience has shown that tea will get damp as at present exported, even when both these conditions have been carefully observed. This must be due to the humidity of the air enclosed within the lead-lining, establishing within the chest a renewal of the process of fermentation; and, when once this is established, it is not difficult to account for the corroding of the lead.

4th.—I had the opportunity, during the Calcutta International Exhibition, of inspecting some 200 tea-box woods from all parts of India. Mr. Manson, the Forest Officer in charge of these collections, performed, along with me, a large series of experiments. With four slabs of wood, between each pair of which a sheet of new lead was fastened, we tested the supposed action of the wood. One pair was unseasoned wood; the other the same wood, only seasoned. After damping the pairs, they were set aside for a time under circumstances intended to similate the effects of the hold of a ship. In many cases, such as the silk-cotton-tree (*shimul*), the wood was completely rotten; in others, firmly attached to the lead, through the growth of a fungus from the decomposition of the wood. Others, such as *toon* wood, seemed perfectly unaffected. In no instance was the lead found to be in ever so slight a degree chemically acted upon. These experiments I repeated once or twice after the close of the Exhibition, but failed utterly to discover any wood which seemed to possess the least chemical action upon lead.

5th.—That the wood is not the cause of the action seems still further indicated by the fact that in China, as in India, a large number of woods are used, and that there does not seem the slightest evidence, either in India or in China, that any of these woods has as yet been shown by experience to corrode the lead. If the question were merely one of flavour imparted to the Tea, one would expect the pine-wood used in China to stand first in this respect; but what is complained of is the chemical decomposition of the lead-lining, and the cause of this might easily enough be determined by chemical analysis of the Tea so destroyed, compared with a chemical examination of the fresh wood used for the boxes, and chemical experiments with the various actions upon lead of the compounds formed from the fermentation of tea. The presence of any active principle amongst the Tea which belonged to the wood would prove my explanation to be incorrect; while the establishment definitely of the peculiar compounds from Tea which possess the corroding power, would lay the foundation for a complete solution of the difficulty.

Sir,—A few words with reference to Dr. Watt's Memo. on Wood for Tea-boxes.

The statement that there is no wood (fit for tea-boxes) that possesses properties injurious to the lead-lining of tea-chests, may be dismissed without any comment, as any planter could mention several woods that would corrode the lead if unseasoned planks are used for tea-boxes.

I believe that if more care was taken to thoroughly fire the tea *before packing*, and in making the lead-linings air-tight, we would hear less about the inferiority of Indian teas. Very few planters pay much attention to these two very important matters. As a rule the final firing and packing is left to the Tea-house Sirdar, and *he* does not trouble himself much about closing holes in the lead if they are half an inch or less in size. Then, again, granting the planter or his assistant does personally attend to this, his care is often simply thrown away, as the chests must be opened in Calcutta, and very little if any attention is paid to careful closing after samples have been taken out. The lids are *fixed* on anyhow, and then the box is very carefully covered with a neat gunny wrapper, and then pitched into the hot and steamy hold of a ship. There is no necessity, then, to follow the adventures (which are many) of these chests after they leave India and until they reach the consumer's hands.

The manufacture of Tea as carried on at present—at least on paying gardens—is as simple and as perfect as could be expected, and is certainly far-away ahead and superior to the dirty practices of the "Heathen Chinee."

To prove that the real weakness of Indian Tea is in the packing, and not the manufacture, I am prepared to submit for the examination of any Committee of Planters or Agents several packages of ordinary Indian tea manufactured without any special care or attention, but packed under my personal supervision. One box was packed in June 1882, and the remainder in November of the same year, and I have no hesitation in saying that the contents of all will be found perfectly sound.

August 1st, 1884. AGENCY.

SIR,—Will you allow me a little space in your columns to give publication to the result of an experiment tried by me on wood used in the manufacture of tea-boxes. My attention was first drawn to the subject by an article in the *Indian Agriculturist*, dated 1st of March 1883, from which I learned that some pieces of a tea-box which had corroded the lining, and destroyed the tea, had been sent to India by Professor Dyer of Kew, to be identified. As this is a question of great importance to all interested in Tea, I determined to try an experiment with the different kinds of wood used by manufacturers in Silchar, and obtained from each work-shop two small boards of each kind, one seasoned and the other green. Between these boards I placed a piece of tea-lead, tied them together, and put them in an almirah. After two weeks they were opened and examined, with the result that the green board of the wild mango (*Mangifera Sylvatica*) had corroded the lead, the surface exposed to it presenting exactly the appearance described by Professor Dyer—*i. e.*, it was covered by a white coating of carbonate of lead. When held to the light, it presented the appearance of having been perforated with a pin. The surface in contact with the seasoned wood was untouched. From this, it seems pretty evident that the green mango-wood contains chemical properties injurious to tea-lead, which are either dissipated, or otherwise rendered harmless, by the process of seasoning. The other kinds of wood had no effect on the lead.

H. J. YOUNG,
Asst. Conservr. of Forests, Cachar Division.

CRYPTOMERIA JAPONICA AS A TIMBER FOR TEA BOXES.

Some eight years ago, Mr. Gammie sent us, from Darjiling, a quantity of seeds of this tree, but they did not succeed at Abbotsford, probably from loss of vitality in the long carriage and perhaps from want of knowledge how best to germinate the seeds. As the tree has been naturalized in the Darjiling hills, growing readily at elevations of 5,500 to 7,000 feet, we cannot doubt that it would succeed on the mountains of Ceylon. Provided the seeds are in good condition, they seem to be easily germinated. Our authority is Mr. Gamble, in whose valuable Manual the tree is ranked with the conifers, and specially with the cypresses. Such being the case, the terebinthine colour so strong in many of the true pines is probably absent from the timber. In any case, whatever odour there may be is dispelled by the artificial seasoning to which the wood is subjected by the sawing and box-making establishment in Japan. When we come to think of it, surely a prominent place in the romance of commerce must be found for the connection which Mr. Deane, of Kintyre estate, Maskeliya, has been the means of establishing between the enterprize of the tea-planters of Ceylon and the forest-wealth of the Far East of the Globe as utilized by the ingenuity and scientific appliances of men from that Far West which has been defined as "a little on this side of sunset." The Japanese call their country, again, "the land of the rising sun." Ceylon lies merely midway between the regions of sunrise and sunset, profiting by the resources of each. And let us not forget that, before the wonderful progress of steam navigation, and the competition which has so largely cheapened freight, we could not possibly be receiving tea-boxes, manufactured by American machinery from timber grown in Japan, at prices below those at which the locally-manufactured articles can be supplied. While not only timber suitable for tea-boxes and building purposes, but even firewood, is becoming scarce in Ceylon, let us be thankful that so large a proportion of the Japanese Archipelago is clothed with luxuriant forest, much of it close to the seashore. The gentleman who recently left Ceylon for Europe with the purpose of getting tea-boxes manufactured from the pines of Scandinavia, may find his plans affected by this sudden opening of imports of boxes in shooks from Yokohama, but as neither the forests of Northern Europe nor those of Eastern Asia are inexhaustible, it may be well for Ceylon tea-planters to devote some portions of their estates to the cultivation of trees which in the minimum of time will supply useful timber from their trunks, and firewood from their branches. Next to the Australian Blue-gum in Eucalypt rapidity of growth, and perhaps the superior of it in available timber, seems to be this Japan cypress (it grows also in China), which the botanists call *Cryptomeria Japonica*. Mr. Gamble describes it as of excessively rapid growth in Darjiling, where it is largely cultivated. He says it is a large tree of China and Japan, the seeds of which were originally brought to India by Mr. Fortune. It grows best at 3,000 to 6,000 feet, say 4,000 to 7,000 in Ceylon, and probably seeds could be more easily obtained from Japan than from Darjiling. It seeds abundantly, and the seedlings are, according to Mr. Gamble, very easily raised in boxes and sheltered beds. He describes the tree as brittle, the tops and branches being easily broken by high winds. Thickly planted, we should think the trees would shelter one another. We quote what follows from Mr. Gamble :—"Bark brown, fibrous, peeling off in narrow strips. Wood soft, white, with a brown, often almost black, heart-wood, very uniform, with narrow bands of darker and firmer tissue at the end of each annual ring. Medullary rays short, fine and very fine, and extremely numerous —*Ceylon Observer*.

SECTION XX.—PART II.

TIMBERS OF UPPER ASSAM.

It will be easily understood that in a Country where the temperature of the plains and low hills never falls below 45 degrees F., and never rises above 100 degrees F., with an average rainfall of 120 inches a year, vegetation cannot but be of the most luxuriant character and extreme variation. In fact, one of the characteristics of Upper Assam is its interminable jungles, constituted in places by thick forests of colossal trees, and in others by impenetrable cane or bamboo groves.

As a rule, cane jungle will grow in swampy ground where water lodges for several months, and sometimes all the year round. Bamboo jungle will grow in low lands flooded occasionally, where the water does not remain for any length of time. Forest jungle generally grows in dry soil, and one or other of any special tree seems to prevail according to the different altitude of the ground,—or perhaps it would be better to say, according to the different degrees of moisture retained by the soil. The prevalence, however, of any special tree is by no means strikingly apparent. In spite of favourable ground, and the gregarious tendency of nearly all forest trees, it seems that a great variety will grow and flourish side by side in a way which would seem quite incongruous in our own country. The only clear fact in these forests is the total absence of certain species of trees under peculiar circumstances. Thus *Nahor* and *Makahi*, as will be seen hereafter, are never found in lo w lands, especially if subject to occasional floods, while *Uriam* and *Hollock* are never found in hight well-drained lands. However, as a rule, one may stand in one of these forests, surrounded by trees growing as thickly as possible, and he will find it difficul, to detect half-a-dozen trees of one species. This fact considerably enhances the wild beauty of the Assam jungles ; but it has been, up to the present time, a great drawback, from a mercantile point of view, to the proper utilization of the timber. For the purpose of collecting one kind of timber, it necessitates going a great distance through untrodden jungle, and after having found and cut it to the smallest size, elephants are required for the purpose of dragging it off. This process, of course, causes a large portion to be wasted, which, under other circumstances, would be very valuable.

The Assam Railways and Trading Company, amongst other concessions obtained from the Government of India, have the monopoly of the timber-trade of 1½ miles along each side of their line, which runs from Makum Junction to Margherita (a distance of 23 miles), and the specimens on view at the Health Exhibition came from these forests, which extend, practically, uninterruptedly from end to end of the above-mentioned portion of the line.

When the Company first commenced work in opening out the country, little or nothing was known as to the real value of many of the timbers, and as the Company's works depended so much on them, they had to start at the beginning, and thus acquired an amount of information which will prove very valuable for the future of the Timber-trade of that country.

The following is a description of the various specimens exhibited :—

Mesua ferrea.—Assamese name, *Nahor ;* English, *Ironwood ;* specific gravity 1·23 ; co-efficient of rupture in cwt. and decimals, 27·9 ; loss of weight when chemically dried, 25 per cent. ; maximum shrinkage due to above operation, 8 per cent.

There are some good patches of almost exclusively *Nahor* trees to be found here and there growing on high, well-drained ground, but they are not extensive. The stem is generally straight, and the average size is from 25 feet from the foot to the first branch, by 5 feet girth ; maximum height found, 45 feet from foot to first branch ; maximum girth, 12 feet 6 inches. The branches are generally thin, and of no use as timber, but they produce excellent charcoal, and make first-class firewood.

The timber is of a deep-red colour, with very close undulating fibre, rather brittle, warps and splits when cut into planks or small scantlings ; heart-wood not attacked by insects of any kind ; and stands almost indefinitely, both exposed and under cover, without deteriorating. Before being used it should be stripped of all its sapwood ; and, thus prepared, forms an invaluable material for bridge-piles, beams, and thick scantling generally ; in fact, it serves almost as a substitute for cast-iron.

Artocarpus Chaplasha.—Assamese name, *Sam ;* English, *Monkey Jack ;* specific gravity, 0·63 ; co-efficient of rupture as above, 12·3 ; loss of weight in chemical drying, 32 per cent. ; maximum shrinkage due to above process, 5 per cent.

This tree does not seem to have a preference for any particular ground. It grows in low land with as much vigour as upon the hills. It is never found in patches, but is liberally scattered all through the jungles. The stem is seldom very straight, and branches off soon, sometimes at a few feet from the ground ; but the branches often produce good timber. It is of a bright-yellow colour when cut, and deepens into a brown-walnut colour in the course of time. The fibre grows pretty straight, not very close, breaks short, and receives easily a clean polish. It warps and splits very little. It stands well either exposed or under shelter, and insects will not attack it. It is a very useful timber for any purpose where great strength is not required, being specially adapted for household furniture, as it is equal or superior to teak for this purpose.

Bischoffia Javanica.—Assamese name *Uriam ;* English, *none ;* specific gravity, 1·04 ; co-efficient of rupture as above, 15·2 ; loss of weight in chemical drying, 24 per cent. ; maximum shrinkage due to above process, 10 per cent.

It grows abundantly, though never gregariously, along the banks of the rivers in the low plains, and perfectly where occasional floods cover the ground. It sometimes grows straight, but not generally so. Thick branches soon divide the stem, and yield useful timber. The girth of the stem varies very much, and the timber obtained from one of 4 feet girth seems to be as good as that obtained from a 12 feet girth (which size is not uncommon). The timber is of a dark cold red colour, the fibre straight and close, and hardly recognisable; it warps and cracks under shelter; and if the place is very dry, becomes very brittle. White ants will attack it. On the other hand, it is almost imperishable in wet ground or under water. This circumstance makes it particularly suited for pile foundations and railway sleepers; and for this latter purpose especially, we believe, considering the present prohibitory prices of other wooden sleepers in India, it will soon become very useful.

Terminalia Myriapteron.—Assamese name, ***Hullock;*** English, *unknown;* specific gravity, 1·06; co-efficient of rupture as above, 13·4; loss of weight in chemical drying, 35 per cent.; maximum shrinkage due to the above process, 2 per cent.

This tree grows under the same circumstances as the Uriam, and almost invariably where Uriam is to be found, Hullock is also found. It is not so abundant as the former, but grows to a much larger size, and shows a gregarious tendency here and there. Although branches are often to be seen starting a few feet from above the ground, it possesses generally a long stem, growing to a considerable height, and the branches yield good timber. It is frequently recognised by its towering above the surrounding trees. The stem also grows to a great thickness, 10 feet to 12 feet girth being the ordinary size, but one, on being measured, was found to be 21 feet girth. The timber of young trees is almost valueless, as not only is it greedily attacked by the carpenter-beetle and other insects, but soon deteriorates when exposed to the climate. On the contrary, the timber of the maturer trees is excellent for many purposes, straight-grained, pretty hard, of a brown colour, does not warp or split to any considerable extent, even when not seasoned, and stands well in and out of doors without deteriorating. Its only enemy is a kind of small borer, which is easily got rid of by planting it with crude petroleum or coal-tar. It is especially adapted for cheap furniture, windows, doors, railway-carriages, and generally for any work where accurate fitting is the main object.

Dipterocarpus Pilosus.—Assamese name, *Hollong;* English, *none.* No experiments have been made on this Timber. It grows in high, well-drained land, is not gregarious, but is pretty thickly scattered about. Its stem is very straight, and attains a very large size, averaging 8 feet girth and 60 feet to 50 feet from foot to the first branch. Instances of 18 feet girth by 90 feet to first branch are not unfrequent.

The timber is of a reddish-brown colour, close and pretty straight-grained. It does not warp or split much, but quickly deteriorates unless kept in a dry and ventilated place; is attacked by nearly all timber-insects. Thus, notwithstanding its large size, it is of little or no use, except for temporary purposes and for packing-boxes. It must, however, be borne in mind that in Assam this latter use forms a very important business, as not less than 400,000 boxes for packing Tea are used yearly, the making of each one requiring about 1·50 cubic feet of rough timber. A large quantity of such boxes are now imported from Calcutta, and the balance is made by hand-saw, and a few saw-mills, which are busily engaged exclusively in that trade all the year round.

Shorea Assamica.—Assamese name, *Makahi;* English *none;* specific gravity, 0·82; co-efficient of rupture in cwt. and decimals, 13·2; loss of weight in chemical drying, 36 per cent.; maximum shrinkage due to the above process, 5 per cent.

This tree deserves, for many reasons, more attention than any other. It is, for one thing, quite a new tree, so to speak. It was but a few years ago that Mr. G. Mann, the Conservator of Forests in Assam, took special notice of it, and studied and classified it with the devotion and care peculiar to all true naturalists. To the best of my knowledge, it grows exclusively along the hills on the south bank of the Dehing river, forming a belt which thins out and eventually disappears as it approaches the Patkoi range to the south, and the Jaipur (Assam) district to the west. How far it extends eastward I cannot say. Not one Makahi tree is to be found north of the Dehing river. It grows to various heights, and always in well-drained ground. Its gregarious tendency forms an exception to all other Assam trees: in some places the forest is almost exclusively constituted by Makahi trees, and in all cases it grows so thick that, were all the other trees to disappear, there would still remain good Makahi forest. Its stem grows perfectly straight to a height averaging 70 feet to the first branch, and a girth of 8 feet. It is not unfrequent to find some of 90 feet, or even 100 feet, to the first branch, and 12 to 14 feet girth. In the construction of some bridges I required fifty trees that should not measure less than 8 feet girth at 60 feet above the ground, and I found them all within a radius of a mile from Margherita. The timber is almost white when newly cut, but soon turns to a dark-yellow colour and brown, if exposed to the open air. Its grain is very straight and not very close, and warps and splits when quickly dried, but not otherwise. It soon rots away in the ground, or when subject to constant and abundant moisture, but stands very well under cover, or in the open air, as long as water cannot lodge in contact with it. White-ants and borers will attack it.

Notwithstanding the lasting qualities of this timber not being very superior, we consider that at no distant date Makahi is destined to represent an important item in the Timber-trade of India. We may incidentally mention that its liability to rot and to be eaten by insects can be disposed of by pickling, and that this pickling has proved to be very effective when done with crude petroleum, of which there are abundant springs belonging to the Assam Railway, right in the centre of these forests. But independently of that, a cheap Timber for General Purposes, to be used as common deal is used in England, has been entirely wanted up to the present in Assam and Bengal. Bamboo is often substituted, but as often as not this does not answer, and then the expensive Teak or Sâl is used. Makahi does not present the same difficulty as other Assam timber in felling and collecting ; it is easily worked, leaves little waste on the ground, and there is such a quantity as will supply the market for many years to come. Up to the present it has been practically unknown and inaccessible. This latter difficulty has been done away with by the opening of the railway from Dibrugurh to the Makum coalfields. The former will disappear as fast as the advantages of this Timber are recognised.

We will finally remark that, besides the trees above mentioned, there are at least a dozen more species equally good, though not so abundant. The great drawback of their growing so mixed is, in the case of the Assam Railway, removed to a great extent by the peculiar feature of its timber concession, owing to which the farthest tree has never to be dragged by elephants more than 1½ miles to reach the Railway.—*Timber Trades Journal.*

INDIAN TIMBERS FOR TEA BOXES & OTHER PURPOSES.*

In classifying Woods for practical purposes, we may omit their botanical relationships, and look on them solely in regard to their uses ; thus, some Woods may be specially suitable for special things, while others may be good for several.

Firstly, we may take those more suitable for outdoor work ; and in doing so, divide them into two groups,—those that are in the ground or water, as posts of houses and bridges, and those for upper-work.

For Outdoor-work, as Posts, &c.

The lists of Woods suitable and reliable under this heading are comparatively few ; extreme hardness and weight also are not, as some might suppose, essential. The lasting qualities appear to be due more to chemical or organic structure than to density : thus Saw, heart-wood, of old trees at least, (*Acacia stipularis*), is both extremely lasting and extremely light, and like the Maiphak, (name so far unknown botanically) appears due to a resin among the fibres of the wood, and which also, seems to protect them in some measure from the ravages of insects.

The Woods best suited for outdoor posts, &c., are—

Sâl, ...	...*Shorea robusta.*	Tita Sopa,	...*Michelia.*
Jack, ...	...*Artocarpus integrefolius.*	Korika Sopa.	
Nahor, ...	...*Mesua ferrea.*	Uriam,...	...*Audrachne trifolium.*
Ajar, ...	...*Lagerstræmia regina.*	Gahora.	
Gondserai.		Toi angoli jamok.	
Koroi, ...	...*Acacia.*	Sonaru,...	...*Cassia fistula.*
Gomari.		Amsia.	

No doubt a secondary List might be made up of such woods as Moj, Maipak, Paroli, &c., but the above are more reliable as bridge-posts, or house posts, most of which,

* This Series of Articles has been expressly written for us (I. T. G.) by Mr. S. E. Peal, of Assam.

while they often last well above, yet go, between wind and water, or near the surface of the ground. It is seldom that a post decays to the very foot, say at 5 feet below the surface ; decay usually occurs within a foot of the surface each way, and may be due to the presence of air and moisture, both at the one spot, inducing some form of oxidation.

Of the foregoing Trees undoubtedly *Sâl* stands the highest (for we have no Teak naturally), but it is not seen in Upper Assam, except in a few places, where it has been planted, and grows well. Like most of the harder woods, it sinks in water. At times the *Sâl* grows to a large size, as 10 or 12 feet in girth, at six feet from the ground, where it is usual to measure it, unless there are large roots standing out like buttresses. A clear shaft, also, of 50 feet to the first branch is not uncommon, but timbers of such a size are seldom needed, and very difficult to deal with. It may not be out of place here to say that trees should be rung or have a large ring of bark and sap-wood removed, near the ground, some months, or even years, before they are required. Failure to season the wood in this way often induces dry-rot. It is also better to season the stem standing, and before it is felled and cut up, as it is then much less liable to warp.

This rule of ringing timbers applies to all those having so-called heart-wood ; with softer wood it is not always possible : there are some that actually seem to rot ere they can dry.

Most of the woods in the above List are cross in grain, and difficult to work, requiring all tools to be both strong and sharp, the *Sopas* being the easiest, and straightest of grain.

Jack is seldom found, in the Plains at least, very straight. It is usually more or less curved, and with large branches comparatively low down ; and if grown for timber, these should be removed when young. There are said to be 2 or 3 kinds of Jack, but the difference in the woods is not very great. Jack is a good wood for the tables of rolling-machines, being tolerably tough and dense. It stands weathering out of doors better than many other woods on this List.

Nahor, if well grown, is a fine wood ; at times it is seen 10 to 12 feet in girth, and straight clean shaft for 45 and 50 feet. As a rule, in the Plains, the straighter ones are young, and the old ones more or less crooked. The forest, if properly studied, often yields information of a peculiar kind : thus, the above gives a clue to the density of population compared to what we see now. These large old and crooked-branching Nahors clearly indicate that, when young, the country (now forest,) was then open. They are often along the sides of old bunds, in dense forest, and evidently planted ; and from the seed, the surrounding Nahor forest has sprung up, and it is generally as straight as the old trees are the reverse. As a tree, the Nahor is very ornamental ; the young foliage, out in March, is a bright crimson, and the tree, in the open, a cone of foliage ; and later in the year, about May, the blossoms, out in profusion, are like large white wild-roses, often in bunches, and perfume the air all around. The immense bunch of stamens in each flower are a deep golden colour, and contrast beautifully with the large white petals. No wonder the tree was a favourite in old times. It was mainly on this account that it was planted about. As a wood, Nahor is hard and cross ; it is also fairly heavy, and the " heart" lasts well in the ground as posts, going for 16 to 20 years or so. For indoor and lighter work, Nahor is a very second-rate wood, on account of being comparatively difficult to work : there are so many much better. Its main use is for posts, in tea-estates at least, or where strength is needed.

Ajar (called in Cachar *Jarul*) has also a handsome purple blossom or spike of blossoms. It is at times a large tree, 8 and 9 feet in girth, and perhaps 40 to 50 in the shaft ; and, if in the open, is very handsome when in flower.

For lasting in the ground, or water, it has a reputation quite equal to Nahor ; and the heart, if large, can be relied on for 12 or 14 years. The wood is rather lighter and more easily worked than Nahor, which it somewhat resembles, in other characters of strength and toughness. It is a first-class useful wood.

Gondserai.—Gondhori, or Gondri, called by botanists " Cinnamomum Glanduliferum," is a fine tree and lasting wood, though a little cross. When fully grown it has a girth of 8 to 10 feet, and bole or shaft of 50 or 60 to the first branch. The bark is dark brown and rough, with longitudinal markings ; and when cut (like the wood), has a powerful aromatic smell. Chips of the heart-wood are often put by Assamese among their clothes. The leaf is about 4 to 6″ long, oblong and pointed, and has serrated edges ; young shoots having a reddish tinge. Like most other woods the sap-wood is light in color, and rapidly decays if exposed to weather ; the heart (which is not always strongly demarcated from the sap-wood) is of a neutral tint, inclining at times to be a grey purple, cross or involved grain, and not much diversified in markings. It is moderately hard and heavy—lasting well in the ground, and resisting more or less the attacks of white-ants. An instance has been seen where an old Gondri-post saved a Bungalow from total collapse during a great storm. when all the other posts had given way. Occasionally it is large enough to make 200 and 300-maund Canoes of; and I once travelled in a Gondri Dug-out for 3 weeks, that was 500 maunds. Standing on a floor a foot from the bottom, I conld barely see over the gunwales, that were 6′ 4″ apart, and it must have been an enormous tree.

The strong scent of Gondri would render it dangerons as a wood for tea-boxes, but it is not very common, and is scattered among the mixed plains, forests, and on the hills. It does not grow in dense patches like Sâl, Nahor, or Jutuli, which are gregarious.

Being rather scarce and durable, its main value is for posts of bridges, or houses, though it is useful for beams or girders, as it somewhat resists the attack of white-ants.

Koroi, (Albizzia odoratissima,") called *Moroi* in Cachar (I believe,) is a tree, or wood, that has a good reputation among Assamese, by whom in old times it was more or less " preserved." It seems to stand exposure well, and I have had a piece quite sound cut from an old log that lay on a Potar 16 years. Like many of its allies, the stem of Koroi is often inclined, forks frequently, and the branches are rather long. The stem is often 7 or 8 feet in girth, and 40 long, with a grey or drab-colored bark, and flaky ; outer thin coat brown, and the inner bark yellow.

The foliage is a series of small leaflets, in pairs, on a centre rib ; leaflets an inch long, oblong, and entire. The seeds in a very thin pod 6 or 8″ long × 1½ wide. As usual, the sap-wood will not stand long if it is exposed to weather ; the heart-wood, a dark brown or grey, has a fibrous involved texture, not hard or particularly heavy, unless the tree is very old. It is too irregularly seattered over the country to be very generally used, and does not grow in clumps gregariously—too valuable indeed to make boxes of, for which there are so many other common woods equally or more suitable. Its main use is for posts in bridges, or houses ; and for dark furniture it would be a good wood, not unlike walnut, though less figured in the grain.

Gomari, or *Gumaia* (" Gmelina Arborea,") has a reputation very similar to the foregoing,—a dark heart and light sap-wood. The tree is 6 to 8 feet in girth when fully grown; has a stem say 50 feet in the shaft ; the bark a dark grey or drab, lighter in colour when young, and slightly fibrous texture ; the leaf heart-shaped and pointed, 4″ long, of a bluish-green color, on a leafstalk 2 or 3″ long. The flowers come out ere the foliage appears, and often cover the ground around the foot of the tree : they are rich brown and bright yellow-color, something like a foxglove in shape, and handsome. The seed is a yellow berry, not unlike a cherry. The wood is often used for posts, or canoes, planks, drums, and furniture. Like most trees, its growth in the open is different to that in the forest. In the open it is shorter, and branches lower down. The flowers come out and fall off during March and April. It is very persistent in its efforts to grow from a stump or stool—remarkably so, and hence would be a valuable tree for renewal by coppicing.

Tita Sopa, Champa, or " Michelia champaca," is a fine tree, like most of its allies. The Sopas are, *Tita Sopa*, *Korika S.*, *Bor S.*, *Phul S.*, *Gowry S.*, and *Pan Sopa*. The last two have *no heart;* of the other four there is very little difference in size. They are all immense trees : if anything, the Bor S. is the largest. The value of their heart-wood is in the order in which they are named. The group is closely allied to and passes into the *Magnolias*, as it were, and the flowers are all powerfully perfumed. Those of the Phul Sopa are more or less terminal, 8 or 9″ across, like a large open water-lily, pure white; the petals 4″ long, thick, and more or less spoon-shaped. The seed of the Phul S. are in cases, on a cone 3 or 4″ long by 2, and the foliage, as in all the others, is more or less *bunched* at the ends of branchlets. The flower of the Bor S. is like the Phul S., but much smaller, seldom over 3 or $3\frac{1}{2}''$ across; the petals of a yellow white: the seeds are in cases, on a long curved stem, often 8 or 10'' long, and not in a cone. The flower of the Korika S. is almost the same as the above, but yellow, and the tree is known at once by the seeds being in cases on a 3'' or 4'' cone, from which *strong* curved spines arise, and remain on after the seed is shed. The dark rough fibrous or cracked bark, so like the Gowry Sopa, at once distinguishes it from the Tita, Bor, and Phul Sopas, with their grey and whitish bark, inclined to flake, and blotched with white and colored lichens, like mosaic,—on the branches especially.

The flower of the Gowry Sopa is extremely small. That of the Tita S. and Pan S. I have never seen; and there are, I believe, other Sopas, not here named, though not common or conspicuous.

The heart-wood of *Tita S.* is, when new, a dark-greenish color, large compared to the ring of white sap-wood, and it has an intense bitter taste: hence the name *Tita.* When dry, the wood is lighter in color, and turns more brown. It seems not unlikely that the lasting quality of this wood is due to a bitter deliquescent salt, that prevents rot. Old posts are often, on removal, found to be as wet inside as the day they were put in,—a natural hint how to preserve wood.

Both heart and sap-wood of the whole group of the *Sopas* is easy to work,—the seasoned heart-wood of Phul S. especially: few more so, as the grain is straight, fine, and even.

The heart-wood of *Korika S.* is also large compared to the ring of sap-wood, and its color darkish green—turning brown when dry. It is a fine timber for building purposes, and can be used not only for posts, but beams, flooring, and ridge-poles, wall-plates, or marolis, &c.; it is too valuable to use for boxes.

The heart-wood of Bor Sopa is very like Korika: so much so, that it is not easy to distinguish them. It is not so reliable in the ground, but in all other respects is equally good. Occasionally, Bor Sopas run so large that they would easily cut to 250 tea-chests from the one stem, even allowing liberally for waste; but such trees are actually too large to cut up profitably, unless near a large saw-frame. Towards the east of Assam this tree attains a height of 80 feet in the shaft and 150 to the crown, with a girth of 13 and 14 feet at 10 ft. up. One tree would suffice to floor a bungalow 60×40 with $1\frac{1}{4}''$ planks.

The heart-wood of Phul Sopa is small compared to the size of the ring of sap-wood, and like the others, is greenish while wet, but dries a pale brown or drab color. As before noted, it is a beautiful wood to work, but it does not last in the ground: hence this tree is more suitable for boxes and upper-work in a house.

The Gowry S. has no heart at all, and the woodis white, and not so easily sawn as the others. It is useless in the ground, but makes good planking.

Pan Sopa, that has a large leaf, has also no heart, and the wood is white and soft—not a common tree.

Noga Kat, called also "Noga-be," I see in Mr. Mann's list is called *Gugra* and *Makria.* This fine tree, which is now named *Schima Wallichi*, was formerly *Gordonia integrifolia.*

It belongs to the *Ternstromiaceæ*, to which Tea also belongs, and flowers about May. As a rule, this tree is tall and straight, with a bole 40 or 50 feet long by 8 or 10 feet in girth. The bark is very like Sâl, and is thick, dark, and deeply fissured longitudinally: inside, it is free from fibre, and pink. The sap-wood is pink, and not strongly demarcated from the heart, which is darker in color. The grain is even and close, and in general working qualities and color is very like Jutuli, (*Altingia excelsa.*) It is more lasting than the latter, though if exposed, or in the ground, I do not call it durable. For planking and upper-work of buildings it is very good. The flower is extremely like Tea in every way of form, size, and color. The seed-case is also a hard capsule, with an outer skin like tea-seed.

The leaf is from 4 and 6 inches long and $1\frac{1}{2}$ wide, lanceolate and entire, generally covered by fine down; and when young, they are pinkish and soft. If cut into planks the sap-wood should first be removed: even then, if the planks are wide, care should be taken to keep the ends moist, or shaded from the sun, or they will split.

If tools are sharp, it is a very nice wood to work—not too dry. It is rather heavy for boxes.

Paroli, (*Pareya* of Cachar, and *Paral* Hind.) is called *Stereospermum chelonoides*. This is a large deciduous tree that seems to be found more or less all over India and in Burmah. In Assam it is found with a tolerably long clean stem, say 40 to 50 feet, by 5 and 6 in girth. Though often straight in the main, it occasionally has a most provoking bend or two at the upper end. This peculiarity is continued, and often ludicrously intensified, in the branches and branchlets; so much so, that when destitute of foliage, it is a ready means of identifying it at a little distance.

The bark is dark neutral tint, granular in appearance, and also in structure, and $\frac{3}{8}$ to $\frac{1}{2}$ inch thick. The sap-wood is whitish, and becomes grey or drab-grey towards the centre, and is hard and heavy: when dry, it is tough and hard. It is said to last a little in the ground as a post, or if it is exposed; but I cannot vouch for this, and so far doubt its lasting long. It is too heavy for boxes, but good for beams, planks, and for furniture,—the branches for charcoal.

The flower (out in June) is nearly white, about an inch across, and not unlike a little geranium. The seed-case is a long sinuous pod, like a large worm; a foot or so long.

The foliage is remarkably like Ash. Five or seven leaflets, 2 to 4″ by $\frac{1}{2}$ or 2 broad, are entire and stalkless, having extremely long points, and are on a leaf-stalk; and when young, the foliage-shoots are often dark-purple.

Am, (Mangifera Indica), *Mango*, is a tree that seems pretty common now in all parts of the tropical world. Throughout Assam it seems to have been planted wherever we now see it. Occasionally it grows to a large size, 40 and 50 feet in the stem, by 10 in girth. In the open it has a short stem, and globular head of dense dark foliage. If among forest, it runs up, and has a long straight stem, with a total height of over 100 feet. The bark is generally a dark-grey, and unless when young, is rough, $\frac{1}{2}$ inch to $\frac{3}{4}$ inch thick. The wood when seasoned is grey, and has a coarse grain that is also rather cross, but not hard. It seasons and saws well, and is much used for box-making of sorts.

I do not think it can be the wood that was referred to some months ago as having caused corrosion to tea-lead and injury to tea. I have purposely cut out a block of fresh mango-wood, and splitting it in two, have enclosed a piece of ordinary tea sheet-lead, and tied the pieces together again. After 3 months the lead was quite unchanged, and the wood not discolored.

Bon Am, or Wild Mango, is also found in Assam. It is a taller tree, with foliage that is much the same as the preceding,—the leaves somewhat longer. as is the fruit, which has a curved point. The wood and bark are very similar, and the leaves, when rubbed, smell like Mango-leaves.

There is another tree in the forest here with leaves precisely similar, and that come out soft and purple, and hang down, but there is *no smell whatever*. I have never seen the seed of it, and so far can get no native name for it. I have never cut Bon Am, so can say nothing as to the wood, except from native report.

Tekeras—Of this Group, called Garcinia by botanists, we have several in Assam, as the—

Kan Tekera	...	...	*G. Lancefolia*,
Bor ,,	...	...	*G. Pedunculata*,
Kuji ,,	...	...	*G. Roxburghii*,
Rupoi ,,	...	...	*G. Purpurea*.

and in our Conservator of Forests' list I see also "Usaquang," *G. anomala*.

Of these it may be said generally that there is no distinct heart-wood, but throughout it is white, and moderately soft, with considerable power, and resisting cross strains, but has a tendency to split. The poles of young Kuji Tekera make fair kutcha marolis, (rafters and wall-plates).

None stand exposure for any time, nor are they good as posts. The leaves of all are bright-green and glossy, entire, and have not got conspicuous venation.

The fruit of Kan Tekera is of the size and color of black-currants. Bor Tekera has a large green globe, 4 or 5 inches diameter, with what looks like a small orange embedded in its centre, and is not unlike an orange in flavour.

Kuji Tekera has a deep orange, mango-shaped, fleshy fruit, 2 or 3 inches long.

Rupoi Tekera, which is a small tree, has a handsome scarlet fruit, 2 or 2½ inches in diameter. All these trees exude a bright-yellow sticky sap, and gamboge is made from others of the group. *G. anomala* I do not know, so far.

The peculiar tree called "Tepor tenga," belongs to this class, and is called *G. Xanthochymus.* Its long pendulous leaves and conical growth make it an ornamental feature in lawns or borders of roads.

Morhal, the Moal of Sylhet (Vatica lancefolia) is a tree that is found frequently near rivers, and belongs to the DIPTEROCARPI.

I have seldom seen this tree either large or straight, and apparently it branches low,—features quite the opposite of Dipterocarpi generally.

Mr. Gamble, I see, calls it "a large tree;" but so far, the largest I have seen was not more than 25 feet or so in the clean stem, by 4 feet six inches in girth; possibly it may exceed this in other parts of Assam.

The bark is smooth, even, thin, and grey in color, often blotched with large white lichens that lie quite flat. The sap-wood is white, and towards the centre the color is pink, the texture being remarkably close, even, and free from grain.

It is tolerably heavy, even when dry, and pleasant to work. The wood makes good planking, and excellent charcoal. A clear thin gum exudes, that I for long time took to be copal; when dry, it is quite hard and brittle. As it stands very near the *Vateria Indica* in Mr. Gamble's "Indian Timbers," which is the Indian copal-tree, they are possibly related. The leaf is lanceolate, entire, with short leafstalk. The flowers, yellow, white, and fragrant, are in open clusters on a stem; they are 5-petalled and like little shuttlecocks, or the winged seeds of Sâl. The fruit when ripe is yellow and globular, 1 inch across, with five enlarged sepals at base.

Bon Bogorí is a fairly large tree, that, so far, I cannot find the botanical name of. It is tall and fairly straight. Those I know of did not branch low down; stem 40 to 55 feet by 5 to 6 in girth; bark reddish, even, and thin; wood whitish-pink to red in centre, hard, even, close grain, and heavy.

The leaves are peculiar, being almost pure white underneath, and from 3 to 3½ in length; short leaf-stalk, and taper to a point: same shape and size as Nahor leaves, but not so dark, and not smooth above. The flower is very ornamental, has 5 white petals. The sepals of the calyx are long, and curve round into circles that are over an inch in diameter, and *interlace* in each other. The wood seems good for planks and beams, though rather heavy for boxes. It is possible that this Tree may be in Mr. Gamble's "Indian Timbers"

O. Tenga, (Hind *Chalta*; Beng. *Hargesa*, and *Phamsikol*), Lepcha, *Dillenia; Indica* is very common in Assam, as a large and evergreen tree, with a large and dark head of foliage. The bark is red, and comes off in thin scales; outer wood white, and inner is reddish, close grain, even and pretty hard,—rather heavy for boxes. It is not gregarious, but scattered alongsides of roads and rivers, and here and there in the forest. The leaves are about a foot long by 4 inches wide, very stiff, and strongly serrated, having large veins parallel and close. The seeds are inclosed in the thick sepals of the persistent calyx, and are an agreeable acid, and make a nice jelly. The petals are large and white, and soon fall off. It makes excellent charcoal, and is good for planks: especially good *under* water. The *Dillenia Pentagyna*, a variety that I have not seen, has leaves 3 and 4 feet long.

Uriam, or Joki as it seems called in Cachar, I see has had its botanical name changed since I made out my List some years ago, and is now *Bischoffia Javanica.* This tree, of which the Assam Rajas used sometimes to have their coffins made in old times, seems to grow almost equally well in high or low land, and is common on the flats near rivers. Assamese were, I am told, not allowed to cut it formerly. It attains a girth of some 6 or 8 feet, but the bole or shaft is not generally so long as the preceding trees, and runs 30 to 40 feet. It has a large and dense crown of rather dark foliage; the stem is seldom so straight as in the Sopas. The bark outside is very dark-brown, and rough, remarkably free from stains and lichens; the inner-bark is thick, fleshy, and pink, exuding red sap. The leaf is in three distinct lobes like a bramble, but larger, and dyes a yellow color. The seeds are in large open clusters of dark berries, the size of large peas, eaten by monkeys and natives.

The young leaf-shoots have a good reputation as a febrifuge, and are extremely bitter. Properly, this wood has no distinct heart strongly marked in conspicuous contrast with the sap-wood. It more generally gets denser and darker towards the centre gradually. When wet it is a deep red, and when dry is of a dull purple; pretty hard and heavy, though it will float. It is a more common tree than Nahor or Sopa, and is useful for posts, planks, canoes, &c., but too heavy for boxes, which need a *strong light wood* that is also tough.

Gahora, the Dalo Ujah of Cachar, *Premna speciosa* of botanists, is a useful tree for posts. It is peculiar in several respects: the stem is so very rarely straight, and so generally deeply grooved, that it is seldom sawn. When young, the central whip-like shoot seems particularly subject to curvature by creepers. The branches also are frequently broken off by storms, and hence the growth is very crooked; now and then a straight piece can be got pretty long, if grown in forest. There is no true heart-wood, but when old, the centre changes from yellow to brown. In any stage it lasts fairly well, partly due to its keeping wet; small posts of young trees often last 4 or 5 years until dry; old and large trees will go 10 and 12 or more. It is a fairly good tree to secure for the posts of lines, as it is pretty common, and will outlast thatch or walls, which is more than so many others will do. Large old Gahoras are good for bridge-posts, as they go so long in water. The bark is pale-drab color or whity-brown, and thin, with a flaky surface; the true bark is not shed apparently, and hence it is a great favourite with orchids of several kinds. The leaf is 4 to 5 inches by 2, pointed and serrated. The wood is yellow, and splits readily.

Toi Angoli Jamok, or Jamu, one of the *Eugenia*, is on the List, but it is seldom large and straight: when it is, and the young wood is removed, it lasts fairly. Small trees of it are good for posts of lines.

Bor Jamok, or Jamon, *Eugenia lancefolia*, is often a large tree, 6 or 8 feet in girth, and 30 feet in the bole. The heart of it lasts pretty well, but no more than half as long as Nahor, Gondri, or Ajar.

Sonaru or Bandolat, *Cassia Jistula*, is a fine wood for posts and other purposes, but in the plains is not common: near the hills it is more frequently seen, and is larger, though never a very large tree. The girth 4 to 6 feet, and 40 feet stem; the bark is grey, and the seed a long rod-like pod, a foot or 18 inches long by 1 in. thick. The blossom, however, is the most conspicuous feature,—a huge panicle of brilliant pale-yellow pea-shaped flowers, not unlike Laburnum, but ten times the size. The heart-wood is *heavy and dark, most durable*; but unfortunately the tree is rare, and not large. It grows readily from seed. Planted alternately with Nahor and Ajar, it helps to form a fine avenue.

Amsia is another wood almost equally good, and equally rare in the plains. The heart when young is bright greenish-yellow, and in a variety called *Amsilika* the heart is often a brilliant orange. Both last long, and in the hills Amsia is often used, and runs to a large size: the wood dark neutral-green. It is so seldom seen in the plains that it is hardly worth recording as an available wood.

So far this has been only a list of Timbers most useful for bridge and bungalow posts. In giving lists of Trees, it is better to have some system, or a Work of this kind is almost useless for reference. This first group, therefore, has been taken because the need for good wood posts is so common, and the timbers are so few, that they are easily picked out.

Many trees are almost peculiar to certain localities, and well known, perhaps, to but few. The next group of Trees, for many reasons, had better be confined to those useful for general purposes, and will include many of great size; a subsequent List to be devoted to box-timbers and one for charcoal-woods. A List founded on botanical bases would be of less value to a planter than one founded on *uses*.

In this 2nd series of timbers, large and small, that are good woods, and yet not fit to put in List No. 1, I had best place them in alphabetical order as far as possible; and I may here mention that since these Notes were begun, the importance of the question of good and bad box-woods has considerably increased.

The 3 samples of wood alluded to by Mr. Gamble were kindly forwarded to me by Mr. Mann, our Conservator of Forests. It is not easy to verify a tree from a sample 2″ square and $\frac{1}{4}$″ thick (more especially if neither bark nor leaf can be seen.) The sample No. 3 that has the bad reputation, and the lead attached to it as a white film, like paint, may be, as far as I can see, either mango, or wild mango, Moj-Poreng or Gondri, (Gondserai) ; these are all extremely alike, and if the wood had a strong aromatic smell when first sampled, I should say it was Gondri, and may tell you that I have had samples of Mango and Gondserai made, and lead attached, closely, between, and shall report the result as time goes on, or the moment I see anything to report. Ere closing this Notice I may tell your readers what no doubt many know—that there is far less danger from a dry seasoned wood than one wet or half dry, especially when heated in the hold of a ship. The quantity of moisture in a wet tea-box, or one of unseasoned wood, is also far more than most planters or agents would suppose, and in some cases it is exactly half the weight of the box. I append a case where a Simol-wood tea-box was weighed just as it was made up, and the same when quite dry—in 20 days.

November	6th	at	30	lbs.	November	15th	at	17	lbs.
,,	7th	,,	29	,,	,,	16th	,,	$16\frac{1}{2}$	,,
,,	8th	,,	$28\frac{1}{4}$	,,	,,	17th	,,	$16\frac{1}{4}$	,,
,,	9th	,,	$26\frac{1}{2}$	,,	,,	18th	,,	16	,,
,,	10th	,,	$24\frac{3}{4}$	,,	,,	19th	,,	16	,,
,,	11th	,,	23	,,	,,	20th	,,	15	,,
,,	12th	,,	$22\frac{1}{4}$	,,	,,	21st	,,	$14\frac{3}{4}$	,,
,,	13th	,,	$19\frac{3}{4}$	,,	,,	22nd	,,	$15\frac{3}{4}$	,,
,,	14th	,,	$18\frac{1}{4}$	,,	December	6th	,,	$15\frac{1}{2}$	,,

This should show those who insist on even tares, the utter impossibility of getting them unless the woods are quite dry ; and in the height of the Season the planter is often between two stools.

LIST OF TIMBERS USEFUL FOR GENERAL PURPOSES.*

Sahm, "Artocarpus chaplasha," is a really fine tree, and remarkably good wood for many purposes if not exposed to the weather, or put in the ground. At times it grows to a great size, 12 and 16 feet in girth, and 50 or 60 in the shaft, with a large rounded head of foliage rising another 50 feet.

Though found scattered all through the mixed plain-forests and along the foot of hills and lower ranges, it is not a gregarious tree, even though the seeds fall and germinate in thousands around the foot. The outer bark is dark brown, and rough ; the sap milky ; the seeds, as large as marbles, are embedded in an acid pulp-like jacket, and form an orange ball, when ripe, 4 or 5″ diameter. The fruit is greedily eaten by monkeys, and the seed is thus transported.

The leaf is 8 or 10″ long × 6″ wide : extremely rough and stiff. Sap-wood of Sahm is seldom of use, and clearly divided from the deep-yellow of the heart, which has a tolerably even and close grain, which, when dry, turns brown, and lighter, floating in water. This tree should, like many others, be seasoned standing by ringing, so as to prevent warping when cut and sawn. For planking, battens, girders, joists, and for marolis or wall-plates, it is excellent : also for doors and frames, or such-like work. It is good also for furniture, and when polished often shews nice, figured grain, like coarse satinwood. Large dug-out canoes are cut from Sahm ; and though at times used for posts, it is hardly safe, as it then frequently developes dry-rot near the foot : while the part above ground is quite sound, that below it can be pulled out in large pieces by the hand, all rotten.

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* Trees not fit to put in the ground as *posts*, yet fine timbers and large trees. Some would do for boxes, but as a rule not plentiful enough ; they constitute *the bulk* of the valuable timber trees of Eastern Bengal.—S. E. P.

Sahm would make excellent tea-boxes, but the wood is really too rare and too good to use for such a purpose.

Jutuli—"Attingia Excelsa," is another fine tree, with wood extremely suitable for certain purposes, and equally unsuitable for others.

As a rule Jutuli is a gregarious tree, *i. e.*, found in more or less dense patches, and is remarkably tall and straight. The girth is from 6 to 10 feet, and the height of the bole, or shaft, 50 to 60; while the crown is often over 140 feet from the ground. The bark is peculiar, inclined to flake off in large flat pieces, and of a chocolate color. If Jutuli is to be sawn, it should be cut when green, or not quite dry; the difference between the green wood and dry is remarkable. In the former state it is not at all difficult to cut, and has a close grain; when dry it is extremely hard, and difficult to either cut with edged tools or saws. But even when dry, this wood is heavy, and from its appearance likely to mislead as to durability. A large tree of it felled say this year, and left lying, will be quite useless as a rule, by next (if out of doors), and by the end of the 2nd year be all rotten,—probably clean gone in the 3rd; yet a forest of Jutuli is often quite a sight, from the beauty and size of the tall straight trees.

It is extremely good for planks, or work indoors in dry places, but too heavy for tea-boxes. The leaf is 3 to 4″, long by 1″ or 2″, and serrated like a tea-leaf. The seeds are small, and fall in March.

Poma ("Cedrela Toona").—This is a beautiful wood for many purposes, and is really worth preserving or propagating, as it seeds profusely, germinates easily, and grows rapidly. It often attains a great size, 8 or 9 feet in girth, and 40 or 45 in the stem to first branch, and is used for canoes. The bark is dark brown and scaly; sap-wood not very strongly divided from the heart, which is deep pink color, and has a strong cedar smell. The texture of the wood is rather open, like Honduras Mahogany, but is remarkably easy to work. When dry, it is light, and has a reddish hue; a particularly good wood for planking or boxes, if enough of it could be got: it is also good for doors and rough furniture. I do not know a better wood than Poma for planks for bungalows or godowns, if raised off the ground, and on wooden posts or joists.

When old and very dry, white-ants eat it as they do so many other of our woods, but it is not so greedily attacked as some of them. It is not more than two-thirds the weight of toon-boxes from Burma; and a different wood, strong, handsome, and light,—an A 1 wood. The foliage of Poma can be easily recognized, as there are some 12 to 20 leaflets in pairs on each side of a long centre rib; leaflets 3 or 4″ long, *not* serrated at the edges, and 1″ wide, with rather taper points. The seed has wings, and is contained in a pear-shaped case that splits open into five segments when ripe, and the wind blows the seed out.

Jamoks are a large Group, called "Eugenia" by botanists, and partly noticed among the post timbers. We have here in Assam seven kinds:

1. Bogi Jamok, *Eugenia jambolana.*
2. Bor Jamok, *E. lancifolia.*
3. Bhula Jamok, *E. magnifolia.*
4. Kotai Jamok.
5. Nahorpatia Jamok.
6. Bongali Jamok.
7. Toi angoli Jamok.

Of these the Bogi Jamok, or Jamon, is well known by the very white stem from which it derives its name. It is a fine tree, and the wood is extremely useful, though of very different quality to Poma.

Bogi Jamok is at times 8 to 9 feet in girth, and 40 high. I have measured one 13 feet round and 60 in the shaft, straight and round as a mast.

It often forks into two equal branches at an acute angle as V, and a capital sledge can be made from such a fork, if a strong piece is bolted across, like the letter A, the total length, say 12 or 16 feet. Such a sledge is far better than a low truck on small wheels, for transporting boilers, as it will go easily over holes that would bury the wheels.

This tree has peculiar bark, white and flaky on the surface and below it, another bright-green, and thin as paper; the inner bark, ¼ inch thick, is pink.

The wood is nearly the same, all through pink, and dries light brown. In texture it is somewhat like beech, even, fine grain and heavy, saws well, and is a good wood for girders, joists, planks, marolis, and such like. There is sore temptation always to use it for posts, but it hardly pays, as it will not last in the ground. It is too heavy for boxes, where lighter woods can be got plentifully. It makes excellent charcoal, like all the other Jamoks, especially for blacksmiths' work.

Bor Jamok (Eugenia lancifolia) is not a common Tree. It has a fruit like a Damson, and about as large. It is a superior wood, much like Boji Jamok, but rather harder. Bor Jamok grows to be 6 or 8 feet in girth, and at times 30 in the stem, branching very irregularly, and lower down than most of the preceding trees. The bark, an inch thick, is grey, and has *not got* the thin bright-green middle-bark of Boji Jamok. The leaf, oblong, 4 to 6″ long, pointed at both ends, 1 to 2″ wide, has a leaf-stalk $\frac{1}{2}$″, and the veins are small and close. The fruit is eaten, and makes a good dark-purple jam. A good use for Bor Jamok is to make blacksmiths' charcoal, as it stands a good deal of blowing.

Bhula Jamok, or Eugenia magnifolia, is not a large tree, 4 to 5 ft. girth, and 25 or 30 in stem. It is known by its very large leaf,—oblong, and about a foot long; the bark is white, and flakes somewhat. It is reputed to be softer than the other Jamoks, and in all other respects so like Boji Jamok that its description will do for this one.

Kotai Jamok is a smaller and very common Tree, seldom straight, and I should strongly urge Government to place it (with a few others) on a List to be posted in every namgurh and village as one the villagers can use without tax.

The Government insist on tea-planters posting a "schedule of work" in some conspicuous place in Tea-factories, to prevent the Bengali being *cheated*. It would be well if they could get the beam out of their own eyes, so as to see the oppression of villagers by smaller officials, as Police Mozadars and Jungli Darogas. It is simply scandalous, and Assamese can get no redress: mischievous sympathy for the Bengali and gross apathy for the Assamese,—that is the fact. A case has just occurred here where a poor devil of a villager has been told by the Police he must stop building his house till he pays Rs 54 for 9 sticks of the Kotai Jamok; and yet this tree is really not on the prohibited list. Villagers do not know it, as the Lists are not publicly posted, as they should be, in *every village*. This Kotai Jamok is common on all the odd heaps of waste land near and among Potars. It sprouts almost everywhere, does well for posts of small houses, and is not a fine timber-tree.

Nahor Patia Jamok, as its name implies, has the foliage remarkably like Nahor, not only as to form, size, and arrangement in pairs, but the very same bright-crimson of the young shoots and leaves. It is generally mistaken for Nahor by new-comers. The tree grows fairly straight, 3 to 5 feet girth, and 30 to 35 in stem; occasionally larger.

The wood is extremely like Boji Jamok in color and texture: is also excellent for charcoal.

Bongali Jamok is rather a contrast to the others,—seldom more than 3 feet round, even near the ground, where it generally forks, and hence has the appearance of being all branches. Even in the forest it does not always run up, but leans about, as though the crop of fruit weighed the branches down; said fruit is like a large damson or plum.

The flower is out in March, and like a puff-ball, 3 inches across,—a huge branch of stamens: the petals are 4, and sepals 4.

As a wood it is not much used, except for the *best* charcoal; and where for special work very superior wood-charcoal is required, the best is *Bongali Jamok*. Toi Angoli Jamok was noted among the trees fit for posts, in List No. 1.

Maiphak, is a rather fine Tree, and has peculiar qualities that make it especially suitable for certain purposes. So far, I believe it has not been named botanically.

Occasionally it grows 6 feet in girth, with a stem 40 feet, generally somewhat inclined, and not quite straight. The bark is greyish brown, and pretty even; sap-wood is pale yellow or white; and when the heart-wood is first cut (while wet), it is whitish-yellow, rapidly turning brown, or rich burnt-sienna color. If great care is not taken in felling this tree, the most unexpected result may follow, and, with a loud report, it splits right up. It is necessary to cut it almost through on the side to which it will fall, and, if possible, break that fall by some large saplings laid to receive the shock. When felled, the butt should have some foliage piled over, to shade it from the sun, and in cross-cutting it is best to cut in alternately from both sides, or it will split. If to be sawn, the sap-wood should be removed, and the planks taken off the outside first. I once started sawyers on a dressed log 16 feet that had the sap-wood left at the sides, and when the pit-saw had gone about 3 feet down the *centre*, there was a loud report, and the two halves of the log came tumbling down.

It is a specially good wood for shingles, as it can be split so easily; and one tree will often give 1,500 to 2,000, 18″ × 6″ × 1″. For shingling, the stem should have the sap-wood *nearly* all removed, and then be cross-cut into drums 18″ long. These can readily be split by a shingle-knife, and cost about Rs. 6 per thousand.

Assamese use this wood in looms, as it is both strong and very light; it is also not readily attacked by white-ants. It is almost unique as a very light wood that resists ants and dry-rot. I attribute the lasting immunity to a resin, or the dried sap. As it propagates easily and grows rapidly, it is specially suitable for growing on any reserved waste lands. The heart-wood when dry is as light as pine. The foliage is like that of Poma, but the leaves when bruised have a powerful aromatic smell, which at once distinguishes it. If the bark is pierced or cut, the sap exudes, and forms into *amber*-colored beads. It is rather too easily split to be good for tea-boxes, unless they were thick. I have seen a plank of it that lay for 2 years on the ground, under jungle; white-ants had nibbled at it, but did not seem to like it; there was no decay; and when dried again, the first shaving taken off by a plane shewed the clean sound wood at once. Singphos use it as a support under their chang floors, which is an argument in its favour. The seed is glittering black, and about the size of No. 1 shot: the seed case or lining has a most powerful aromatic smell.

The peculiar property of the sap, which evidently undergoes some rapid chemical change on exposure to air and light, which seems to enable the wood to withstand dry-rot and ants, points to this tree as one worth the attention of the Forest Department. It should not only be reserved, but, as far as practicable, grown in all forest reserves. It stands to become a valuable Timber in the future.

Mekai, "Shorea pennicellata," (a Dipterocarpus) is perhaps one of the largest and finest forest-trees in Eastern Bengal. I have measured them 13 ft. girth at 10 ft. up, where round, and 100 in the stems, clean and true as masts. The foliage forms a dense round head, that looks small in proportion. Leaves are from 6 to 8″ long by 3 or 4," and the veins are strong and regularly parallel. The bark is brown and rough, and the globular seed, of an inch diameter, has two large lobes, or wings, rising parallel from the end, and curving out. In falling, these act as blades of a screw, a rapid rotation opening them wider, so as to retard the fall. In this way the wind—that breaks them off so high up,—is able to blow them a considerable distance ere they reach the ground. Though found in the mixed plain-forests here and there, it is far more common near and on the lower hills, where it seems to be gregarious. Saplings of it, not a foot thick at the ground, are yet at times 50 ft. high, and seem to show that this tree gained its characteristics, in certain features at least, through being so drawn up in forests of its own kind, mainly. The great height and clean stem were evidently not differentiated in low, mixed forest.

A good sample of Mekai forest is a grand sight, with the leaf-canopy away up so high, and there being often so few small trees or foliage below. The enormous stems rise all around, and are easily seen. If anything, the tree is so large as to be unwieldy, and it is not felled for sawing. Of course, where they can be easily felled and taken out, the natives till recently dug them into canoes, and though it may sound barbarous to waste 5-6th of a stem in chips, there is some excuse when we see them decaying and falling naturally, through not being worked out ere their time is up.

Perhaps the most profitable use they could be put to is to cut up for tea-boxes, if only the requisite steam-machinery was near enough. A large Mekai tree, if all used up for tea-boxes, should give a profit-return of fully Rs. 200=350 boxes, 9,000 superficial feet ½ in stuff. It is a wood, also, that appears good for the purpose, if we judge by its planking, when dry.

The heart is a light brown or grey, and not very heavy, while also pretty strong. So far it is rarely felled or used, except for boats.

Sum, "Machilus odoratissimus," is one of the commonest and most characteristic trees in Assam, and thrives in a country that is only half out of water over large areas. It is the tree on which Mooga silkworms are reared, and is gregarious.

As a rule, it might be supposed that Sum was a rather small tree, but in suitable forest it is often found running 4 and 5 feet in girth and 30 in the bole. The tree is seldom *quite* straight, though not very crooked, and has a large heavy head of foliage. Bark is brown and rough, at times greyish. This tree seems particularly liable to be broken—stem and branches—by wind. It is a bad tree to have among Tea ; and a Garden that has been opened on Sumoni may expect fully 50 per cent. vacancies ere all the stems have rotted and the stumps died out. In clearings of the 2nd and 3rd year, each Sum-tree will generally be found to have killed ten tea-trees (on an average). As many as 40 vacancies and dead tea-bushes have been counted as due to one stem and its stump and roots.

But Sum makes uncommonly good tea-boxes,—a little heavy, but very tough ; it also makes excellent charcoal. Clearings for tea in Sumoni should be avoided ; and where a Sum is found, it is best at once to dig it clean out ; and burn stem, stump, and branches. The roots of Sum are a dense matted mass near the surface, and plants near have small chance in competition, when it is alive. Its injurious qualities for Tea, however, are greatest after its death ; and an old Sum-log lying in a row of Tea has killed every one of the tea-trees near it in the row, covering the roots with a dark rough crust, evidently a disease of the root-bark. Dead Modar (*Erythrina Indika*) at times causes the same disease and death.

Hingor, "Castanopsis," is a very common tree in Assam and the countries around. There are several species,—*C. Rufescens*, *C. Indika*, *C. Argenti*, and *C. Tribuloides*, one that causes great tribulation to those going bare-footed over the spined seeds. When travelling east and west of Daphapani in the Singphu country, in January 1882, my party had 3 days of it on them. After the first day of these Hingory-seeds, every soul in the party made knowing sandals, and started next morning jubilant (for the first mile or so)—sandals of simol bark, thick and tough, sandals of flat creepers, sandals of spilt wood,—quite an exhibition.

At last! first one, then another, catching his toe in a root, went sprawling, "nose, knuckles, and knees," all full of the thorns—enjoyment for those who had not so far "gone a cropper ;" but at last all the sandals had departed with a whiz through the air, followed by vernacular curses, and they all hobbled on like a string of cripples.

C. Rufescens has the young foliage reddish, and the seed-case densely covered with fine needles : the leaf, $5'' \times 2,''$ is also serrated, and the veins shew strongly on the back : (leaf-stalk in all, short.)

C. Tribuloides has a seed-case covered by sharp, strong, and thick spines; leaf 4 to $5 \times 1\frac{1}{4}$ or $1\frac{1}{2}''$, *not* serrated. Seed of Echinocarpus tilliaceous, or Phul hingory, is also covered with needle-spines, and the whole Group allied to the oaks and chestnuts have wood more or less like oak. They run to 6 feet in girth, with a clean shaft for about 30 to 40ft. tolerably straight, and then generally at once fork into large branches. The bark is somewhat fibrous, dark grey outside, and $\frac{1}{4}$ to $\frac{3}{4}$ in. thick. The wood towards the centre gets dark and hard, with strong smell of Tannin ; and in old trees the heart often decays first, and leaves a hollow. When clearing, once, where there were many Hingorys, I fired the felled jungle, and burnt all by evening, but about midnight we were roused by a dull roaring, and on going out, a huge column of sparks was shooting up from the top of a large dead Hingory, fully 200 ft. high, as though out of a tall chimney, and no fire seen below,—the whole forest wonderfully lit up for a long way round. On getting close, we found a hole at the foot where the air entered, and the fire had got to the powdery inside, and resulted in a huge "firework." As a rule Hingory will stand as a post 3 years, but is so second-rate that I have not put it among the trees fit for posts. It makes excellent planking, not good boxes, and execrable charcoal, splitting up into thin flakes and powder. It is bad in Tea, and dwarfs the growth of all the bushes around or under it.

Hirih, or Siris, is one of a Group alluded to before as allied to Roroi [Acacias]. Moj and Saw, also Medelloa, are others of the group—peculiar in foliage, seed, growth, and qualities. The heart-woods of Koroi, Saw, Hirih, and Moj, are remarkably alike both in appearance and quality.

Hirih generally grows tall, has a clean shaft, and forks. The branches rather long and thin—a character carried out even to the branchlets, giving the tree an open growth. It is easily known by its very peculiar bark, pale grey and covered with *horizontal* markings. If rubbed hard by the hand, or a stick, the outer flakes of grey come off, and shew a *cork-like* structure and color, quite unlike any other tree. The inner bark is $\frac{1}{4}$ in. thick, and fibrous ; sap-wood white, 2 or 3 in thick ; and the heart natural-brown color, that turns grey-brown when dry. The wood is conspicuously fibrous and strong. I once had a tall tree of it close to my house, towards the north-west side, and dreading the well-known " Nor-westers," often asked Assamese if I had better not cut it down, as it would have collapsed the whole house if it fell. They invariably told me it would never snap off, though so tall and exposed, nor the branches break. It weathered several bad storms that snapped the Soom-trees near, like carrots.

I should say that for girders, and work where there is great cross strain, this wood is particularly good. The foliage is a number of small leaflets, in pairs each side of a midrib : the seed in a flat pod. It is said to last well in the ground, *i. e.* good for 6 or 7 years, probably.

Saw, "Acacia stipularis," is very like the preceding in general appearance, though forking more regularly into 2 and 2. The leaflets of Saw are also very small. It has its name from the large crimson stipules or sheaths at the foot of the leaf-stalks ; when young and soft, these bend over. Elephants are passionately fond of these shoots, and the most nervous kutcha-trained elephant will eventually get quite spoony on any-one who habitually feeds it with Saw-shoots.

The contrast between the sap and heart-wood of this tree is quite remarkable. Saplings, or young saw-trees, are the rottenest wood I know, yet the heart of mature ones lasts for many years, exposed to all weathers. In 1881 I took a small sample from an " old log" that I found in making clearances in 1865. I have seen several cases like it. The heart-wood is also as light as it is lasting, and a Dug-out " Rob Roy" of it, 12 feet × 22, weighed only 22 ℔s., and lasted me many years.

If used *under water* it is said to last for ever! and this is singular, considering that it is one of the lightest woods we know. The color and grain is not unlike rosewood, which is particularly heavy. It generally astonishes those who see it, especially if the plank is mislaid for a year. It will be found curled up in all directions, with a surface like a door-mat.

Moj (Inga Bigemena) —This is a fine Tree, and at times attains a girth of 6 feet, with a bole or shaft 40 or 45 feet, not always straight or upright: nevertheless, it is a useful wood for many purposes. It lasts in the ground somewhat better than the Jamoks, probably: so is occasionally used as a post

The heart-wood is a dark brown, and turns lighter as it dries ; it is very strongly and abruptly divided from the white sap-wood.

In general appearance and style of growth, Moj is somewhat like Koroi and Hirih; the heart-wood also is much the same in grain and quality, and the most conspicuous difference is in the bark and foliage, the latter especially. The bark is even, greyish, and has no tendency to flake, nor has it the horizontal markings of Hirih. The disk-like seeds, $\frac{3}{8}$ inch across, are in a flat pod 6 or 8 inches long × 1 inch wide.

The foliage has generally five leaflets, 2 or 3 inches long × 1 or $1\frac{1}{2}$ inch wide, entire, and pointed, on a leafstalk ; these latter often fork, and have a peculiar little wart, or gland, near the insertion where the stem joins the branch.

The flowers (out in June) are like small tufts of cotton, and not conspicuous. As a wood it is good for planking, battens, steps, &c. ; but, like the Acacias, it is not easy to work, unless tools are in *beautiful* order.

Medeloa (Acacia elata).—This Tree grows very like its allies—Koroi and Hirih; has the same open head, long thin branches, seldom straight, and has a tendency to fork low down. It has no heart-wood, and seems of the same white color and even texture all through. The bark is drab or grey color, and rough, inclined to flake at $\frac{1}{6}$th inch:

it lies in layers like brown paper, and is a total of $\frac{1}{4}$ of an inch thick. The young foliage (out in May—June) is at first very pale green, and turns to a deep blue-green. The leaflets, 2 inches by 1 inch oval, and not pointed, are entire, *i. e.*, not serrated at the edge, and are set alternately right and left on the leafstalk, which in *young* shoots has two stipules or sheaths $\frac{1}{2}$ inch long. The pods are 3 or 4 inches by 1 inch, and thin. It is a good wood for boxes and charcoal ; but being so like, and so closely allied to, the foregoing trees, I place it here for more ready comparison. It also makes good planking, I believe.

Hulong (Dipterocarpus Baudii).—This Tree, from its size, straightness, and freedom from branches, should rank as an important one. I must confess to knowing very little about its qualities as a wood. I see it called "inferior" in our Conservator's List.

It is seldom seen in the plains, and is more generally found on the skirts of the hills and among the lower ranges, where it occasionally attains a height of some 70 or 80 feet in the bole, with a girth of 10 or 12. As a rule it is remarkably upright and straight, with a bare shaft ; the foliage all in a dense rounded head, that often looks small compared to the size of the trunk.

Like Mekai, to which it is closely related, Hulong grows more or less in patches; the seed and leaf are also like those of Mekai, already described.

As far as I can ascertain, it makes good charcoal, and would be good for planks, joists, and upper sawn-work of houses. From the name, one would suppose that it was at one time largely used for canoes, and occasionally boats of it are seen, but the large trees of it, where near rivers, have all been felled and carried off.

It should be a good wood to saw, and valuable for boxes ; a fairly large tree would probably give 200 tea-chests.

Hilika or *Hurtuki* (Terminalia Citrina).—This is one of a group of 4 or 5 large trees that are fairly common in Assam, as far as I can see, as follows:—

1 Hilika, or Hortuki—*Terminalia citrina*
2 Hilika ... —*Terminalia tomentosa.*
3 Holoh, or Jhalna—*Terminalia bicolorata.*
4 Bhumra, or Boñora—*T. Belerica* (I believe.)
5 Urjan ... —*T. Arjuna.*

In most of these the sap is very astringent, with a large amount of tannin in the bark and seeds. The dried fruit of *T. belerica* are sent home for tanning leather, as myrobolams.

Nos. 1 and 2 are occasionally large trees, 40 and 50 feet in the bole and 6 in girth, fairly straight ; but the main stem in all, except No. 4, generally breaks up in the head into large branches.

Trees may be roughly classed, as to growth, into

A. Those with long clean stems crowned by a small head, as Sotiana, Alstonia, Scholaris ; or Mekai—Shorea penicellata.

B. Those with central stem right through, and lateral branches lower, as Nahor, Mesua ferrea, Roughu, Nauclea cadamba, Simol, &c.

C. Those having a clean stem that ends at base of the crown, and at about half the total height, as Sahm, Artocarpus, Sopas, Michelia, Hingory, &c.

D. Those, lastly, with little or no main stem, or that often fork low down, as Carya arborea, Falah, Amluki, Phyllianthus emblika, &c.

Holoh or *Jhalna* (T. Bicolorata).—This Tree, found in the mixed plain-forests, is also seen often near rivers, and generally exceeds the others in size : hence is used for canoes. It is a fairly good wood for all general purposes, and buildings, if not put in the ground.

Bhumra, or *Bohora* (T. belerica) is generally very straight and clear in the stem; often branches somewhat radially like Simol. It is found 50 to 60 feet in the bole by 5 and 6 in girth, and is a tall tree ; the bark drab-color, inclined to flake (like Gohora, Premna hir). The leaf is 4 to 5 inches by 2, not unlike Tea, but *not serrated;* and the flowers, small and in dense branches, emit the most horrible smell.

One good sniff at the flowers of Bhumra will fix this tree for ever in the memory of the most forgetful !

Urjan (T. Arjuna)—I see planted along the roadsides near the station of Sibsagar; it is also in Lower Assam. It seems to fork low, and has a bark like a Jar or Jarul ; and this is all I know of it.

I have received a copy of Mr. Gamble's fine Work on "Indian Timbers," and in looking over it am surprised to see how very difficult it is to identify many of our Trees from the description. This is partly due to the fact, that, in many cases, the local, or at least Assam names are not given ; in some cases, also, there is no description of the seed, flower, or leaves.

The rings, pores, and medullary rays, are usually very fully described, but it would hardly do for your planter readers to cut the tree down to find out what it is.

We need outward and visible signs, and easy external means, of identifying our Trees, and that will stand good more or less all the year round. For instance, at one time of year there is the flower, later on the fruit and seed. If these are taken together with the foliage and the bark, added to the general aspect, one need not be very far wrong.

As an instance I may mention the group of Sopas (or Michelia), of which I find five in the Book—not one of which can I recognize with certainty, as the seed-cone or spike is not mentioned in any, and it is the best and safest guide to go by in this Group. Also we have probably 9, and possibly 12 Sopas ; so, many are omitted. I understand Mr. Gamble will consider these matters in future Editions, and really the space to slightly describe the seed, flower, and leaf, need not be very great. I had purposely refrained from writing until I had looked into the Book. But I will now go on, and do my best.

There is a group of fine Trees allied to the Cedrela or Toon, and the Mahogany, that I will take up. In it we have the Amari, Gendeli-poma, Bandor Dema, Hindur Poma, &c.

Amari, "Amoa spectabilis," is at times a really magnificent Tree, and an equally magnificent timber for furniture and such work : at times it reaches 50 feet in the shaft or bole, with a girth of 8 or 9 feet, and quite straight. I have seen an Amari felled across a khud, and it formed a fine 60-foot bridge. A piece 16 feet long was cut off the butt-end, that was sawed down into a slab, 3 feet wide by 1 thick, for a Rob-Roy canoe. I planed (cross-wise) a part of it, and the grain, figure, and color, were equal to the very best Spanish mahogany. Pianoforte-makers would gladly have given Rs. 1,000 for the tree-stem, in Calcutta. The bark of this tree is rather thin, even, and grey, like Bandor Dema ("Guarea, or Disoxylum-binectiferum.")

The flower I have not seen, but the leaflets are five or seven, in pairs on a stalk (and one at end,) entire and oblong ; the seed in open bunches like grapes, but with thick opaque-green skin. The tree seems to be a close ally of Mahogany, and why we should try to grow the latter so very persistenty and so abortively and *expensively* when we have an equally fine or finer tree so like it, indigenous to India, I cannot imagine.

Bandor Dema, from all I can find out, is Guarea or Disoxylum-bineetiferum, and not, as far as I am aware, a very large tree. It reaches at times a girth of 5 feet, and has a tendency to branch. The stem is fairly straight, with a thin, even, greyish bark ; leaflets entire, 2 or 3 inches long, in pairs, (10 or 12) on a stalk a foot to 18 inches long. This tree is at once easily known, when in seed, by bunches of very red fruit *like apples*, hanging on stalks 4 or 5 inches long, that look very tempting. The seeds inside are like beans, 3, 4, or 5, and are deep purple, and encased in a yellow aril or skin. Few animals or birds seem to eat them. The wood is hardish and dense, red, grey, or pink, making, I believe, good charcoal and planks.

Gendeli-poma, which I believe is the Guarea allarea, called also Disoxylum Hamiltonii, is often an enormous tree. I have measured them 18 feet round at 10 feet up. As a rule, the bole is from half to $\frac{1}{3}$ the total height, *i.e.*, 40 to 45 feet (total say 90 to 120). The tree has a large and globular crown, with branches hanging down. The stem, straight as a rule, is covered by a brownish-red and very scaly bark ; the scales are large, long, and attached at *upper* end.

On cutting into the bark and wood, the reason is at once obvious why it is called Gendeli, as it has a most unpleasant smell, which, once experienced, will not be forgotten. The leaflets (17 to 23 or so) are entire and pointed, in pairs, along a central leaf-stalk, and are 2 to 3 inches long. The seeds like green plums, in an open bunch on long stalks.

The wood is pale reddish-brown, close, even, and heavy ; but I have no experience of its durability : it is reported not to last well, though it may do so as planking, in a dry place. I have reason to think it must be the tree we see in lists and books as the "Boga Poma" of Assam. This name is, I see, applied to another of the Pomas (or Cedrela) that has much darker and red wood, and that, I have reason to believe, is the *Henduri Poma*—Chickrassia Tabularis. I see in Mr. Gamble's Book that this tree is called "Roga Poma," and our ordinary Poma (*i. e.* Jati Poma) is called "Henduri Poma." I think it probable that these are mistakes, *i.e.* that the Boga Poma is Gendeli, (it is pale for a Poma) and I have never heard the name "Henduri" as applied to our ordinary Jati Poma. Again, the Chickrassia Tabularis is conspicuous in all ways for redness ; the sap is like thin blood ; the inner bark is like layers of deep crimson paper. The sap-wood is, if anything, a darker red than the heart of the other Pomas, and the heart-wood when wet a *deep* red, and when dry turns lighter, but has a beautiful lustre peculiarly like the sheen of satin-wood. Again, the flowers yield a red dye, and the young shoots of the early foliage are a most *brilliant crimson* against the sky. For these reasons I associate this Tree with the name "Hendur," the Assamese name for the red-powder of the bazars.

The bark of Henduri Poma outside is very like that of Jati Poma, (Cedrela Toona) rather darker ; and if the same is not cut, might be confounded with it. The foliage, when mature, is much the same. The fruit is about the size of an egg, and hangs by stems, three or four together. The outer part $\frac{1}{4}$ to $\frac{1}{8}$ inch. thick, roots off, and leaves a hard case, that eventually splits at the point that hangs down, and, opening, allows the winged seeds to escape.

There is little or no sap-wood in this Tree, and for furniture it should vie with Amari, as it is hard and dense, with a beautiful sheen in the grain that few woods possess.

I have seen this Tree 40 ft. in the bole and 10 in girth. There is another tree belonging to this group, called Hila Poma (not to be confounded with the Sila Poma, which is our *Lawa*, Englehardtia Roxburghiana). It has a thin grey even bark, and foliage not unlike Bandor Dema ; the wood is softer, and makes good charcoal.

Another Tree, the growth and bark of which is very like Bandor Dema, has serrated leaflets, and the fruit, in open bunches, turns yellow, and is the size of a crab-apple.

In considering the suitability of Wood for Tea-boxes, several qualities have to be kept in view, the disregard of which may end in occasional or systematic loss.

It has to be borne in mind, for instance,: that most of the boxes that leave the Tea-districts have not only to stand a certain amount of rough usage *en route* to Calcutta, but often an equal or even greater amount ere they reach the retailer : therefore a comparatively strong wood is needed.

Freight, again, has to be paid on the entire package, and hence a very heavy wood is not desirable ; so that a comparatively light yet strong wood is necessary. Bnt this is not all ; many timbers are both light and strong, and yet are very unsuitable, through splitting so readily, and hence we need a certain amount of toughness.

Many kinds of wood are very strong—but generally too heavy ; many again are very light, yet split at the slightest provocation : we need the three qualities, as far as possible, combined, *i e.* strength, lightness, and toughness. One of the lightest woods we have is Simol (Bombyx) or cotton-tree, and I have known whole chests made of it weigh only 12lbs., though the wood was $\frac{1}{2}$ an inch thick. Boxes are often made of it, that are sent home ; and if cut, say 5 inches thick, it might be fairly safe if well put together. It is, however, liable to split if it receives hard knocks.

One of the best woods for boxes is *Roghu*, formerly Nauclea kadamba or Kodom, "Anthocephalus kadamba,"—called Kodom in Bengali, and Halamba in Cingalese. When seasoned, it is fairly light, strong, and tough. In Assam it generally has a tolerably straight, clean stem, 30 to 40 feet long, which is continued up through the head or crown, the latter composed of a mass of *radial* branches.

As a rule the head of foliage is domed, and the lower branches have a tendency to droop and hang down all around. *Roghu* is one of the very few trees that generally carries its stem, or central axis, right through the crown to the very summit; and when young, it is very symmetrical.

Externally, the bark is dark brown or grey, and fissured by cracks longitudinally; inside, it is a brown or dark dun-color. When young, the bark is particularly clean and smooth, of a pale-grey green.

There is no heart, and the wood is yellowish-white, soft and even in texture, easily cut, whether green or seasoned. The leaves are stiff, large and entire, pointed, and with short footstalk ; on old trees they are from 8 to 10′ long × 5 or 6′ wide—much larger on young trees ; and I have measured one 31′ long × 20′ wide, on a one-year old plant 10 ft. high.

The flowers are small, and clustered in a ball, 2′ diameter, that ripens abont October.

Roghu has several peculiarities worth recording ; the growth is remarkably rapid for the first six or eight years, becomes slower on to twenty, and then is very slow. During the first two or three years it grows some 10 feet per annum in height, while the girth in same period is often an inch per month. I have cut 10′ planks for boxes out of Roghus only 8 years old, and am now felling a good many that are 16 years old, and at six feet up measure an average of 5 to 5′ 5″ girth, while at 30 feet up they measure 3′ 8″ in girth. Up to eight or ten years old it grows so rapidly as to be worth planting; bnt after fifteen or twenty years, is so slow that it is most profitable to fell when about twelve years old.

Another peculiar feature of this tree is the difficulty of propagating it from seed, while at the same time it springs up in millions, naturally, on new clearances. I once estimated that I weeded out 450,000 Roghu seedlings on 25 acres of clearance. Taken altogether, this Tree is one of our best for Tea-boxes, both on account of its natural qualities as a wood, and as a tree ; and the pity seems that it is not more extensively grown by Planters and Government, especially as it takes such a short time to reach useful size. It is on this latter account that I place it first on the list of *Box timbers.*

Sotiana, " Alstonia scholaris"—called in Bengali Chatin, and Hind. Satni, Chatiwan in Nipali—is very good Box-wood, though somewhat lighter and more brittle than Roghu. The tree has a peculiar growth, *i. e.* a remarkably tall and branchless stem, surmounted by a dense and globular head, that generally looks small in comparison to the size of the stem, 80′ high by 8′ in girth. The bark is a drab grey, tolerably even in the main, but with small reticulations that give a roughish texture : the sap is milky.

The leaves are 5 or 6′ long × 1 or 1½′ wide, smooth, entire, and lanceolate, set in whorls. The flowers are small and tubular—cream-colour—scented, and the seeds in long thin pods.

The wood when fresh is particularly easy to work, is whitish, or cream-colour, and has no markings or grain. It is said to be difficult to season, but I have not experienced it. If cut in wide slabs 1 to 1¼ inches thick, it makes beautiful drawing-boards. Being clean, even in texture and colour, besides fairly light and strong, it makes very good tea-boxes, though it should not, for this purpose, be less than ⅝ in. thick. Dry boxes of Sotiana weigh about 20 to 25 lbs. each.

Patihonda, " Cinnamomum obtusifolium"—called Ramtezpat, Beng. ; Bara Singoli, Lepcha,—is another very good wood for Tea-boxes.

It is a little heavier than Roghu or Sotiana, and much the same strength and colour. It is a beautiful wood to work in, and has very little grain or crossness in the fibre ; also no heart-wood.

I have never seen this Tree very large, and it seems to have a clear stem and irregular head, some branches rising from the stem below the true crown.

The bark is reddish grey, ¼ inch thick, and aromatic, the tree belonging to the Cinnamon tribe.

The leaves are easily recognized by having but three conspicuous veins and a blunt point, or rounded tip ; they are thick, shiny, and aromatic, 6 or 8′ long by 3½.′

The *Patihonda*, often called Honda Gos, is pretty commonly scattered in the forests, but it is not gregarious, and Assamese do not seem to use it much except for charcoal. It is, however, like Roghu and Sotiana, a capital wood for planking of all sorts, provided it is kept from the weather. Neither this tree nor Sotiana grow quickly, and, as far as I can see, neither would be suitable for plantations. The Patihonda, too, does not always grow quite straight, but has generally a bend in the stem somewhere.

In my last I drew attention to *Roghu*, or Kodom, formerly "Nauclea Kadamba," as one of our best box-timbers; also to Sotiana Chutni, or "Alstonia scholaris," and Patihonda, which is "Cinnamomum obtusifolium." I omitted to notice that the last is called Obtusifolium,—perhaps in consequence of the way in which the points of the leaves are damaged.

I have frequently searched the foliage of a felled tree for an entire leaf, and generally failed to get even one perfect,—all seem eaten by some insect. It would be interesting to know if this peculiarity is local or common.

Poma—"Cedrela tuna," or the Tun-tree, before noted, is an excellent box-wood; it is both light and strong, though not very tough. Unfortunately it is not a very common tree, and if used for boxes, the supply would likely run short. It is easily propagated, and grows rapidly, so that it is a good one to have in reserve. It is apt to split in felling, unless care is taken. Poma boxes weigh about from 20 to 25lbs., and this is not the same wood that comes to us as "Cedar" from Burma: the latter is heavier, harder, and less attacked by white-ants.

Sum, or "Machilus odoratissima," I have already noticed as a good box-wood. It is strong and tough, but rather too heavy compared to Roghu, Poma, and other woods. A whole chest of Sum, when dry, weighs 30 lbs., and a 21 inches cube (outside measure), about 35 lbs.

Being the tree on which muga silkworms are reared, the felling of it is prohibited on Waste-lands, and the supply is thus limited to that on Grants under Fee-simple. It does not grow particularly fast, nor yet straight, so is not worth planting for box-making.

Kokan, "Duabanga Sonneratoides," or the Bandor hulla of Bengal, according to Mr. Gamble, is a good box-wood, being light, strong, and tough. The tree is easily recognized by its peculiar growth. The stem generally rises bare, and the crown is composed of long branches, carrying a lot of large leaves: these branches, also, seldom fork, and at a little distance the tree often looks very like a Palm. It is not very common in the plains, and is more generally seen on the lower slopes and spurs of hills, and near rivers.

Mas Koita is a largish tree, the wood of which is very good for boxes, but the botanical name of which I cannot yet find out. I have seen them 30 feet in the bole, with girth of 5 and 6 feet. The bark is grey and roughish, $\frac{1}{4}$ to $\frac{3}{8}$ inch thick. There is no heart, and the wood is a dirty white,—clean, even grain, light, and strong.

The leaves are 6 or 7 inches long by $2\frac{1}{2}$ inches; lanceolate, serrated, and white underneath; by which it can be recognized. It flowers in May and June, and the seeds are clusters of small purple berries, the size of No 4 shot.

Sasi or *Hasi* (Hind. Ugúr) "Aquillaria-agallocha," is a tree the wood of which is so very light, that, in these days of *exorbitant* freights and small dividends, I feel inclined to recommend for boxes. A few years ago I should have thought it too soft, and not lasting. I have, however, now the most conclusive proof on several hands that, if kept from exposure while seasoning, it lasts remarkably well, and, strange to say, seems, when cut up and dry, to resist the attack of white-ants: it is even said to do this before it is seasoned, and in many Estates is split up, and used for walls of houses that are afterwards mudded,—a very severe test indeed. As a tree, Sasi grows generally tall and straight, with a clear shaft (if in forest) and a conical head. This is the tree often barked by the natives for writing on, as the bark is thin and tough, and very even in surface and texture. I have often, also, when camping out, seen my men go and cut themselves large mattrasses, and even counterpanes of it, and lay them on ferns. The tree is generally round and not grooved; and, to bark it, a series of cuts are made in a circle below, and another ring of cuts above, at 5 or 6 feet; these are then connected by one vertical cut, and the bark rolled back right and left, till the entire piece is off, leaving the stem bare, smooth, and white. The tree does not seem to resent this, but appears rather to like it, and thrive under this skinning process. The leaf, 4 × 1, is lanceolate, entire, and smooth. A peculiarity of the wood seems its freedom from the attacks of insects, and mildew or rot; it is however very soft, tongh fairly though and strong, becoming harder as it dries; and if used for tea-boxes, should be of planking $\frac{5}{8}$ inch thick, when the box would weigh from 18 to 20 lbs. only. I hope to cut up some Sasi ere long, and shall have a few boxes made up of it as an experiment. As the tree grows naturally fast and straight, it seems one well worthy the attention of the Forest Department. The tree often attains a great size—6 and 8 feet in girth by 40 in the shaft. I presume it is the same tree as on page 316 of Mr. Gamble's "Indian Timbers," as natives report that it often has "irregular masses" of scented wood inside the old trees.

Gahori Sopa, Michelia Sp., called a Champa, though not much like the majority of them, is fairly good wood, pretty common, of good size, and straight. It has no heart, but right through is white, soft, and even,—more or less destitute of ring-markings; is also light, and pretty strong.

The tree generally is straight, and 30 to 40 feet long in the bole by 5 to 6 feet in girth: outer bark dark grey or neutral color, with longitudinal markings—very like the bark of Korika Sopa. The flower is extremely small, and quite unlike the Sopas; the leaf is 5 to 6 inches $1\frac{1}{2}$ by 2, entire and pointed, with footstalk an inch long; veins conspicuously parallel. It dies yellow, then black. The other Sopas have leaves much the same as to size and shape, but they die brown.

The general growth is not as a rule peculiar, though I once saw a Gahori Sopa that had escaped the many accidents and enemies that all trees are liable to, and the regularity with which the branches radiated in fives, at every 4 to 5 feet up through the crown to the top, was most extraordinary. Taken all round it is perhaps, as a rule, the most irregular in its growth of all the Sopas.

I have had sawyers complain that it is not easy to cut up; this I do not believe. It is simply not quite so easy as Simol, nor so "cheesy" as Sotiana or Roghu; it is however rather more fibrous in grain, and involved, but as we do not plane up our boxes, this does not matter. *Boromthuri*, which is closely allied to the Sopas, or Michelia, called "Magnolia Sphenocarpa," is very good for Tea-boxes. It is a tall deciduous tree, and, like its allies, the foliage is bunched radially at the ends of branchlets, from whence, also, the flowers eventually issue; these latter are like those of the Sopas in form and odour, but much larger. It is called an Evergreen, I see, by Mr. Gamble (on page 5 of the "Indian Timbers"), but here in Assam it sheds its leaves about March. The young leaf-shoots, as a bunch, are all enclosed in a sheath like a "*thuria*" (or silver ear-plug): hence the name. These thuris are collected by Nogas at Bihu in April, and sold or exchanged to Assamese, who chew them with sali, having an aromatic taste. The leaf is very large, and often 15 inches by 6 inches. The wood of Boromthuri is white, rather soft, very even in grain right through, and fairly light and strong: also not fibrous, like G. Sopa. It is excellent for Tea-box shooks, but, like so many other woods, will not bear exposure to wet if used as planking.

Rudai, called also Rudrak, is "Elœocarpus Ganitrus," the tree that yields the so-called Brahmini beads, made into rosaries, and often seen trying to grace the persons of those criminally-filthy impostors called faquirs. The wood of Rudai is particularly even and white,—one of the whitest I know, so far,—and works, as far as I have known it, easily, with straight and fine grain; is strong and tough. The tree is generally tall, and branches above, not unlike the Roghu, having also a straight stem, 30 to 40 feet in the bole by 5 in. girth. It has a thin dark bark, and the leaves, 5 inches by 1 inch, seem long and narrow, pointed like bamboo, and serulated or slightly serrated; footstalk $\frac{1}{2}$ an inch long. The flowers are small, and hang like a row of 10 or 20 little bells on a small stalk, the seed being the well-known bead, rough and hard, $\frac{3}{4}$ of an inch diameter.

Totoa, Elœocarpus, is another large tree of the same kind, though different in appearance and detail. Generally it has a clean stem 40 to 45 feet long, heavily buttressed at the ground, and in girth attains to 5 and 6 feet. The head of foliage is dense and globular ; the bark is dark-grey, ¼ inch thick, and even. The tree is easily recognized by its leaf, 8 inches or 10 inches long by 3 inches, with footstalk of one inch, bulbed where it joins the leaf, and again enlarged at the attachment to the branch. It is somewhat pear-shaped and pointed, and dies a bright-red to brown.

The flowers are like those of Rudai, but larger ; and the fruit, like a small green plum, hangs in bunches. The wood of Totoa is whitish-pink, tolerably soft, but heavier than Rudai ; there is no heart. "Elœocarpus Aristatus," or Poreng, another of this Group, is generally too small to be of much use as a box-timber.

Phul Kat is another Elœocarpus, conspicuous for its profusion of blossom, but is seldom very large in the stem : the wood very white, even, soft, and light ; leaves with much longer footstalk, and, like the others, die bright crimson ; the wood is apt to split.

Jalpai, or Sakalang, "Elœocarpus Lancefolius," is another of this Group, a very large tree, and said to be good for boxes. Very likely true, but I cannot vouch for it.

Bhelu, or Kondlo, is, I see, called by Mr. Mann, our Forest Conservator, "Toricellia Tiliapolia," an immense tree, with a girth up to 20 feet, and tall in proportion. The stem often runs up clear for 60 or 70 feet, clean and round, the foliage generally in a globular crown ; bark, ¼ inch thick, is of a clean grey color, granulated. There is no heart, and the wood is the same all through, and a yellowish-white color : very little grain, or markings, or fibre ; it is soft, light, and easy to work—but attacked occasionally by insects, called guns, so badly, as to be reduced in a year to a mass of powder ; no doubt if seasoned this would not occur. It is said to go this way if cut during full moon. Bhelu is such a large tree, and so short in texture, that unless felled with care, the stem may snap or be "shaken" in several places.

The leaves are heart-shaped, 6 or 8 by 4 inches, pointed, and on a long stalk, turning deep *yellow* when dead. The flowers are in masses on a terminal spike, and very minute. It is very easily sawn, but, being so large, is at times not easy to handle.

I have never yet used it for tea-boxes, but I am told it is good for that purpose, and is clean, easily worked, and light ; a large tree of it, also, would give quite 100 to 150 Tea-boxes.

I note Mr Gamble calls it "a small tree," at page 211. This shews how much we need a visit from that gentleman, ere he gets out a second edition of his "Indian Timbers."

It is astonishing what a large number of trees there are in these forests that, so far, seem unknown, Some have no local name, even ; and though large, are rare.

S. E. Peal.

SECTION XXI.

PACKING.

SIZE OF PACKAGES FOR FOREIGN MARKETS.

If any argument were wanted to impress upon our readers interested in Tea the all-importance of not sending *whole* chests of tea to the Australian market, the following table, extracted from the Comparative Statement of Stocks in Bond at Melbourne at the end of the years 1880, 1881, and 1882, given in the *Australasian Trade Review* of January 17, 1883, would furnish it:—

	1882.	1881.	1880.
Chests ...	6,774	1,171	1,614
Half-chests ...	179,108	163,126	68,466
Boxes ...	122,021	146,647	45,172

We have very little doubt that the increase in 1882 (six times the number of 1881) is owing to the mistake made by Indian exporters, and the figures above given will show that there is simply no demand for whole chests, and any one who now sends these, does so with his eyes open, and must not be surprised if he throws away good tea.

It will be seen that although the number of whole chests is but a very small percentage of the whole, yet the market is unable to absorb them without, as advices indicate, a serious loss to exporters from this country.

This also points to the fact that the population of Australia is scattered, and that families up country send for the half-chests and boxes for their own consumption, these sizes being convenient to handle, and not lasting too long. Another point against whole chests is, that being heavy, porters at the port of debarkation find them difficult to handle, and with a labour-market as independent as that of Australia, this is a most important matter.

Although the question never appears to have arisen, it is a point worth the consideration of Tea-agency Houses in Calcutta, whether half-chests, which are so popular in the Colonies, would not find a ready sale in the London and other markets.

THE PACKING OF INDIAN TEA.

Size of Packages.—All packages weighing over 28 lbs. gross are subject to the draft of 1 lb. per package. Boxes grossing over 28 ℔s. should if possible not be sent, as the draft and the loss by the system of weighing amount to a heavy percentage on the contents of the package. Tea in boxes, if of good quality, as a rule realize on the home market from 1d. to 3d. per ℔. more than the same quality in chests.

Half-chests are subject to the draft and loss by weighing, and as nearly the same quantity of Tea packed in a chest would only incur one loss by draft and weighing, it is doubtful whether the slightly-enhanced price sometimes obtained would compensate the extra loss that occurs.

Fine and Finest Teas often sell better in boxes and in half-chests, but any material increase in the quantities so packed will lessen this advantage. Where the Garden is small, or the quantity of Tea insufficient for fair-sized breaks, it is perhaps a better plan to pack in half-chests, so as to increase the number of packages, and ensure a better chance of buyers seeing them. The smallest quantity placed on show at the Warehouses for public sale, unless special orders are given, is 8 chests, or 8 half-chests, or 20 boxes : many buyers do not find it worth while to see breaks of less than 15 chests.

Gross and Tare.—Teas, on first arriving at the Warehouses, are weighed for gross ; the contents of the chest are then turned out, and the empty package together with its lid, lead, cramps, and hoops, are weighed to ascertain the tare, the Custom House authorities taking no notice of the Garden gross and tare.

In weighing for gross, all fractions of a lb. are not reckoned ; and in taking the tare, any fractions of a lb. are reckoned as a lb. more, thus :—

	cwt.	qr.	lb.	oz.		lbs.	oz.
A chest weighs gross, say ...	1	0	10	14	or	122	14
the tare, say ...		1		2	or	28	2
		Exact weight				94	12

		cwt.	qr.	lbs.		lbs.
But the Customs enter the gross	...	1	0	10	or	122
and the tare	...		1	1	or	29
On which amount duty is paid				...		93

Further, the buyer is allowed by the Importer draft to the extent of 1 lb., which reduces the weight to 92 lbs., or a total loss of 3%. The above Example, for the sake of an illustration, is somewhat extreme ; still it serves to shew what loss is liable to be incurred unless some attention is devoted to the weighing of the empty chests and of the Tea at the Garden. This heavy loss can be partly avoided by making the tare to be just below an even number of lbs., that is, had the tare been 27 lb. 14 oz. instead of 1 qr. 0 lbs. 2 oz. in the Example given, and the gross just over the lb., say 1 cwt. 0 qr. 10 lb. 2 oz. instead of 1 cwt 0 qr. 10 lbs. 14 oz., the net weight, excluding draft, would have been 94 lbs. Attempts should be made to fill up the packages so as to weigh somewhat over the lb. ; but when doing so, some allowance must be made, for the smaller the size of the Tea the greater the loss by leakage.

If the tares are fairly even, it is allowed to turn out a certain proportion, usually 10 per cent., to ascertain an average tare for the whole break. This is an advantage if the Teas are carefully bulked in India ; but if the Teas are not bulked, or run unevenly and the tares uneven, no advantage is gained, as in the one case all the Teas will have to be bulked, and in the other turned out to obtain separate tares.

Packing Tea.—See that the lead lining of the boxes is free from holes. Pack the tea when perfectly dry ; after which, solder up sharp.

Boxes.—Frequently, mistakes and oversight occur in this department. Boxes are ordered and sent up by the agents of soft and cheap wood, but they prove very injurious to the tea. Why should one not get good boxes, such as teak-wood, which is generally well seasoned, dry, and best adapted for tea-boxes, being neat, clean-joined, no shrinking or opening, as often is the case with boxes made of other woods. Teak-wood boxes may be a little expensive, but what is that to what is attained—a good strong chest, not liable to shrink or warp, or be attacked by dry-rot ; and a *lasting* box After all the care in cultivation, manufacturing, &c., &c , for teas to be packed and sent off in soft-wood and common-wood boxes, is *folly*—" Penny wise and pound foolish." All boxes ought to have corner-pieces put in, which strengthen them ; and after being packed, all to be bound with hoop-iron, and neatly marked.

PACKAGES AND MARKS.

Owing to the convenient size and weight of the usual "half-chest" for carrying from the Garden, this particular package is in favor with growers, but for estates which are near a means of transport, we certainly recommend full-sized "chests" of from 80 to 100 lbs. nett, as they are more liked by London dealers for home trade; some of the choicest kinds might be packed in "half-chests," or even "boxes." When packed in the latter, care should be taken not to let the gross exceed 28lbs., otherwise a loss equivalent to five per cent. in weight will result, owing to the trade custom of allowing 1 lb. draft on all packages over that weight. The only marks requisite on the packages are—the description of contents, Garden numbers, and the name of Garden, in preference to any elaborate device.

SIZE OF BREAKS.

As regards Sorting, the tendency to make as few sorts as possible is gaining ground steadily, and we strongly advocate it, especially on small Gardens. We still look forward to the days of unassorted Tea, but the time for that has not yet arrived.

The proportions of breaks under 20 chests in Garden invoices, and of subdivided lots in Calcutta purchases, has been less this season (1884). Now that it has been arranged that all parcels under 8 chests are sold by themselves after the Sale, it is the more necessary that the breaks should be large, so as to ensure the attention of all the buyers. For fine and finest 20 to 50 chests (or half chests), and 50 to 100 chests for common and medium descriptions, are the best.

On the subject of *Breaks*, it may be remarked that while it is desirable to have these of a good size, the system of rebulking in London renders it unnecessary that the tea in each break should be of uniform character and quality, so long as it is of the *same class*, and so long as *unsound* or very inferior teas are not mixed, or breaked, with *sound* and decidedly superior sorts. This admits of packing being carried on uninterruptedly with each day's teas, simply putting the chests containing each class by themselves till they are numerous enough to form a Break, which should not, if possible, consist of fewer than fifteen chests.

Col. Money says, the larger the quantity of Tea of any one kind to be sold at one auction, the higher the price it will probably fetch. Sell, if possible, twenty or thirty chests of one kind of Tea at the same time, for small quantities, as a rule, sell below large, both in Calcutta and London.

DEAR SIR,—I must admit that the extent to which multiplication of breaks is carried on makes it impossible to classify the auction sales in four or five columns. The Brokers are the best persons to know whether this is not in the way of getting good prices. My Brokers value my teas to be so much in a large break, and so much in a small break, and the difference is fully 30°/₀. This is no slight matter, as you must know. It is rather strange that most tea proprietors persist in disregarding the unanimous advice in these respects. There should be a few breaks, say four, but every break should be a large one, consisting of at least 1000 lbs. of tea, at any rate,—two fine teas and two coarse teas, or two whole teas and two broken teas. By sieving into, say, four breaks, a break of 1000 lbs. of any description is completed in half the time than it would take if teas were sieved into eight classes. Thus, teas might be put into market sooner. People talk of bulking: why not bulk Pekoe fannings, Pekoe Souchong fannings, Souchong fannings, and Congou fannings, and broken tea and broken black?

The style of sieving varies so much that it is impossible to make a fair comparison. The rule I follow, which I believe is the general rule, is to sieve with No. 13 mesh wire-sieve for Broken Pekoe, with No. 10 for Pekoe, and with No. 8 for Pekoe Souchong. What is still left on the stop is broken with No. 8, and sieved with No. 10, for equalising it; all fannings of Pekoe, Broken Pekoe, and Pekoe Souchong, are mixed up with it; this forms Broken Tea. I think this style of sieving is the simplest and best. Some persons, when they have taken P. and B. P. from the bulk with Nos. 10 and 13 sieves, break the rest on No. 8 sieves, *jhar* (winnow) out the fannings, remove the heavy flat broken teas, and sieve it through No. 8 for equalisation, and call it Pekoe Souchong. There are others who sieve the P. S. thus made with No. 10; what passes through is mixed up with Pekoe, and the rest is classed as Pekoe Souchong

AD TAT.

TEA AND BOX TO BE WEIGHED AND NOTED SEPARATELY.

Weight of Tea in each Box.—The boxes, ready lined, with a lead cover, loose must be all weighed *before* the Tea is packed, and again *after* they are filled and soldered down, but *before* the wooden lid is put on. The difference of these weights, minus the weight of the little solder used in fastening down the top lead (for which allow say one pound, to give a margin, also), will be the net weight of Tea in each box.

The invoice you send with the break must give for each box the number, the gross weight, the tare, the net Tea, and the kind of Tea, with a declaration at foot that the Teas of each kind have been respectively well bulked and mixed together before packing.

Equality of tares is the most important point to attend to in packing Teas. It may be difficult, but with machine-sawn boxes nearly the same weight, any difference must be made up with extra hooping, lead, solder, or nails. Anyhow, it *must* be done, so that no tares shall differ more than half-a-pound.—*Col. Money.*

PACK HOT, AND DRY THOROUGHLY.

Whether you use sun or charcoal, put the Tea *hot* into the boxes. The *only* object of the final drying is to drive off the moisture which the Tea will certainly, in a more or less degree, have imbibed since its manufacture. Even the large zinc-lined bins which should be fitted up in all Tea stores, and in which the Tea is placed after manufacture, will not entirely prevent damp: so in all cases a final drying is necessary.

Keep it in the sun, or over the charcoal, until it is hot throughout, hot enough to ensure all the moisture having been driven off.—*Ibid.*

HOW TO FULLY FILL THE BOX.

Then put into the box enough to about one-quarter fill it. Now, let two men rock the box, over a half-inch round iron bar, placed on the ground, until the Tea has well settled. Then place a piece of carpet over the Tea, the exact size of the box, and let a man stand inside and press it down a minute or two with his feet. Now fill up nearly another quarter, and press it again over the carpet as before. Repeat this, putting less and less into the box each time, as you near the top, until it is quite full, but do not rock it at all the last two or three times: only press it with the feet, as described. No patent screw-press, or anything else, will pack the tea better or more closely than this plan.

I have seen a machine advertised for packing Tea, that is to say, for so pressing it down that a large quantity shall go into a chest. I have never seen the machine, and so cannot say how it works, but I do not think such a machine at all necessary. As much Tea as a chest will hold *with safety*, should be put into it. If more were forced in, the chest would probably come to pieces in transit.—*Ibid.*

COMPLETING THE PACKING.

It is sometimes the custom to defer soldering and nailing down the lids of a break till the *whole* is ready for the process, but this should be avoided. Each chest should be finished off as it is ready, and not kept waiting for others.

SIZES OF WOOD FOR TEA-BOXES.

The ordinary chest, to contain 80 lbs. Pekoe Souchong, is made up of 16 boards as follows :—

1	Side—	24 by 6, 24 by 6, 24 by 7	=3 boards.
1	,,	Ditto	=3 ,,
2	Top and Bottom,	3 of 24 by 6	=6 ,,
2	Ends,	2 of 17 by $9\frac{1}{2}$	=4 ,,
			16 boards,

or ten boards of 24 by 6, two of 24 by 7, four of 17 by $9\frac{1}{2}$. The outside measurement is 24 by 20 by 18, or exactly 5 cubic feet; and ten of these go to a ton of 50 cubic feet.

Some other outside measurements are—

100 lbs.	Pekoe Souchong	... 24 by 22 by 20
60 ,,	do.	... 20 by 18 by 17
40 ,,	do.	... 19 by 19 by 13
25 ,,	do.	... 16 by 14 by 12
20 ,,	do.	... 15 by 15 by 11
10 ,,	do.	... 11 by 11 by 11

SIZES OF TEA-LEAD.

Sizes are 37 inches by 22 inches, boxes of 2 cwt. = 126 sheets.
25 ,, by 19 ,, ,, ,, ,, = 210 ,,

A full-sized Tea-chest of five cubic feet takes two sheets of each of above sizes For 100 chests 1·58 box of large and ·95 box of small lead are thus required; or, for all practical purposes, one-and-a-half box of large, and one box of small lead per 100 Tea-chests.

SOLDERING TEA-LEAD.

The following is the easiest and cheapest way of soldering tea-lead, and one that an ordinary native understands, and does very well :—First cut the lead so as to exactly fit the inside of the box : edges of sheets must slightly overlap. Three pieces are required : one long piece, that covers two sides and the bottom, and two small side pieces. Now, with the fingers or a flat bit of wood the packer smears the overlapping ends with rosin (native name *Gunda Boroza.*) After this he takes a heated soldering-iron and rubs it in a vessel containing soldering-lead, and then runs the iron along the ends of the lead sheets where the rosin had previously been placed. The sheets immediately unite, and form a perfectly close-fitting and air-tight case inside the box. An experienced man can cut and solder up the lead for an 80-lb. box in from 10 to 15 minutes.

Solder.

There are 44 sticks in a box of 28 lbs., and one stick fastens up 8 Tea-chests—say 352 chests to a box of 28 lb.

Soldering Fluid.

1 quart Baker's fluid is sufficient for 300 tea-chests.

NAILS.

French, $1\frac{1}{2}$ inches, 64 are used to fasten a
full sized chest (5 cubic feet) or $18\frac{3}{4}$ lbs. to 100 chests.
$1\frac{3}{4}$—(300 nails to 1 lb.) ,, $21\frac{1}{2}$,, ,, 100 ,,
Hoop-iron, French, of $\frac{5}{16}$ inch size, 56 go
to a chest when clamps are employed
(880 nails to 1 lb.) ... ... or $6\frac{1}{2}$,, ,, 100 ,,
Clamp Tacks, $\frac{1}{2}$ inch ... ... 6 bundles ,, 100 ,,

HOOP-IRON.

Of ½″ size : 8 oz., or 10 feet, to a tea-chest, when clamps are employed.
1 bundle of 56 lbs. thus goes to 112 chests.

Of ⅝″ size „ „ „ 100 „

PACKING OF TEA IN TIN-BOXES.

A gentleman largely interested in Tea, but in no way connected with the manufacturers of the Patent Tin Boxes, writes to us from England,—

I made enquiries as to the condition in which Tea packed in Messrs. Harvey Bros. and Tyler's lacquered Tin Boxes is turned out in London. I found that the tea was not at all injured by this method of packing, but that its condition is quite as good as that of tea packed in chests. Messrs. W. J. & H. Thompson assured me that you were entirely mistaken in your remarks as to the contamination, but they thought that an objection to the packing in the lacquered Tin Boxes was the labour of putting up in these boxes. Catalogues were shewn me in which I saw that the teas in the lacquered Tin Boxes fetched higher rates than the same teas packed in chests, the difference being in one case *3d.* per ℔.

This is certainly a most favourable testimony, and coming as it does from a disinterested party, who writes simply in defence of what he considers the right, we cannot but accept of his statement in its entirety.

Another correspondent writes,—

I now give you a few sales of these boxes, made at Public Auction, shewing the preference of the Trade for Tea so packed, and the higher prices realized :—

			s.	*d.*	
	Public Sale 3rd November.				
Koliabar.	28 chests Pekoe	...	1	10½	per ℔.
K. Assam.	28 cases, each 4 boxes	...	2	¾	„
	Public Sale 16th November.				
M. L. B. D. S. A.	30 chests Pekoe	...	2	0¼	„
	30 cases, each 4 boxes	...	2	2½	„
—:0:—	20 chests Souchong	...	1	3½	„
	20 cases, each 4 boxes	...	1	4¾	„
	Public Sale 23rd November.				
M. L. B. L. P.	20 chests Pekoe	...	1	6¾	„
	19 cases, each 4 boxes	...	1	9¾	„

In every case the above teas were packed out of the same heap in India, and the difference in the selling price arises chiefly from the *better condition* of the tea on arrival, and the growing preference of the country trade for teas so packed.

Besides the above there have been numerous other sales, those mentioned being selected because the weight of tea in chests and boxes was about the same, the difference in the price obtained being therefore a more crucial test.

I have also heard of several instances where buyers have offered, privately, outside prices for teas so packed, as they were desirous of obtaining them before being offered at Public Auction.

SECTION XXII.

TEA WEIGHMENT.

The New Customs Rules.

Weighing of Indian Teas in Bond.

Tea Weighment.—Advice to Managers.

THE NEW CUSTOMS RULES.

TEA planters in India had become so used to the iniquitous way in which they and their produce were treated, and they had for so many years fruitlessly protested against the evil, that the granting of the boon so long asked will have come upon all with surprise, but with all the more pleasure because of the surprise. As a correspondent expresses it: "No more *dik* or worry, needlessly, to managers and assistants; no more damage to Tea by exposure; no more loss to proprietors: common sense and the Right triumphant for once, anyhow. The victory is worthy of a history of the fight." To give a history of the fight, so long protracted, would serve little purpose. It was the old story of Red-tape *versus* Common-sense; of the Circumlocution Office with all its "Tite Barnacles" against the interests of an important Industry; and although willing now to express gratitude for justice at last done, our thanksgivings to Government are somewhat tempered by the knowledge that but for the pressure brought to bear upon the Customs authorities by the determined and earnest action of our Home Association, matters might, and doubtless would have remained as they were. The grievance has been over and over again brought to notice, but individual remonstrance has not been heeded, as it hardly ever is. Probably no reform of many and many abuses would ever have taken place but for the existence of our Public Associations, which at home are so much more powerful than they are here; and yet even here they have been able to effect much good. You will generally find, however, that in public movements emanating from Public Bodies, there is one man who has set the ball rolling, and to whose persistent endeavours to keep alive an agitation begun among his *confreres*, a great measure of credit is due. We believe we are not wrong in saying that it is greatly owing to the untiring energy of one member of the Indian Tea Districts' Association that this important matter of an improved tareing and weighment of Indian tea has been kept alive, until at last that justice demanded by the Association has at length been granted. We refer to Mr. Geo. Williamson,—one well known in all Indian tea-circles. In saying this, we are far from desiring to withhold praise from the many who have worked so earnestly and to such good effect with him, but we think a special meed of praise is due to him, and we do not believe it will be grudged by his colleagues.

To turn to the New Rules themselves, we find that, like everything in this world, it is impossible to give satisfaction to all, and while the importers are jubilant over the amended Custom House system, the buying trade are by no means satisfied with the change. They are quite willing and anxious that injury to the Tea by the process of turning out and bulking at the Custom House should cease, for it was as much in their interests as in those of tea owners that such a state of things should no longer continue; but they split upon the rock of the declaration of the importer as to the net weight of each package being accepted in respect to all but 10 per cent. of the parcel. They say in effect, No doubt the Customs have protected themselves fully by stipulating that if the difference between the weight stated of any package and the weight found exceeds 3lbs., the whole parcel shall be weighed net; but is it likely that such an excess will ever occur? True, the given weight is generally exceeded, but if a package weighing 85lbs. is to be allowed to pass as weighing 88lbs., though the revenue would not suffer, but quite the reverse, the retail grocers who received the package in question, and lost some 6s. worth of tea and duty, would have serious ground for complaint. This is the view taken by the Trade Organ, the *Produce Markets' Review*, and no doubt there is something in it. But buyers have hitherto had a very fair allowance in the "draft," and it is hardly to be expected that Gardens will in future throw away more of their Tea than they have hitherto done, by exceeding a fair surplus on the net weight of the chest contents; and now it is ruled that quantities over a half pound are to be subject to duty of 1lb., factories will be careful to avoid mistakes in this direction, and they will be more careful in their weighments, because to prejudice the buyer would be, in the end, to prejudice themselves. The interests of sellers and buyers is, or should be, in common, and we believe it is only necessary to draw attention to the difficulty raised by the home trade, to induce owners on this side to see that every precaution shall be taken that the buyer is not injured.

There is one thing in connection with this subject which cannot too forcibly, or too often, be impressed on managers, and that is, careful bulking, wherever possible, on the Factory. If the Trade find that the 10 per cent. of any one class of tea turned out does not tally in the quality and value with the remaining 90 per cent. left untouched, they will surely petition to have the old system restored. In many cases, no doubt, bulking on the factory is expensive and difficult, and involves delay, but if the new system of turning out only 10 per cent. is to continue, it is essential that teas should be properly bulked.

The new Rules issued by H. M.'s Commissioners of Customs in London with reference to the weighing of Indian Tea are as follows :—

1. The Tea on arrival to be weighed to ascertain the gross weight of each package.

2. With each entry the importer to give an endorsement of the net contents of each package.

3. To test the accuracy of this endorsement, 10 per cent. of each Break to be turned out and weighed net.

4. If the difference between the weight given of any package and the weight found exceeds a reasonable margin, say 3lbs., the whole parcel should be weighed net.

5. Duty to be charged on the average weight of the packages weighed net, unless the importer elects to weigh the whole parcel in the usual way.

6. When the average of the packages weighed net amounts to so many pounds and-a-half, an additional pound will be charged on each of the whole parcel; when the fraction is less than half a pound, it is to be rejected.

Managers of Gardens should make special efforts to ensure the satisfactory working of the new system, by taking extra care to have their teas carefully weighed in India, allowing only a margin of a few ounces; otherwise, duty will be leviable on an additional pound, under Rule 6.

It is also very necessary that each break should be carefully *bulked*, as this process will not now be gone through in London, and if the quality of Tea in a Break is found not to be uniform, great dissatisfaction will be given to the Trade, and the character of Indian Teas will be injured.

ADVICE TO MANAGERS.

Tea Weighment.

1. The chest, with lead and lid, to be weighed immediately before being packed.
2. The chest to be again weighed immediately after being packed, and the net weight of its contents (that is the difference between the weight of the full chest and that of the empty chest ascertained as above) marked on the chest.
3. The chest, after having been soldered and nailed down, to be again weighed in order to arrive at the exact tare, by deducting from the gross weight the net as ascertained above.
4. The gross weight and tare to be distinctly marked upon each chest, as well as the net.

SECTION XXIII.

BRICK TEA AND BURMESE WET TEA.

CHINESE BRICK TEA.

THIBETAN BRICK TEA.

DRY CAKE AND WET TEA IN BURMAH.

CHINESE BRICK TEA.

The following accounts of the manufacture of Brick Tea in China and Thibet will prove interesting. There seems to be no reason why Darjeeling planters should not go in steadily for making Brick Tea for the Thibetan market. Only the coarser kinds need be used, and they would, thus, pay well:—

"The greatest source of wealth to the city and surrounding district of Ya-tzow is the Brick-tea, which gives employment to thousands engaged in the manufacture and portage of tea from Ya-tzow to Ta-tsian-loo. The tree from which this peculiar kind of tea is manufactured grows chiefly along the banks of the Ya-ho, and, unlike that which produces the tea exported to Europe, is a tall tree, often fifteen feet high, with a large and coarse leaf. Little care is bestowed on the cultivation. It is often planted along the borders of fields and homesteads, each farmer gathering his small crop of tea, and finding a ready sale for it in Ya-tzow, to merchants, who pay the Government enormous sums for the monopoly.

I never had an opportunity of witnessing the process by which the tea is made into the exceedingly hard bricks which find their way to Thibet; and so great is the jealousy with which the monopoly is guarded, that even bribes failed to procure permission to enter the warehouse where the tea is packed for exportation. I am indebted to the landlord of the hotel where I lodged during both my visits, for the following interesting description:—The first quality is gathered in June and July, or shortly after the commencement of the summer rains in the end of May, when the leaf is about an inch long. When gathered, it is spread in the sun till slightly withered, and then rolled with the hand until moist from the exudation of the sap. In this state it is rolled into balls about the size of a large tea-cup, and laid up till it ferments. It is then ready for the wooden brick-moulds, which are made with the ends moveable, and fastened by pegs. The moulds, when filled, are dried over charcoal fires until the tea is baked into a tough solid mass. When taken from the moulds, the bricks are ready for delivery to the merchants of Ya-tzow. By them the bricks are enveloped in peculiar yellow-paper covers, bearing a government stamp and the trade-mark of the exporter, and are packed in baskets four feet long, made of thin strips of bamboo. The bricks thus packed form what is called a basket of tea, weighing about twenty pounds. These baskets are carried by coolies to Ta-tsian-loo, a distance of two hundred miles, where they are carefully covered with green hide, as a protection against wet, and are then ready for exportation to Lhassa, and the countries to the west of it, where this particular kind of Brick-tea is principally consumed, selling for about fifteen taels per basket, or four shillings and eight pence per pound.

The second quality, which consists of the older and yellower leaves, is manufactured in the same manner, and exported principally to Lithang and Bathang, where it is sold at five taels per packet, or about one shilling and sixpence per pound.

A third quality is made entirely of clippings, without the leaf, and resembles bricks of chopped twigs. The manufacture of this kind differs from the others, rice-water being used to make the twigs adhere, and retain the brick form. This quality is only used in Ta-tsian-loo and its immediate neighbourhood, selling for ninepence per pound.

The quality exported from Ya-tzow to Thibet has been roughly estimated at over six million pounds."

In a report of a Journey through the province of Tsu-ch'un, Yunnan, and Kwichou, from February 11 to June 14, 1883, some interesting Notes occur on the vegetable products of the country traversed. At one part of the journey Brick-tea is described as being made up into packets of 18 catties in weight. The tea is first enclosed in what looks like dried Banana-leaf, and then cased with coarse matting. The packets are long and flat, and are piled one above another on a wooden framework extending above the carrier's head. At the bottom are usually a couple of half packets, which afford a good rest for the pole which the carrier places under his load when he wants a rest. The maximum load hitherto noticed was ten whole packets and two half packets, weighing 198 catties—a good load to have on one's back for fifteen days—the time usually taken by these carriers between Ya-chou and Ta-chien-lu. The ordinary load was eight and nine packets. The freight between these two places is 300 cash a packet, so that if the journey is performed in fifteen days the wages of a carrier often amount to 200 cash a day. Among carriers of such heavy weights one would expect to find men of remarkable *physique*, but they seem to be distinguished for "want of leg." The same applies to the salt-carriers. They travel slowly, resting every few yards, and giving vent to their feelings, which on such work must be anything but over amiable, in a low whistle, or rather half-whistle and sigh. The Brick-tea manufactured at Ya-chou for the Tibetan market is altogether different from that manufactured by foreign merchants at Hankow. The former is entire leaf and twig loosely pressed, while the latter is tea-dust firmly compressed into actual brick-shape. Beyond Tong-ching Hsien the valley contracts, and the hills on either side become more precipitous, rocky, and uncultivated ; frequently the bed of the stream occupies the whole valley, while the road runs along the hillside. Some distance south of the city the hills are thickly dotted with the Tea-shrub growing on very rocky ground, and you meet a number of carriers with bundles of brown leaves and twigs, which might have been taken for dead leaves collected for firewood, but which turn out to be 'tach'a,' or coarse Tea.

THIBETAN BRICK TEA.

I am in a position to give information anent the making of Brick-tea, as at one time I went in largely for the manufacture of it.

I had the recipe from a Thibetan, and the tea I made was said to be very good by the Lepchas and Bhootias who tasted it,—in fact as good as the Brick-tea from China, of which I believe the Grand Llama of Thibet has the monopoly. I must own I never had the pluck to taste it myself.

The manufacture of this tea would be very profitable if it were not for some difficulty about the sale of it, occasioned, I fancy, by the said monopoly of the Grand Llama. The bricks fetch about Rs. 4 apiece, and cost scarcely anything to make ; but the trouble is in the selling. They cannot be sold wholesale, and even sold retail they have to be smuggled through some influential Llama or Mundle, who sells them for you under the pretence of their having come from China, &c., and of course expects a commission *almost* as large as a Calcutta broker would.

The following is the process, and I have explained the apparatus separately :—

1st.—It must be understood, Brick-tea is not made from the young leaves, like ours, but from the old ones cut off in the pruning in the cold weather.

These leaves, stripped off the branches that have been pruned off, are *boiled* in a large cauldron in water passed through ashes, (keranee ka panee) until the water is nearly evaporated, and the leaves are in a glutinous state, which takes about an hour and-a-half.

2nd.—On being taken out of the cauldron they are beaten with a large wooden mallet, in a box made sufficiently strong for the purpose, until they are in a pulpy state.

3rd.—They are hammered into the mould with the mallet, and a little congè water, from boiled rice or starch, is mixed with them to help them to cake. Of course the leaves should be slightly above the mould when it is full, as the pressure put upon it soon brings the brick down to its proper size.

4th.—They are put into the press, and kept there for 24 hours. Of course the press is managed in such a way that any number of bricks can be put in at the same time, and those that are ready can be taken out without interfering with the rest.

5th.—On taking the bricks out of the press, they should not be taken out of the moulds at once, but left for 12 hours or so ; and on being taken out, they should be placed in a rack over a slow fire, that they may *thoroughly dry* :—this is very important or they will get mouldy.

6th.—They should then be stacked in a dry place, such as the loft of a drying-godown, and should be occasionally looked to, and wiped, if any signs of mildew are observable on them.

This is the whole process of manufacture. The apparatus required is :—

1st.—The cauldron,—a copper " dekchee." The largest procurable is the best.

2nd.—A stoutly-made box and mallet.

3rd—The moulds, 15 inches long by 9 inches broad by 6 inches deep. These should be dove-tailed with a pin to go through the corners, so that they can be opened out and put together again without injury to them or their contents.

4th.—The press. The best kind to use is a beam about 20 feet long, fixed at one end on an axle, and weighted at the other end. Any amount of pressure can be put on by this means, and it is preferable to a screw, as it is a continual pressure.

J. P. B.

DRY AND WET TEA IN BURMAH.

The Revenue and Agricultural Department of the Government of India lately caused inquiries to be made with a view to opening a trade in Indian tea in a compressed state (known as Brick-tea) with Cabul, Turkestan, Central Asia, Thibet, and Burmah. From Burmah the Chief Collector of Customs has furnished the following Note, submitted by Mr. Hardings :—

" There is little doubt that the tea-leaf used by the Burmese, which is imported from Mandalay in the dry, as well as its wet state, is obtained from the plant *Thea Chinensis*, the tea of commerce, growing in its wild state on the slopes and hills in Upper Burmah to the north and north-east from Mandalay to Bhamo. A leaf taken from a sample of the tea sold in the bazar has the same minute serrations and is like the ordinary tea-leaf in shape, and possesses the same aroma ; moreover, from reliable information received, I find that the Burmese tea-leaf is gathered from a bush or shrub never more than eight or ten feet in height, which grows on the slopes ; women and girls being employed in plucking the leaf from the higher branches, and little children from the lower ones. The average price of Burmese dry tea in Rangoon, compressed into balls, is from Rs. 85 to Rs. 90 per 100 viss (365 lbs.), and is used by them (just as we do) in infusion, sweetened with palm-jaggery, but is not used to a very great extent. It is said that the better classes of the Burmese now prefer the cheaper China tea in infusion. It is noted that the Burmese tea can be purchased here by retail at a little over 5 annas per lb. Dry tea-leaf compressed into large cakes of a coarser description is also imported into British Burmah from Mandalay, and sells at from Rs. 80 to Rs. 85 per 100 viss, and is consumed by the poorer classes in infusion. But it is the *wet* tea-leaf, which enters into all the domestic or religious ceremonials of the Burmese, which is the most consumed by them, for no marriage, or birth, or death, or ear-piercing, feast, or any other event would be complete without the introduction of delicious morsels of the *wet* tea in (what is known) its pickled state, to be eaten by the guests invited thereat. It is also lavishly given to the ponegyees, who, no doubt, are large consumers. The information I obtained is, that, after the leaf has been gathered on the hills, it is packed in baskets, and brought down to the waterside, damped, and sent down to Mandalay, where the following process of "curing" or fermenting the leaf is practised :—It is first steamed, and then spread out on mats to dry ; when dry, the leaf is deposited in a pit lined with bamboos, or the large leaves of a tree common in Upper Burmah, and pressed down layer over layer until the pit is filled up, when it is covered over with the branches and leaves of trees and earth heaped over it. The tea leaf is left in that state for a month or six weeks, when it is considered fit for market use, being often sold on the spot while the leaf is in the pit, (each pit, according to size, being supposed to hold a certain number of viss) ; otherwise the leaf is tightly compressed into those curiously-shaped bamboo baskets with two heads or knobs on the top (so familiar to travellers on the Irrawaddy) : the baskets are than submerged for days in a creek near by, heavy weights being placed on them to prevent them floating up ; they are then taken out and shipped into Lower Burmah, the great secret being always to keep the tea wet. The leaf, as prepared above, is eaten in its moist state, and undergoes no process of cooking. The addition of a little tilseed oil, a few slices of fried garlic, a sprinkle of salt and tilseed, and sometimes a little scraped cocoanut, is all that is required to make it the most enjoyable zest a Burman cares to partake of. The wholesale price of the wet tea in Mandalay is from R. 120 to Rs. 150 per 100 viss, and the retail selling price in Rangoon is Rs. 2-8-0 per viss. One Pho Thoung, a wealthy trader of the Kyouktada quarter and also a commissariat contractor, engaged a few Shans and Burmese, and sent them to Bengal, and from thence to certain Chittagong tea-gardens, to manipulate the tea-leaf in its wet state (as eaten by the Burmese), and since that time similarly prepared *wet* tea as received from Mandalay has become an article of import into Rangoon by the seabord, from Chittagong. It sells in the bazaars at from Rs. 120 to Rs. 125 per 100 viss, or a little cheaper than the Upper Burmah leaf, but, it is said, the Burmese prefer the latter. One curious custom which obtains amongst the Burmese engaged in the wet tea-leaf trade has been related to me with the greatest gravity and good faith :—Should any person, male or female, living in the house of a dealer who may have a stock of, say, 50 to 100 viss in his house, get very sick, and if death is apprehended, he immediately removes his stock into another building, for were such person to die while the tea was in the house, the whole of it would turn bad and be completely spoilt. It appears that they implicitly believe in this incredible phenomenon. I have shown the samples received to several people here, who looked grave when told the cost price (9 annas to 11 annas per lb) in Calcutta, and which led to the remark being made, that 'it would answer as a shop article to be sold in European shops.' To secure a ready market for it in Burmah, the cost of manufacture should certainly be reduced below Rs. 205 and Rs. 250 per 100 viss, which at once goes against it, compared with the price of the dry preparations already alluded to."

The Chief Collector of Customs is of opinion that there is little or no hope of opening out a trade in Burmah in the compressed tea prepared in Calcutta. Large supplies of ordinary tea are received from China through the Straits ports, and are retailed in the local markets by Chinese at much lower prices than those quoted for the compressed tea, while the latter cannot take the place of the pickled tea so largely consumed by the Burmese.

SECTION XXIV.

TEA IN INDIA OUT OF BENGAL.

TEA IN DEHRA DOON.

TEA IN CASHMERE.

TEA IN THE NILGIRIS.

TEA IN THE ANDAMANS.

TEA IN ARRACAN.

TEA IN INDIA OUT OF BENGAL.

It is somewhat surprising that Tea-cultivation has not more largely developed than it has done outside of Bengal. We can only suppose that difficulty and cost of transport is at the bottom of it. Kangra and Kumaon grow very fine Teas, which fetch high prices, but their chief sale is local to the Provinces; and owners seem to hesitate about large extensions, on account, as we say, probably, of the heavy expense involved in bringing the Teas down to port of shipment. The progress of Tea-cultivation in the N. W. P. is also slow, and seems likely to continue so. The climate is somewhat too dry, and the Teas are hardly strong enough in liquor, and do not fetch high prices; but the cost of cultivation and manufacture is cheap.

Cashmere has now entered the field, but for local supply only; while, in the Nilgiris, increased attention is being paid to Tea extension, both for local consumption and for export; but the Enterprise is still on a comparatively small scale there. Tea Cultivation is also being carried on, on a very small scale, in the Andamans; but the attempt there, though so far successful, has no Trade significance.

The following Notes on Tea in India out of Bengal will show how far progress has been made to date :—

TEA IN DEHRA DUN.

The origin of the Tea Industry in the Dun dates back some forty years ago. Dr. Royle, then Superintendent of the Botanical Gardens at Saharunpore, recommended the cultivation of Tea in the Himalayas to the Indian Government in the year 1827, and again pressed the matter on the attention of Lord Bentinck during his visit to Saharunpore in 1831. In his opinion, Jerrapani, situated about half-way between Rajpore and Mussoorie, at an elevation of about 5,000 feet, was the best site for the experiment. About 1834 Lord Bentinck, with the sanction of the Court of Directors, determined to give Tea Cultivation a fair trial, and the inevitable Committee was appointed to draw up a plan for carrying out this design. Guided by the fact that, "in the mountainous tracts of our northern and eastern frontier, several species of plants are found indigenous which are also natives of China, and are not met with in other parts of the world," plants raised from imported China seed were distributed to several of the Sub-Himalayan districts; and Dr. Falconer, Dr. Royle's successor, in May 1838 succeeded in growing tea-plants in Saharunpore itself, from seed procured from Nurseries at Koth, in Gurhwal. In 1844 a Government Tea-plantation was commenced at Kaulaghur in the Dun, a couple of miles west of the city of Dehra, under the management of Dr. Jameson; some 400 acres of land having been taken up for the purpose. The soil is described, in Williams's *Memoir of the Dun*, as "composed of clay and vegetable matter, with a slight mixture of sand, resting on the usual shingly subsoil of limestone, sandstone, clay, slate, quartz, &c., found in the surrounding mountains." In 1850 Mr. Fortune, a gentleman familiar with Tea-cultivation in China, was deputed by Government to visit the various Plantations, and reported rather unfavourably on the condition of the plants at Kaulaghur, making various suggestions for the improvement of the cultivation. Again in 1856 the same gentleman reported much more favourably on the Garden.

In 1857, Dr. Jameson estimated the tea-bearing capabilities of the Dun as follows :—

Number of acres capable of producing tea ...	100,000
Yield per acre	100 lbs.
Total outturn	10,00,000 ,,

This appears to be a greatly-exaggerated estimate as regards the area available. Tea in the Dun, though unable, perhaps, to rival the large out-turns in Assam and Cachar, which are known in some cases to be as much as 700 to 800 lbs. per acre, is yet capable of producing at least four times as much as Dr. Jameson allowed ; one Garden of the Dehra Dun Tea Company showing an average for 1877 of more than 400lbs. per acre. On the other hand the area likely to be available for cultivation is considerably over-estimated. Including the southern face of the Mussoorie hills, from the watershed down, and the Northern face of the Siwaliks, the total area of the district is about 450,000 acres. Of this, fully 250,000 acres must be deducted for forest reserves, the area of the Stations of Mussoorie, Rajpore, and Dehra, and for the numerous village sites. Of the remaining 200,000 acres, it is improbable that any of the area at present devoted to the cultivation of cereals and other crops will be given up ; nor would such soil be profitable for Tea Cultivation. Deducting this area, and allowing for the considerable amount of unprofitable land, such as the banks and beds of the broad stony "*sots*" or streams in which water flows only in the rains, it is improbable that more than 50,000 acres of land are practically available for the cultivation of Tea. Taking into consideration the fact that Tea-gardens required considerable amount of capital to start, and entail waiting several years for any profitable return, it would appear that 15,000 or 20,000 acres is about the largest admissible estimate of the area of land in the Dun likely to be brought under Tea, at least for some time to come.

Several Tea-gardens were opened out in the Dun within the decade succeeding the commencement of the Government plantation at Kaulaghur ; and by the year 1862, about the same time as the elder Williamson was planting out Garden after Garden in Assam, and several Tea Companies had been formed there, the present Dehra Dun Tea Company, comprising Hurbunsuala (formerly the North-West Tea Company's Garden) and Arcadia, was started. The Dehra Dun Company has passed through many vicissitudes and changes of management, but now,with a local board of direction, and two thoroughly practical and experienced planters as managers, its Gardens are undoubtedly among the best in the Dun, and are doing fairly well.

TEA CULTIVATION IN CASHMERE.

The Maharajah of Cashmere having become satisfied with the results of the Experimental Gardens planted in the different Districts of his Territory some years ago, has approved the introduction of Tea Cultivation on a large scale in his dominions. The Superintendent of his Improvement Department, a year or two ago, personally visited the Kangra Valley, for the purpose of selecting Seed. He bought 2000 Maunds of the finest seed obtainable, and this was sown in a carefully-selected site. The Nursery-bed was 4000 feet above sea-level, by the roadside of the Srinagar road, and facing a high mountain with snow-covered peaks. The spot is three stages from Jummoo. The plants are now growing luxuriantly, and there is no sign of Blight.

A greater portion of the cultivation, on a first light plucking, yielded 3,000lbs. of made Tea, all of which was sold in Cashmere itself at good prices. The Tea is said to be of good quality and flavour, and readily fetches, locally, from 10 to 12 as. per lb. As the cultivation is sure to increase, the Maharajah should now employ skilled European management ; or perhaps, better, he might lease his Gardens to a European planter or planters. He would then know the most that could be made of them, and be able to judge as to the wisdom or otherwise of further extensions.

TEA IN THE NILGIRIS.

As we have before mentioned, Tea in the Nilgiris has been seriously undertaken, and with every promise of success. There is the advantage, also, of nearness to the port of shipment. There is little or no Labour-difficulty, but Government are occasionally found troublesome in regard to the acquisition of Land. Another drawback is, that the smallness of the Gardens prevents the erection of adequate Buildings, &c., whereby a uniformity of manufacture might be secured; but as Extensions take place, this will become remedied, doubtless.

Mr. Robertson, in his Report on the Nilgiris, writes as follows :—

The manipulation and curing of the leaf is the most difficult part of the tea-planter's work, and the value of the manufactured tea altogether depends upon the skill and care with which this is performed. It matters not that the leaf may have been produced under the most favourable conditions of climate, soil, and manure, if the curing is defective. The great drawback to the general consumption of Neilgherry teas, is their varying character, each plantation and garden producing different samples and qualities : these teas are thus, to a great extent, kept out of the wholesale market. If tea-planters, instead of each attempting to cure the leaf produced, would raise the capital amongst themselves for establishing, in each centre of Tea-cultivation, large, well-equipped Factories, in which the leaf of the district could be properly cured under skilled direction, they would be able to produce a tea of an uniform sample and quality, which could be sent in quantity into the wholesale market, where it would take a definite position. One such Factory could be worked at far less expense than the ten or a dozen small tea-curing houses which it would displace; and, under good management, there would seldom be any more difficulty in conveying the fresh leaf to the Factory than is now experienced in carrying it to the present curing-houses.

We doubt whether the scheme proposed by Mr. Robertson could be satisfactorily carried out. If the Gardens are only within a radius of 4 or 5 miles of some central point, the proposal might be feasible, and in such case the plan suggested is a good one ; but if the Estates are situated any distance apart, the idea of a central manufacturing Factory would certainly not pay. There can be only one reason for the great difference in the quality of the teas turned out from the different factories, and that is, that the manufacturers are not experienced tea-planters, and manufacture the leaf each according to his own idea. If the same system were adopted by every planter, there would be no cause for such complaint as Mr. Robertson puts forward. The Report gives, on the whole, a very favourable account of Tea Cultivation in the Nilgiris.

At Kotagiri, Coonoor, and other places on the beautiful hills of the District, the tea-bush is found to flourish remarkably well, and to possess, when manufactured, a full though fairly delicate flavour.

Assam hybrid seems to be the most suitable variety for the Nilgiris, where both soil, situation, and climate, are undoubtedly well adapted for Tea Cultivation. Bushes attain, in South India, a magnificent growth, and afford very large and profitable plucking-surface. The average prices realized for Nilgiri Teas are good, and the yield per acre is highly satisfactory.

A planter of experience writes as follows with reference to Tea Cultivation in the Wynaad :—

" I find 4 by 4 the best distance to plant: this would give 2,722 trees to the acre: 6 by 6 quincunxed would not give quite so many per acre, and I do not think it would be so easy to work, and certainly would not look so well. 400 lbs of made tea per acre may be confidentially looked for at 3,000 feet elevation in Wynaad. *I am not sure that there is any preference for forest-land over good grass, for Tea.* I have it growing very well on abandoned coffee-lands, but I am doubtful about it lasting so well as on land that has not been cultivated. I find that from the bush to the bin, the teas, ready for assorting and packing, cost about 1 anna 8 pice per lb. This only includes packing, rolling, firing, and making charcoal. We roll with a Kinmond Centrifugal Roller, worked by water-power, but we fire, in the old fashioned way, over chulas. Were we to use a Kinmond Dryer I do not suppose the cost would exceed 1 anna 6 pies. Cultivation, &c., has to be added.

" Machinery for Tea is more expensive than that for Coffee. Our Roller, with 32 feet $3\frac{1}{4}$ in. leather belt, cost £106 8s. at the Docks. A small-size Kinmond Dryer, with driving-belt, cost £156 95s. at the Docks, to which may be added 30 per cent. for putting on the Estate. Then, a 16-in. or 18-in. water-wheel would be required to drive the machinery. If it has to drive both Roller and Dryer, an 18-feet wheel would be best ; mine, to drive Roller, is only an Abernethy's 16-feet wheel (segment-wheel). It works beautifully I think for Rs. 2,500 a Tea-house sufficient for an Estate of 200 acres might be built of kiln-brick and clay, chunam-pointed and with upper batten-floor for withering leaf, and with a corrugated-iron roof. If a steam-engine is necessary, the cost would be much more, and a more expensive Building would be required."

TEA CULTIVATION IN THE ANDAMANS.

After a trip to Port Blair, a few years back, we brought prominently to public notice the existence of the Government experimental Tea-garden at that place, and strongly recommended the Government energetically continuing the experiment. We are glad to find that the hopes we then expressed of ultimate success are likely to be more than realised. The experiment was first commenced in 1878, the lot of tea-seed being planted in nursery-beds in February of that year. Lt.-Col. Berkeley took charge of the Plantation on the 12th April 1880, and found, on taking over charge, that the trees had grown very tall, some being as much as 8 feet high. The weather being favourable, he therefore pruned them in May. That he should commence pruning operations so late as the month of May will no doubt surprise many of our readers, but Col. Berkeley satisfactorily explains the enigma. He writes :

PRUNING.—This is the most difficult operation of all in the Andamans The tea-plant at the Andamans flushes the whole year round, thus altering the entire conditions of the plant. The usual time for pruning is from the middle of November (in some places October) to the end of January :—this is because in the Tea Districts in India the rain ceases in October, and the sap is down and the plant at rest during those months. In the Andamans the sap never ceases to flow until quite the end of the dry season. The seasons in the Andamans vary very much, and it may be possible some years to prune in November, but the time in the Andamans for heavy pruning is the beginning of the rains. Light pruning in November and December is desirable, but heavy pruning at this season is liable to destroy many of the plants. The sun being very hot in March and April, it is of great advantage to the Tea-tree to have a leafy covering to protect the roots throughout the hot weather. The best practice is to prune the trees after the hot weather, directly the rains have fairly set in.

This is contrary to the course pursued in most places, but during the last two seasons the result of heavy pruning at this time has proved satisfactory, the rain commencing here early in May. The prunings are not buried between the plants, but put in a heap with other refuse to rot, as it is found at Port Blair that burying the prunings encourages white-ants.

A portion of the Garden gave a large yield during the year under review, no less than $5\frac{1}{2}$ maunds per acre being obtained off the $3\frac{1}{2}$ acres of Tea in bearing, and this from plants less than four years old from the time the seed germinated, and about three years from the time the young seedlings were planted out. The Commissariat Department purchased 1,501 lbs. 11 oz. of the Tea for Rs. 1,372-3-11, giving for Pekoe Rs. 1-2-6 per lb., for Pekoe Souchong 13 annas per lb., and for Dust 4 annas per lb. The Pekoe, we are told, sold well amongst the free inhabitants for Rs. 1-2-6 per lb. The Pekoe Souchong was issued to the European troops, who liked it very much. The Calcutta tea-brokers reported very favourably on the samples of teas sent them for testing, the valuations given being, for Pekoe Rs. 1-2, and for Pekoe Souchong 0-12-6. Of the three varieties of the Tea-plant, the Indigenous, the China, and the Hybrid, the Hybrid has been the most successful.

TEA IN ARRACAN.

There seems to be a good field for Tea Cultivation in the province of Arracan. The only area at present under cultivation consists of some 100 acres, the production of which is stated as between 20,000 and 30,000lbs. annually. The price realized in London has been from one to three shillings per lb., while in Rangoon it appears impossible to buy Arracan tea under 2 rupees a lb. The Burmese are inveterate tea-drinkers, and there is apparently no limit to the demand which could be created were Arracan tea sold locally at a much more reasonable price, which would clearly be practicable, with still a large margin of profit. What is wanted is extended cultivation.

SECTION XXV.

TEA IN CEYLON.

THE TEA INDUSTRY OF CEYLON.

TEA CULTURE, &c., IN CEYLON.

TEA YIELD IN CEYLON.

TEA IN CEYLON.

THE Tea Industry of Ceylon has now attained such a prominent position in that Island, that a WORK of this kind would hardly be complete without special reference to Tea Origin and Progress there ; and although the system of Cultivation and Manufacture is different somewhat from ours, there may still be something to be learned from our not-so-very-far-off neighbours. It will be interesting, also, to note what solid success has attended steady pluck and perseverance ; for at first it was by no means an easy task for our neighbours across the sea to acquire the necessary experience in what was a comparatively unknown Product in the Island. But the planters of Ceylon set to work with a will ; and they not only studied the subject of Cultivation and Manufacture as practised elsewhere, but by discriminatingly adapting the knowledge thus gained to the peculiar features of their own soil and climate, they have succeeded in securing a success which is the more remarkable from the comparatively short time in which it has been achieved. The efforts made have exhibited that Anglo-Saxon pluck which has so often overcome large difficulties. Not overwhelmed by the serious crisis which occurred in COFFEE, the Planters of Ceylon set themselves bravely to work to create for their Island a new Industry ; and the example set may not unprofitably be studied by us in India, where, doubtless, "fresh fields and pastures new" still await the thoughtful and persevering ; for there must be, and doubtless are, other branches of Industry in India than those at present occupying European capital and energy, which could be turned to account in the further development of the resources of this great Country, as well to the benefit of those who may embark their capital and energy, as to the advantage of the thousands whom that capital and energy may employ.

It is true that, as regards Ceylon, planters there had not so much to *unlearn* as we have had to do in India, where, by reason of reckless and unthoughtful speculation, with want of due knowledge at the commencement, the Indian Tea Industry stood at one time to run imminent danger of almost total wreck ; but, still, the Ceylon Planter had much to *learn,* and, like a sensible business man, he set himself earnestly to work thoroughly to learn it. In doing so he had to bring to bear the fullest amount of Thought and Observation, for the climatic peculiarities of the Island rendered useless any slavish copying of mere Indian methods. The care and intelligence displayed by the Ceylon Planter has borne its fruit in the creation of a rapidly-spreading and remunerative INDUSTRY, which will go far to recoup the losses which COFFEE has entailed ; and it is not too much to say that we have a sturdy and worthy Competitor,—(we will uot say Rival,—for our interests are really one) in the Crusade against China, which latter is bound, in the not remote Future, to become of smaller and smaller account in the Tea-consuming world. It is, no doubt, a hard struggle to conquer a great vested Interest ; *but we are doing it,* and

Ceylon is becoming no mean ally in the process. We say, therefore, All-hail and Good-fellowship to our Ceylon Tea Brethren ; and may the united power of Purity and Real Economy, in as early a time as possible, triumph over Inferiority and Adulteration,—and so China be left behind ; for in the honest and good Fight we are making, China deserves no consideration, part, or lot.

Several Indian planters have, in the last few years, found their way to the Ceylon Tea-fields, and we believe in no case have they had to turn back disappointed. There is, probably, room for still more, and we are sure that the advent of Indian Tea-planters will be always welcomed in Ceylon, where Tea Cultivation is so rapidly increasing, and promises still further to increase.

A significant fact as to the confidence which is becoming felt in the progress of Ceylon in the prosecution of her new Enterprise, is, that the terms upon which a new Ceylon Loan has been lately issued are highly favorable, and if Ceylon can beat India in yield per acre and cheapness of production, and, further, can equal India in quality of Tea, there is no wonder at the confidence which is being manifested by capitalists at home.

According to Messrs. Geo. White and Co., recent sales of Ceylon Teas averaged 1*s.* $3\frac{3}{4}$*d.* per lb. as against 1*s.* $1\frac{7}{8}$*d.* per lb. for Indian Teas as given by Messrs. W. J. & H. Thompson ; but the averages of Ceylon Teas have been even higher. The Ceylon shipping-season closes in September of each year. Taking the figures, then for eight years, we find that there has been a continuous gradual increase of Export, from 282lbs. in 1876 to 623,292 lbs. in 1882 ; and a further remarkable stride from the figures of 1882 to 1,522,882 lbs. in 1883.

It is calculated that there is not less than a total of a quarter million of acres, in the Eastern Provinces alone, suitable for Tea ; and there seems little reason to doubt that this area will in due time fall under Tea-cultivation. We trust, however, that the Ceylon Tea Enterprise will be allowed to grow gradually from natural causes of demand, only, and not be rushed unadvisedly.

THE TEA INDUSTRY OF CEYLON.

The following Articles appeared some few years back in the Ceylon Papers, but we have purposely selected them on that very account, as showing the "faith" that animated the pioneers of the Ceylon Tea Industry, in its earlier days.

The Lecture delivered by Mr. Armstrong is itself a carefully-thought-out Paper on Tea Cultivation as it should be, in Ceylon, and will be read with interest, as a comparison with our own systems.

Although the Tea-plant was grown in Ceylon a quarter of a century ago, and has been cultivated on a small scale for more than a dozen years, it was only when the increasing depression in the Coffee-trade was sensibly felt, that the area of land under this new Cultivation began rapidly to increase. Tea was grown in half a dozen localities, all more or less at a good elevation, in what is known as the Coffee-zone, say from 2,500 to 5,500 feet. For several years, however, this new Industry had to contend against prejudice or indifference in the home market, and in some instances against a lack of experience in the manufacture of the leaf on the part of our planters.

Two of our oldest and best-known brands, those of "Rookwood" and "Loolecondura" estates, steadily rose in public estimation at home; but Ceylon teas, as a rule, attracted very little attention from buyers, and were scarcely noticed in brokers' reports until a few years ago, when improved cultivation and more careful manufacture enabled far better samples to be shipped. These at once attracted the attention of the Trade: consumers very shortly afterwards found the quality of our teas superior to most China leaf, and equal to the best breaks from India; and, as a consequence, the article rapidly rose in public estimation. Tea-brokers now notice our brands with marked approval, and one of the leading Firms in Mincing Lane now publishes a fortnightly Circular devoted entirely to Ceylon Teas, while all give a place to the now frequent sales of this article.

The increasing favour in which our new Product began to be held has led to a very considerable extension of the area under Tea, and has attracted the attention of tea-growers and sellers generally to Ceylon as a desirable field of investment.

Our shipping seasons close on the 30th September in each year. Taking this period for eight years it will be seen how rapidly our exports of Tea have increased from very small beginnings:—

Season ending	30th September,	1876	...	282	lbs.
Do.	do.	1877	...	1,775	"
Do.	do.	1878	...	3,515	"
Do.	do.	1879	...	81,595	"
Do.	do.	1880	...	103,624	"
Do.	do.	1881	...	277,590	"
Do.	do.	1882	...	623,292	"
Do.	do.	1883	...	1,522,882	"

During the last five or six years attention to Tea-planting has been extended to the lands of the low-country, both chena and forest, nearly all in the Western Province, where a rainfall of one hundred to a hundred and sixty inches occurs in the year, and at altitudes ranging from 2,500 to very nearly sea level. Owners of Coffee-estates, whose lands have ceased to be profitably cultivated, are planting them up with Tea, shewing very good results both as regards quantity and quality.

The Tea hitherto shipped has been the produce of about six thousand acres of cultivated land, and it is estimated that there are other four thousand acres also in Tea, not yet at a producing age. This area is quite insignificant as compared with the extent of land available, but the results obtained from it enable us to state with accuracy the financial outcome of this new Industry. There are two estates in their ninth year of production at altitudes from three to five thousand feet, and there are others at lower altitudes of less age, say, up to five years. The data obtained from a dozen or more of these shew that the annual yield per acre on high estates is 350 lbs. to 400 lbs. of Tea per acre, whilst on new land at lower altitudes, where the heat and rainfall are greater, as much as 600 lbs. and 700 lbs. per acre are obtained. Most of these returns have been obtained from trees which have not yet arrived at maturity, at an average of only four years.

The cost of cultivation of Tea-estates, and of the production of the leaf in all its stages until placed on board ship, may be set down at 30 cents for the produce of the low-country Estates. If, on a capital outlay of Rs. 400 per acre (which is a very high figure for bringing into bearing, even with all the necessary permanent buildings and machinery), we add interest at 10 per cent., we have Rs. 40 on a yield of 600 lbs. = 6 cents per lb., bringing up the total cost to 36 cents: this is the cost of hand-made tea; if machinery of approved makes be employed, a saving of at least 3 cents per lb. may be effected, reducing the total cost on board ship to 33 cents per lb.

The above cost of production is obtained by an analysis of the expenditure on labour and materials under the various heads of work, thus:—Cultivation, including weeding, and up-keep of roads, and

	Rs.	Cts.
drains, supplying pruning-tools, &c.	0	4
Supervision, allowances, up-keep of buildings, contingencies, &c. ...	0	6
Plucking green leaf, per lb. of dry tea	0	9
Withering, rolling, and firing	0	4
Labour, sorting, and packing	0	1
Charcoal for firing	0	1
Boxes, lead, and all packing materials	0	3
Transport to Colombo	0	2
Rs. ...	0	30

The cost of freight, insurance, and home selling charges, amount to 10 cents, so that any average result above 43 cents, local currency, will be profit. Recent account-sales of well-known marks have shown averages ranging from 1*s.* 3*d.* to 1*s.* 9½*d.*, equal to 75 cents and 1·30 per lb. at 1*s.* 8*d.* to the rupee.

Taking only the lower figures for our guide we find a gain of thirty-two cents per lb., which, on an Estate yielding six hundred lbs. per acre, shows a working profit of Rs. 192 per acre of land under cultivation, or nearly *fifty per cent.* on the capital originally invested.

The calculations of cost of working Estates and producing Tea are made on reliable data—the result of actual experience; and that the final results in prices realised are not extravagant may be seen from the following return of averages from the reports of Mincing Lane brokers :—

London.	*July.*	*August.*	*September.*
Sembawattie	1*s.* 7¾*d.*	...	1*s.* 9½*d.*
Blackwater	1*s.* 6¾*d.*	...	...
Adam's Peak	1*s.* 6½*d.*	...	...
Mariwatti	1*s.* 6½*d.*	...	1*s.* 9*d.*
Dolosbagie	1*s.* 6¼*d.*	...	...
Dunedin	1*s.* 4½*d.*	...	1*s.* ½*d.*
Strathellie	1*s.* 4*d.*	...	...
Oonoonagalla	1*s.* 3*d.*	...	...
Loolecondura	1*s* 3*d.*	...	1*s.* 9½*d.*
Rookwood	...	1*s.* 5¼*d.*	...
Imboolpitiya	...	1*s.* 4¾*d.*	...
Aberdeen	...	1*s.* 4½*d.*	...
Calsay	...	1*s.* 3¼*d.*	...
Kandaloya	...	1*s.* 3¼*d.*	...
Culloden	...	...	1*s.* 11⅞*d.*

There is no lack of suitable Tea-land in Ceylon within easy reach of road or river, and at no great distance from the Coast. The upset price is Rs. 10 per acre, exclusive of survey and other fees, but competition may probably double and treble this rate before long. Careful calculations by experienced surveyors show that there are not less than 120,000 acres of Crown jungle available in the Western Province, 80,000 in the Southern Province, and 30,000 acres in the Eastern Province, making a total of nearly a quarter million of acres, irrespective of Coffee-land within the higher mountain zone, suitable for Tea. Ceylon, therefore, presents most favourable opportunities for capitalists to invest in this branch of agricultural industry; the difficulties being so few, and facilities in cheap labor and proximity to the seaboard so manifest—*Ceylon Handbook.*

Mr. ARMSTRONG ON TEA CULTIVATION IN CEYLON.

Read before the Dikoya Planters' Association.

My remarks to-day have more especial reference to the cultivation of Tea in what may be termed our Coffee-zone : in fact, to the practicability of Tea taking the place, in some instances, of Coffee, or of its being planted in forest-land adjoining our Coffee estates, and which we have thought too high for Coffee.

Throughout this Paper, I refer to Assam Hybrid Tea only.

At what elevations will tea grow at, in Ceylon, to pay ? From almost sea-level to over 6,000 feet, provided soil and aspect are suitable.

Soil.—Should be fairly good—the richer the better—deep and friable ; loam well mixed with sand. A shallow quartzy soil is not good. Tea will not flush readily in this, although it may grow to a fair-sized bush. A subsoil, well mixed with sand, or grit, without showing a very good surface-soil, will, although giving a slower growth at first, turn out a better-paying soil than one with a rich surface and clearly-defined clayey subsoil without an admixture of sand. The more we pluck, the deeper the roots must go, and we must have room for them. The higher our elevation, the richer should our soil be, to make up for climate,

Climate.—What is best for Coffee, will, I believe, *for a permanency*, be found to be the best for Tea. The *beau ideal* of a Tea climate is Avisawella, Yatiyantota, and the lower portions of Morawakorale, also portions of Ambegamuwa; but they have not our Coffee-zone subsoil as a whole ; and our zone will, I think, make up, in its deeper soil, for the want of extreme heat, with moisture, which prevails in these districts, where, however, Tea will rapidly make a fortune for its lucky proprietors.

The higher the elevation, the less rainfall is required, and *vice versâ*. Light showers, alternating with sun, if we could order them so, would give us 1,000 lbs. an acre at 5,000 feet elevation. At the higher elevations, continued rain at the height of the monsoon has the same effect in checking the flush for the time being, as a long continuance of sun has in the low country. Perhaps a good thing; for with us the bush has no wintering, and the only rest that of a 10lb. plucking, instead of a 24lb.

Site and Lay of Land.—Gently-undulating land, for choice, is the best ; but I have tea on steep land doing as well as that on fairly flat undulating land. In fact, any land that is most suitable for Coffee is most suitable for Tea. In our new district especially, we find our fields at the higher elevation making wood freely, but even at the best of times not giving much fruit. Where we have Coffee making most wood, there will our Tea do best. In my experience, I have had poor thin Coffee pointed out to me as beng suitable *only for Tea.* I say no ; if we are to expect Tea to pay, we must not pick out our thinnest or weakest, because washed Coffee, as being the most suitable site, but our free-growing leafy Coffee, that from either a bad aspect with good soil (and we often see this) or from too high an elevation, has always persistently run to wood, which we call leaf, in Tea. With such Coffee there need be no hesitation in at once planting it up with Tea. Again, we have Coffee that in the good old days has borne heavily, but that has now ceased to bear (temporarily or not, is beyond human ken) if we can expect occasional patches. *If the soil has not suffered from wash,* no matter what the Coffee may have borne in the past, Tea can take its place and flourish, as it has that in the soil to give it a start, and it can seek for nourishment far deeper than the Coffee has ever reached.

Land at 4,000 feet to 5,500 feet that has failed in Cinchona, provided soil and climate are suitable, will grow good Tea. I have now Tea, $3\frac{1}{2}$ years old, on land that I planted up four times with Cinchona (both *officinalis* and *succirubra*), and that failed completely, although no expense was spared in the opening and planting of it, doing as well as could be wished. Again, I have Tea doing well on abandoned Coffee-land that was cleared and planted $7\frac{1}{2}$ years ago with Cinchona, which died out at 3 to 4 years. Elevation, in both instances, was 5,000 feet and over. I have Tea also doing well in land that was under Cinchona for ten years.

Although Tea does well, remarkably well, up to 5,600 feet in my own experience —and I have had figures shown me proving that Tea, at over 6,200 feet, gives at 4 + 4, 400 lbs. per acre at 6 years old—it does not follow that all and any land, at these elevations, will give the same results. The higher we go the better our soil must be. We must be rather dry than wet; not absolutely without rain for any length of time; but this we need not fear near our mountain tops; and the more shelter from the monsoon winds do we require. I will treat further down of the yield per acre from Tea at the lowest to the highest elevations, and will now enter on *seed, nurseries, opening and planting of Tea, its cultivation and manufacture.*

Seed.—The greatest care must be taken to ascertain that the seed you obtain is from the highest-class hybrid, as, with a poor jât, neither care in the manufacture or cultivation can make a good liquoring tea, or give a profitable yield. Making allowances for poor plants, accidents, bad plants, and the having ample plants over for supplies, I calculate on the maund of 82 lbs. for 6 acres planted 4 by 4; a maund of locally-grown gives from 27,000 to 33,000 seed, according to the time that is allowed to elapse in weighing after husking; the sooner the seed is in the ground after gathering, the better.

Nurseries.—Choose the site as near a stream as possible, for the sake of water. Let the land be as flat as possible; make your beds 5 feet by 20 feet, with 18-inch walks (which act as drains) between them. If you are going to plant out at six months from seed, sow your seed 2 in. apart every way. I find a very useful little tool for this is one I made many years ago for picking out Cinchona—a flat board, with handles on the top, and pegs—50—underneath, any required distance apart. Press the board, the pegs being underneath, on to your prepared bed, and you have it marked out in fifties to the distance apart you wish to sow your seed. If your are going to plant them out at 1 to 4 years, 4 in. by 2 in., or, if space will admit, 4 in. by 4 in., sow 1½ inches deep if no shade. If your plants are to be forced to save a season, manure your beds, sow 2 in. by 2 in. apart and 1 inch deep, shade with flat tats of jungle-stuff 18 inches to 2 feet deep above the bed, and water freely twice a day. You may begin to remove the shade by degrees, as soon as the wood at the collar of the plant hardens. Unless it is necessary for your plants to save the season, do *not* manure, nor pick out too good soil, as plants grown in better soil than it is intended to plant them out in suffer a check from their first start in the clearing. Give your nurseries time; do not dig your beds more than 6 in. to 9 in. deep, or the tap-root, always unmanageable, will run deeper than ever. Every Tea-garden must keep a Nursery for supplies, which is a work we have to attend to every year. Stumps are best for supplies, and should be at the least two years old; even up to four, a permanent Nursery can be kept up in *poor* soil sown 3 in. by 3 in., and the strongest plants taken out for supplies.

Lining—In fairly good soil, 4 feet by 4 feet is the best distance; in poorer soil, 4 feet by 3 feet; on weak soil or exposed faces, 3 feet by 3 feet. It is as well to have 4 feet between the lines, as each line is almost a thoroughfare, from the number of times the pluckers have to move along it, as well as weeding-contractors, in the course of the year; and the proper growth of the laterals is in a great measure stopped, if the pluckers have to *force* their way through too much; and in any ordinary fair soil, at a nearer distance than 4 feet between the lines, no light or air can get at the soil or through the bushes themselves, and they become towards the middle of the season an entangled mass of unhealthy wood.

Holing.—If for plants at 6 months or I year from seed, in Coffee, or in new land, 9 in. × 9 in. will do well. If for stumps in Coffee or new land 18 in. × 18 in. If seed or germinated seed is to be sown at stake *in Coffee*, loosen the soil with the ordinary fork; this is better than holing, as we are all aware: the Coffee-roots soon find their way into and fill a hole in which the good surface-soil has been scraped to, in this case the detriment of the seed; the same holds good with regard to manuring a young seedling, which I have heard advocated in Coffee.

Plants and Planting.—The best plants are those at 6 months from seed, as they do not suffer the same check that a 1-year old plant does, and equal it in growth at 12 months from planting out; have not such unmanageable tap-roots, and stand sun better; will do with shallower holes; cost less to plant, and have a better hold of the ground at 12 months. The best of all is 2 to 4 years' stump-roots, which, at this age, are woody, will stand being broken—in fact cannot be raised from the Nursery (which should be in poor soil) without breaking them. They should be stumped as with Coffee at 6 inches, and have roots that will comfortably fit into an 18-inch hole, which they require. In fair soil, a stump can be topped at 3 feet in a year, and regularly plucked at 18 months onwards, giving a fine spreading bush.

Seed in Situ has its advocates. Its advantages are—cheapness in sowing out, and the good hold it gets of the ground: an advantage in windy sites. Its disadvantages are, in any *large* scale, greater first outlay in seed, as from two to three seeds are required at each stake; the liability of its being smothered (as seed) by wash; insect enemies; weeders (more especially among coffee); scraping off, unawares, the young shoot as it comes above ground; being trodden on by workers among coffee: also, a great loss of growth for the first year, in coffee, by being shaded by it. If you have no insect enemies, notably the black grub, which nips off the young shoot just above the ground, and it is desired to sow sites, germinate the seed first, and then one seed will suffice at each stake; and, although great care must be taken in sowing, I have found that, even if the root-germ is broken or wounded, it throws out a bunch of rootlets, and no harm happens.

Staking.—This is not generally thought necessary. However, I consider it *most important*; and wherever we have enough wind to have made it necessary to stake our Coffee, it it is there necessary to stake our Tea, up to two years old certainly, and sometimes even up to 3 years of age. A stake driven straight through the middle of the bush, without tying, will do at 2 to 3 years; at 1 or $1\frac{1}{2}$ years, it must be tied. Aloe-tape is best for this.

Topping.—First topping should be done at from 15 months, on aspects affected by the S. W. winds, to 18 months; 3 feet is the best height, or, at lower elevations, or on exposed ridges, 2 ft. 6 in. to even 2 ft. In topping, the coolie has a stick of the desired height, which he should place in the middle of the bush; the only care necessary is, to see he does not gather up a bunch of branches in his hand to cut at one operation, but cuts each singly as it grows; the result will be a perfectly flat surface across the centre of the bush, with many young laterals round the bush untouched, which will soon reach the level to which we have topped. When they, and the topped part, begin to run up, all should be nipped back to the second leaf below the bud, to keep as flat a surface as possible, giving, say, at 6 months later, or at 2 years of age, a bush with a fairly flat surface, which will have reached 3 ft. 6 in. to 4 ft. in height. This very slight plucking after topping must be carefully done, only plucking those shoots that show an inclination to climb, so to speak. The plucking with the topping is necessary to force the lower laterals up, and keep your bush down, and so form *surface*; otherwise the bush will grow up somewhat in the shape of a poplar, and surface be lost for years This plucking comes in useful in teaching your labour plucking and manufacture, and will eventually pay its cost in increased diameter of bush, and, therefore, increased yield.

Pruning.—This is a most important work, and in Ceylon must not be too severe, yearly; more especially if your bushes are topped early. It should take place from June to August, in any part of Ceylon; perhaps July is the best month. There are three ways of pruning:—1st, with a flat surface; 2nd saucer-shape, *i. e.*, hollowing out the centre; and 3rd, hacking down the bush. This last is murder, so I will pass it by without further remark. Saucer-shape pruning does well for a time, but inclines to too matted a growth in the centre of the bush, which leads to too heavy a pruning yearly: more costly, and bad eventually for the bush. I have no doubt, myself, that pruning with a flat surface is best; so I will only treat of this mode.

When our branches *after* topping have reached up to, say, 3 feet 6 in. to 4 feet, having been kept down to this by plucking at 2 to $2\frac{1}{2}$ years of age, according to whether the planting was done in the N. E. or S. W. (I am referring to Tea at from 3,000 feet elevation upwards), they should be again cut to a level surface at 3 feet 3 in., or, if topped lower as explained above, 3 inches above the topping. Any thin, whippy branches trailing on the ground should be cut off close to the stems with a clean cut, and this is all for this year. Next pruning season, when our bushes will be 3 to 3½ years old, they should be first topped to 3 ft. or 2 ft. 6 in. according to elevation of garden, with a flat surface. All cross wood (*i e.* branches growing *through* the bush) and all white-barked whipping-branches, wherever growing, should then be cut off with a clean cut close to the main stems or branch, and all growth encouraged outwards and upwards. No laterals should be cut back, except those growing into the bush, which, as I have said, are to be entirely removed ; but every branch should be topped or nipped back, whether it has reached up to the limit of growth allowed—*viz*, 3 ft. or 2 ft 6 in.—or not. Thus we have given our bushes their first real pruning, and have got them into shape, which, with little pruning, they will keep for 4 years. Our procedure yearly for 4 years is then as follows, always keeping a flat surface :—1st year, our bush being 4 to 4½ years old, top at 3 ft, 3 in. ; 2nd year, at 3 ft. 6 in. ; 3rd year, at 3 ft. 9 in. ; 4th year to between 3 ft. 6 in , and 3 ft. 9 in. ; or if topped at 2 ft. 6 in., rising 3 in. yearly, keeping as much *red* wood as we can, and removing *each* year thin white-barked whippy branches, and cutting out all crow's feet from the surface, caused by plucking, leaving not more than a single fork on each branch at the surface ; 5th year cut down to 3 ft. or 2 ft. 6 in. at lower elevations, or just below the original cut, and proceed as before. Thus, low topping and heavy pruning is best done every 5th year. At our higher elevations, say, 3,500 ft. upwards, we can top our bushes far higher than at the lower elevation, and so get increased surface. The flush does not run up from the bush in the same manner it does lower down ; our limit here, however, should be at the outside 3 ft. 9 in.

Exceptions.—Some bushes sulk, either from over-plucking or from bad wood, or from some other cause. These should have the knife applied freely, either by being cut down to 18 in , or by removing, with the aid of the same, one or two of the main stems in the centre, cutting down the outer growth as well, to 2 ft. or 18 in. The centre thus opened out will send up a new growth. These bushes should not be plucked till they are well up, say, to 4 ft., when they can be plucked and then topped with the knife to 3 ft.

PLUCKING.—This again is a most important work, and requires close supervision. As a rule plucking can be begun at 30 to 40 days after light pruning—I am speaking of coffee-zone teas, be it remembered—and should not be begun till the bud, with opened leaf attached, and half the next leaf, can be plucked at one operation, *leaving on* one, or sometimes two, fully-formed leaves to carry on the young shoot. The shoulder of the half-leaf plucked remains on, and protects the eye at its base, which in its turn throws out a shoot. Shoots, according to elevation, will measure 6 in. to 9 in. long *before* the first plucking, after pruning takes place. In after-plucking, a good deal depends on the number of leaves on the shoot. If, with the bud and its partially-opened leaf, we have four full leaves, then I should pluck at the second leaf down (leaving on the shoulder of this leaf, which protects its bud, and will probably give red leaf if removed) at one operation, and again half the third leaf at another operation, leaving one fully-formed young leaf on the shoot. Towards the end of the season, when the bushes are well up, I would act as above, only plucking at the third leaf, leaving its shoulder on the stem, and thus removing at one operation a half-leaf and the shoot consisting of two leaves and the bud. One simple rule in plucking is to avoid having a bare shoot without a single leaf to help on. As in most things, a practical lesson is best in plucking. As for the number of days in which it is necessary to go round the Garden, I learn, at a low elevation, it is considered necessary, according to the time of year, to get round in 7 to 10, up to 12 days at the longest. At high elevations, I have found, in my *best* months, I should get round in 10 to 12 days to keep pace with my flush, and again in 15 to (in the very cold weather, December to January,) 20 days. I do not think any hard-and-fast rule should be laid down, at any elevation, as to time. It is for the manager to watch his flush, and wait on it *just* long enough but no longer ; and not to rush violently round his estate in a given number of days, which *must* lead to over-plucking, which means a reduction in the yield sooner or later, although perhaps higher prices for the time being. The benefit of *this* is also in a way nullified by a smaller out turn, My average runs this season, from, in my worst month, 10 lbs. up to 29 lbs. of leaf per coolie, including children. Some of my best pluckers have brought in from 36 to 47 lbs.; in ordinary months, I average from 20 to 26 lbs. My plucking last season, 1881-82, cost $\frac{3}{5}$ cents per lb. of Tea. This season it will cost 6 cents. Leaf should be weighed in twice, daily—at mid-day and at knocking-off time. It is best plucked into the ordinary cooty-sack, and emptied into cane or bamboo baskets of the following dimensions, to avoid any chance of tight packing:—2 feet high, 18 inches across bottom by 1 foot across top. Cane baskets cost me 62 cents each; bamboo 25 cents to 37 cents, but cane are the cheapest in the long run, and nearer the cane-country than I am, would probably run from 37 to 50 cents each. Leaf must not be pressed down in either cooty-sack, or basket. Each basket is best kept by its owner in the line he is working in. The cooty-sack should be repeatedly emptied into it to avoid any risk of fermentation. As soon as weighing-in begins, leaf should be removed without delay to the withering-shelves. Both baskets and cooty-sacks should be taken in after the last delivery, or the coolie may use them to carry bazaar-stuffs, which may taint the leaf, and in any case they get smoked in his lines. *Bangy* tips, *i. e.*, a hardening of the bud and stoppage of growth, should always be plucked. If the single leaf of which it consists is soft, it can be utilized; if not, it should be thrown away. It is as well to take the opportunity of any small plucking to nip off all bangy; the next eye will then nearly always throw out a free running shoot.

Withering.—The most simple and best shelves for this are formed of a framework of reapers, covered with sacking—6 feet long and 3 feet 4 inches wide—the reapers forming this should be $2\frac{1}{2}$ inches wide by 1 inch thick; it takes $1\frac{1}{2}$ sacks to cover this, or Jute Hessian forms a good cover. It is most convenient to have 12 of these shelves hanging at 6 inches, one above the other. The reaper forming the front and back of the frame should project $1\frac{1}{2}$ inches; these projections are rounded off, and at the back are let into holes cut in an upright post to fit them, in front. The projecting ends serve to hold up the shelves by fitting into knotted loops 6 inches apart, in rope, suspended from the roof. When it is desired to empty them, it is done by simply pulling out the ropes at each end, when the shelves hang flat down on their hinges, throwing their contents on the floor. The upper shelves are reached, by the coolies who lay out the leaf to wither, by 3-legged stools, 3 feet high. Leaf should be spread as thin as possible, and turned over once during withering—a shelf of above dimensions, 6 feet by 3 feet 4 inches, holds, very thinly spread, 2 lbs of leaf, or at a pinch it will wither safely up to 4lbs., but not more. Say we put on 3lbs. in full plucking-time, we require about 6 feet per lb. of leaf.

Leaf is properly withered if, when held tight in the hand, it does not crackle, and keeps the shape into which you have pressed it: properly-withered leaf is best told by touch, which experience gives us after a time. Leaf, to give a good make, that is twist, and colour of infusion—copper-colour—should be well withered, soft to the touch, not dry or crisp; under-withered leaf will not give a malty liquor, and the larger leaves (souchong) break in rolling, probably lessening the value of your broken pekoe: nor is the make so good as with well-withered leaf.

Rolling.—Rather overdo this than under-roll. When the leaf is properly rolled, it shows a good even twist, is very soft, and gummy to the touch. Liquor that exudes during the process of rolling should be mopped up by the leaf, now called *roll*. In hand-rolling it saves tip if, when the rolling is half finished, the leaf is sifted through a No. 4; that which remains in the sieve is rolled separately; that which comes through *lightly* finished off. A man can take 2 lbs. of withered leaf to roll at one time, and it takes him 20 minutes to finish it.

Fermentation.—After your leaf is sufficiently rolled, break up the roll well, so as to have no lumps in it, and place it lightly in saucer-shaped baskets of bamboo or cane 8 inches wide by 6 inches deep; these again to be placed inside a sack to ferment. Each basket holds about 12 lbs. of roll. No actual time can be laid down for fermentation, as it all depends upon the day or time of year. In cold weather, at 5,600 feet, I have waited for $6\frac{1}{2}$ hours for it to ferment, although my house has been kept at 90°. Again, at low elevations, I have seen roll properly fermented in 20 minutes from rolling. As far as time is concerned, at high elevations in ordinary weather, I find it takes from $1\frac{1}{2}$ to 3 hours. Machine-rolled ferments quicker than hand,—advantage in favour of machines. Roll is properly fermented when it shows at a *first* glance a bright new copper colour. We must not, in making this test, examine the roll too carefully, as, if we do, we will find almost as many green as copper-colored leaves ; the first glance on taking up a handful must decide us. As a rule, we should ferment up our pekoe-souchong, and let the rest take care of itself. If in doubt, under-ferment rather than over-ferment. Over-fermentation may cause the tea to be altogether sour, and, in any case, gives a dark-coloured flat liquor, with dark dead-looking infusion.

For the first two or three rounds after pruning, our leaf will not give us a very bright infusion, and there is no use waiting on the fermentation to try and get it ; all comes right as the wood matures.

Having arrived at a proper state of fermentation, we should hand-roll lightly again, even if machinery is used. Coolies employed in the factory, firing, withering, &c. &c., are sufficient to do this. It is necessarily, as it inclines to roll, opened more or less by fermentation, to take its twist again, as it is being fired, and it also ensures the whole being thoroughly well separated before being placed in the firing-trays.

In Firing over-charcoal the bottom of the tray, which is covered with 24 to 26 brass mesh, should be 21 inches from the fire-grate, which is again 9 inches above the level of the floor: the stoves are from the level of the floor to the top 30 inches high, 3 feet wide at the top ; inside measurement sloping to 1 ft. 2 inches at the grate, which rests on ledges 1 inch wide, making below-grate of floor-level 1 ft. wide. It takes 40 minutes to complete the firing of each tray of roll, as thus :—Each tray, 3 feet square inside measurement, will hold 5 lbs. of roll, which, when fired, equals about 2 lbs. of tea. The tray should be constantly removed from the stove, and contents well turned (on no account should any turning or fingering be allowed when the tray is over the fire, as dust drops through, burns and smokes the tea at once) ; after about 15 minutes' drying, being constantly turned the while, the partially-fired roll should be sifted through a No. 8 sieve ; that which remains in the sieve is again placed over the stoves, being, as before, constantly taken off and turned, and in 15 minutes is ready to be again sifted: this time through a No. 6. It then takes 10 minutes to finish off, being constantly turned the while. The siftings are left on the table till all teas are finished firing : these represent broken teas, broken pekoe, pekoe No. 2, and dust, and are finished off over the hot stoves by the expiring fires—this takes about 10 minutes. Experience alone can tell us when teas are properly fired : they should feel crisp to the touch, and when bent resume their shape. As each tray is fired off, the tea should be put into a bin for the purpose, and exposed on the tables as little as possible.

Tasting.—The first thing the next morning as sorting begins, the "making" of the previous day or night should be infused and tasted carefully ; we then know what to do with it, as we should keep our classes of different values (or grades) separately, and a good break may be spoiled by having one or two days' inferior make mixed with it. Accidents sometimes happen also, such as over-fermentation, if there is much night-work, and this can only be detected by infusing the leaf. No tea should be packed away, therefore, (mixed with the bulk) till it is tasted, and faults, if any, discovered, to be rectified in the future.

Sorting.—This is best done by women—one woman to every 100 lbs. of Tea. Red and large flat leaf is first picked out, and the tea is then passed through a No. 7 or 8 sieve. According to the size of leaf, *i. e.*, tea of any particular day, that which comes through is next put into a No. 10 or 12.—the higher the elevation the smaller and more wiry the make. That which remains in the No. 7 or 8 must be *lightly* broken through by hand, and what still remains in (very little) is congou and black fannings ; that broken through is broken tea and broken souchong, which is mixed, after removing the dust and broken tea, with the pekoe-souchong pure remaining in No. 10 or 12, and the mixture classed as pekoe-souchong. We then have left to deal with pekoe, broken-pekoe, broken tea, and dust, all of which has been passed through a No. 10 or 12 sieve—to extract, as shown, our pekoe-souchong. This we *again place* in No. 10 or 12, *lightly* sifting it, to remove broken pekoe, broken tea, and dust, leaving the pekoe in the sieve. We then, with an ordinary rice-winnower, remove broken tea and dust from the broken-pekoe remaining in the winnower ; the broken tea and dust we then put into No. 24, passing the dust through. To separate tea-dust from pekoe-dust we can use either muslin, or the winnower again. We have now sorted our teas into the following classes :—1. Pekoe, 2. Pekoe Souchong, 3. Congou (and fannings with large unrolled leaves), 4. Broken Pekoe, 5. Broken Tea. Tea-dust and pekoe-dust I do not count as a make, nor yet fannings ; the latter may, in most instances, unless plucking has got ahead of you, be mixed, after breaking, with the broken tea. Fannings we break through a Reid's breaking-machine, turning out a reddish make, about twice the size of our broken tea, which, if poor in liquor, we sip separately as fannings : or if showing a fair liquor and not too much red leaf, mix with our broken teas. Of congou fannings and the dust, we have a very small percentage each day. The numbers of sieves we require are as follows :—No. 4 for sifting green leaf in rolling by hand, to give more " tips ;" No. 5 useful sometimes, when plucking has got ahead of you ; and Nos. 6, 7, 8, 10, 12, and 24.

PACKING.—As, according to the new Rules, bulking on the Garden is now accepted in London, and our tea thus saved from being all turned out, provided tares run pretty equal, I recommend each class of tea to be packed as soon as sufficient can be bulked to make 25 half-chests of 50 lbs. each. These should measure 15 × 16 × 16, and tare, on an average, 18 lbs. including lead. As soon as we have packed all our teas to complete that particular break of shipment, (which ought not to be under 5,000lbs. nett, I think, and the more the better) we may add our dust, fannings, and congou, which will only amount to a half-chest or so of each. These teas will run from 5*d*, per lb. to 10½*d*., and are as well shipped, if a half-chest can be made up, with each break from which they have been made. I find a half-chest takes 3½ lbs. of lead and 1¼ oz. of solder—or cost of half-chest with lead-lining, &c., ready packed, cents 3·50 per lb. of tea. Whilst on this subject I think it would be of great advantage to us all if we could arrange to use one uniform package, and no package can be more convenient for us than the half-chest, as above. The majority of us have to transport our chests to the main-road on coolies' heads, and this half-chest represents just a full cooly-load, whereas a chest takes two coolies to carry it, has to be hooped—a costly work—and there is all the worry of rope, which is constantly stolen, and poles to carry it ; therefore, the saving in draft in London (under ½-a-lb. of tea) and the slight difference in its favour in cost, in the first instance, is more than counter-balanced by the cost of hooping and transport, with the accessories of poles and rope. I trust, therefore, that those interested in Tea in Ceylon will arrange to use one uniform package, which shall be peculiar to Ceylon, and become known as the *Ceylon chest*. This for the bulk of our teas : but we may also pack occasional breaks in boxes ; these should weigh under 28 lbs. gross, and thus save draft, say 10 to15 lbs. nett. Any specially-fine mark could be shipped in this, forming a small break, and will often fetch fancy prices. Brokers at home accept both half-chests and boxes, so there is no innovation here. A coolie can pack carefully 15—shall I call them Ceylon-chests ? —in a day.

I now come to yield, and cost per lb. f. o. b. at Colombo.

YIELD.—In my own experience, at 4,700 to 5,600 ft. elevation, with fair soil, ordinarily-featured land, as our hill country goes, fairly steep, I find the yield has been as follows, and I do not consider I am yet in full bearing :—

At 2½ to 3½ years old	165 lbs. tea per acre.		
3½ to 4½	292	,,	
4½ to 5½	262*	,,	*pruned heavily in July, to shape bushes, which explains shortness of yield.
5½ to 6½	450	,,	
6½ to 7	700	,,	

Again, I have yield given me at an elevation of 1,800 to 2,500 feet :—

Average age 3 years	224 lbs. per acre.	
4 ,,	380 lbs.	,,
5 ,,	315 lbs.	,,

And please note, on this Garden of over 200 acres in extent, there was a considerable loss of leaf from allowing large areas to grow up during these three seasons, for seed, from which little if any leaf was plucked. Had the full acreage been plucked, the average would have reached 100 lbs. more per acre.

Again. I have given me figures of an Estate, at an average of 2,500 feet elevation, 400 lbs. per acre at $3\frac{1}{2}$ to $4\frac{1}{2}$ years old.

Another Estate, at an average of 500 feet, gives for the first *six months* of the year, January to June (being in June four years old) 400 lbs, per acre: the estimate to December is 600 lbs. per acre, and will probably be exceeded. Again, an Estate from 100 to 400 feet, showing an average age all round of 4 years, gives 430 lbs. per acre. This Estate is widely planted, 5 by 6 and 5 by 5, and had it been 4 by 4 would have given a larger yield, as the bushes do *not* cover the ground; but 430 lbs. at 4 years is good enough, you will allow.

I have again many instances of Estates up to 3,000 feet giving 400 to 600 lbs. per acre up to 5 years of age; and at 4,000 to 5,000 feet, from 360 to 420 lbs. per acre.

We have all heard of Gallebodde and its 800 lbs. odd per acre; also of the older portion of Dunedin, with its 730 lbs. per acre. A portion of one of my fields, 3 acres in extent, has given me at $7\frac{1}{2}$ years 1,200 lbs. per acre at 5,500 feet elevation, well sheltered, with fine soil—an exceptional yield, I will allow. These figures are fairly representative of Tea in Ceylon at this date, and not *one* of the Estates mentioned is in full bearing. What *will* the yield be when we are in full bearing, from 8 years of age upwards? We shall want lots of withering-room: so be prepared in time.

Young as we are, and in the face of these yields at 7 years of age and upwards, I feel perfectly safe in estimating an *average* yield of 400 tbs. per acre from Tea in Coffee-zone and above it, say from 2,200 to 5,700 feet, in sheltered situations. And in saying 5,700, ft., I do not wish it to be understood I draw the limit even here, but the figures I have had given me above this elevation, *viz.*, at 6,300 feet, are only from a very small area under Tea which, however, gave, at 6 years old, 400 tbs. per acre at 4 by 4. For low-country teas, that is, teas at from 2,500 down to sea-level, at 6 years old and upwards, I shall be very much surprised indeed if they do not show an *average* yield of 600 tbs. per acre. These estimates may seem excessive, looking at the average yields from Assam and India generally, but compare our yield in this our very infancy with that in India, and you will find we can even now show an average from Estates $3\frac{1}{2}$ years old up to 6, which will more than *double* theirs. Inclemency of weather does not affect us in the same way in which it does our Indian fathers, as we have 11 months in which we pluck. If one month is too wet, we benefit all the more when the sun shines again, as we have lots of time, if we have a spell of dry weather; on the other hand, this again is sure to be followed by rain, when we at once make up any loss.

Cost per lb. F. O. B.—I have to thank many friends for furnishing me with cost F. O. B. at Colombo, and choose the following, which are representative of all, and may be relied on. In all cases the tea was manufactured without the aid of machinery of any kind:—

450 tbs.	per acre cost	36 cts. F. O. B.		Including cost of upkeep of young tea not in bearing.
700 „	„ „	30 cts. F. O. B.		
400 „	„ „	40 cts. F. O. B.		
400 „	„ „	29 cts. F. O. B.		

If we take the average of the four Estates we have, say, 495 tbs. per acre, hand-made, costing 34 cents F. O. B. at Colombo; London charges, including freight, are under $2\frac{1}{2}d.$; but for all practical purposes let us say $2\frac{1}{2}d.$ The above teas at an average price of 1*s*. $2\frac{1}{2}d.$ (and this is not a high average) leave us 1*s*. nett; or, at 1*s*. 8*d*. per 60 cents, a profit of 26 cents per tb. at 495 tbs. per acre; say Rs. 128,70 profit per acre.

With regard to Plucking and Manufacture, I find its actual cost is as follows without machinery :—

	cents.
Plucking (including baskets and cootie-sacks)	7·000
Withering, rolling, firing	6·500
Sorting, refiring, packing (in half-chests) including lead, solder, and chests	4·000
Total ...	17·500

The rest of the work depends upon circumstances, and in many instances can be done cheaper, with regard to some of the items, than I now show.

THE FACTORY should be roomy, and have as much light as possible. All green leaf, whether withering or being rolled, should be shut off from the firing, sorting, packing, and store-room, or it collects dust, etc. Even with a Sirocco, we should be provided with stoves ready for charcoal-firing, in case of accident. Cleanliness must prevail from rafter to floor. Our Coffee-stores, when too large for our crop, as at present, can be at a small expense turned into a suitable Factory, a portion being walled off for our Coffee-crop.

LAND can be opened, not including purchase, of course, at the following rates per acre for the first year :—Jungle Rs. 80, Patana Rs. 50, and Coffee Rs. 40 to Rs. 50. Coffee should be uprooted when Tea is at 1 to 1½ years old, unless it has on it sufficient crop to make it worth while leaving it. Tea at three years of age will prevent Coffee giving sufficient crop to pay, and will eventually kill it out, so the two cannot be grown side by side. Coffee, when uprooted, may be stacked with advantage for firewood or charcoal. We can grow *among* our tea, to advantage, according to elevation, taking care not to over-crowd it, *C. officinalis* (best of all, as it gives no shade to speak of, and thrives better among tea than in the open), small-leafed *Robusta*, and *Ledgeriana*. The up-keep is nil, harvesting being the only expense after planting. We can grow *with* Tea, to a *large saving of expenditure* in both, Coffee or Cacao, according to elevation ; and let us aim, with Tea as our mainstay, to grow all the products the elevation of our Garden will allow of, with it.—
"*Experientia docet.*"

TEA YIELD IN CEYLON.

A correspondent of the *Ceylon Observer* writes as follows :—

"SIR,—With regard to the yield of Tea on one of the fields of this Estate now under comment, I have only to state that the clearing was planted at the latter end of 1879 ; plants, distance apart 3 × 2½.

Yield	1882 ...	450	lbs. made tea
"	1883 ...	735	" " "
"	1884 over	1,000	" " "

In August, September, October, and November, 1883, this tea was made along with tea from bushes of same age, and realized an average price in London during the 4 months of 1*s.* 5¾*d.* Since then it has been made along with the other ⅞ths of the Estate, two years and under, and only plucked once a fortnight and over, according to the circumstances. I may mention that about ⅓rd of the field in question is of very poor soil, and on this portion a large percentage of the plants died in 1882 from white-ants or other causes.

Aberdeen Estate, Dec. 1884."

Mr. A. M. Ferguson, junior, writing to the local Ceylon Paper, as regards yield of Tea on the Abbotsford Estate, says :—

"Fancy, 5,250 lbs. made tea in four days, and an average per cooly for the week of 29½ lbs leaf! The trees are in splendid condition The following is a statement of the distribution of the picking for this and last week :—Cattle-shed field, 15 acres, 4,008 lbs. leaf, 1,002 tea : rate 1,202 lbs. per acre Bungalow field, 5 acres, 1,225 lbs. leaf, 308 tea : rate 1,109 lbs. per acre. Lower estate, 20 acres, 4,490 leaf, 1,122 tea : rate 1,346 lbs. per acre ; 70-acre field, 13,678 leaf, 2,420 tea: rate 879 lbs. per acre. Of course I do not expect, and hardly desire, such a high rate to continue. To show what Tamil women can do when put to it, yesterday 17 coolies brought over 50 lbs. each, four brought over 60 lbs., one 70, one 73, and one 75 ! My books are open to any who choose to examine them. As previously stated, our picking consists of the bud and a leaf and a half, and the above 21,000 lbs. was almost the finest sample of leaf I have ever got on Abbotsford."

Over 700 lbs. per acre of Tea yielded by an Estate in Ceylon.

The late Mr. Cameron was deemed sanguine to excess when he ventured to predict that averages of 500 lbs. per acre would be obtained on high estates, and 700 in the "low country" (all below 2,000 feet, we suppose, in the latter case) in Ceylon. But, we believe his prediction will be more than verified in each case. Indeed, evidence has been furnished to us that on a low-country estate, about 700 feet above sea-level, and not flat, but with rather steep features, Mr. Cameron's estimate has been exceeded. The following is the statement sent to us :—

"As regards the yield of tea per acre in the low country, when there are so many doubters as to the quantities of leaf to be got, it is well to publish ascertained facts as they come to hand. The returns for the year ending 30th June last, from the oldest field of 30 acres on the Dunedin Estate, Yatiyantota, has been shown us, and we find that 89,212 of green leaf were plucked from this field (now five years old). This, at the usual rate of 4lbs. green leaf to 1lb. of dried tea, gives 22,018 lbs., or per acre 733. As all teas turn out rather more than 25 per cent. of the green leaf, it will be within the mark to say, that 740 lbs. of dried tea per acre has been made from this yield during the last year. We are informed that there is nothing exceptional abont the soil, and that the situation is rather steep than otherwise. This yield should be encouraging news to tea-growers in the low country, and goes beyond the 700 lbs. of the late Mr. Cameron, an estimate which was considered so very sanguine not so long ago. There is no gainsaying facts like those put before us, and we see nothing now left for doubters, except the broad question, Will it last? *That* they must work out for themselves : it is sufficient for us that the present is proved."

Our readers will not forget that a result equal to 700 lbs. per acre had previously been announced as obtained by Mr. Armstrong from Rookwood, which must be about 4,500 above sea-level. There is no reason, therefore, why 500 lbs. per acre should not be gathered at altitudes from above 4,500 up to 6,000 feet. Over 400 lbs. per acre, *we know*, have already been gathered at such elevations. The soil in Ceylon seems eminently suited for tea cultivation; but, we suspect, the secret of the large yield of leaf lies in our constantly hot and moist tropical climate, with no winter, except such as may resnlt from the monsoon winds in their strength. "When the stormy winds do blow," flushing is naturally arrested for a time, and it seems settled that the best time to prune, at least on the hills, is June-July. But, as Mr Cameron replied to his Indian friends, who asked "What is your season in Ceylon?" "Just what the planter chooses to make it," so the season for pruning may vary according to elevation, sunshine, and rainfall. In the case of Dunedin, we observe that considerably more than two-thirds of the whole produce for the twelve months was gathered in the three months of March, April, and May. The latter month of this year was specially genial, and the green leaf gathered was equal to 12,657 lbs. Then, there was a fall to 7,534 lbs. in June, while July of the previous severe monsoon gave only 3,000 lbs. But, really, there was an almost steady progressive increase for 11 months : there being a slight reaction in June from the enormous yield in May.

Tea can, therefore, be gathered *all the year round*, but, to prevent exhaustion, rest must be given to the trees by pruning, and after a time manure must, of course, be applied to the soil. It seems to stand to reason that the high Estates will not require the application of fertilizers at anything like so early a period as those in hot low districts ; and when they do, the railway, and good roads, will be of immense help. Our decided conviction is, that for high and low country, in the centre and south-western portions of Ceylon, the prospect of Tea-culture is excellent.—*Ceylon Observer.*

The local *Observer* has the following, as an example of the capability of Ceylon as a Tea-yielding Colony :—

It is stated that, from the area of 100 acres in full bearing on the Mariawatte Estate, tea equal to 900 lbs. per acre has been already gathered, but that, as pruning (which had been delayed) has now been taken in hand, the yield for the year will not exceed 1,000 lbs. per acre, instead of the 1,200 lbs. mentioned by rumour. As in Chittagong previously, so now in the Gampola valley, 1,000 lbs. per acre will be secured by means of a liberal application of manure. Taking this into consideration, the estimate of 700 lbs. per acre for low-country estates, opened in virgin forest, but unmanured, is what ought to be expected. We suppose Mariawatte will be ranked as a low-country estate, seeing that its elevation is only about 1,600 feet above sea-level, the altitude of the railway-station close by being 1,573. The Tea-estate stands on the site of the first regular Coffee-estate opened in Ceylon, but the place had been long enough in "chena" to allow of considerable recuperation of soil. The climate, as regards copious rainfall alternating with genial heat, is all that could be desired. Add to this that the place has special facilities for procuring and supplying manure, and a case is made out for the exceptional yield obtained. The result is a grand one, even allowing for manuring ; but we see no reason to modify the figures for averages of 700 lbs. per acre on low-country estates (sea-level to 2,500 feet) and 400 to 500 lbs. at higher elevations.

From our own Correspondent.

There is one Tea-estate which has been visited by many Indian tea-planters, not only because it is very accessible, being within two miles of a railway-station, but because it is an exceptionally fine property, though only 200 acres in extent, and only giving crop from a half of that area. It is very conveniently situated, and is therefore visited by many strangers, all of whom are struck with the marvellous bearing-capacities of the place. The Manager assures me he expects to take off, this year, a crop of 100,000 lbs., equal to 1,000 lbs. the acre, from 100 acres. I must tell you, however, that this Estate has the great advantage of being manured at a very low cost, being close to a railway-station, and to the town of Gampola, whence all the street-sweepings are carted direct to the Estate, by contract.

The question of yield of tea per acre has had a new illustration in the case of the Mariawattė plantation in the coffee districts. An old worn-out coffee-estate, which had lain fallow for many years, about six years ago was planted up with Tea to the extent of a hundred acres : in the third year following a further like quantity was planted. Off the first area of a hundred acres the proprietors have in nine months of this year taken in and packed 90,000 lbs. of marketable tea, being at the rate of 900 lbs. the acre, and they expect to take off a further 100 lbs. per acre before the close of the season, bringing up the yield to 1,000 lbs. of dry tea per acre. Of course, tea-planters in India will say this cannot be maintained : perhaps it cannot, even with continued manuring, but for all that it is a remarkable instance of productiveness from old abandoned land. We have had nothing over 750 and 800 lbs. per acre in low-country, from virgin forest-land, and an abundant rainfall, but without manure of any kind.

SECTION XXVI.

TEA CULTIVATION OUT OF INDIA AND CEYLON.

TEA IN FIJI.

TEA IN NEW ZEALAND.

TEA IN JOHORE.

THE TEA ENTERPRISE IN JAVA.

TEA CULTIVATION IN NATAL.

TEA-GROWING IN THE UNITED STATES.

TEA IN RUSSIA.

TEA CULTIVATION OUT OF INDIA AND CEYLON.

If we except China and Japan, the *Cultivation* of Tea in which Countries is so different from our own as to render it unnecessary to enter upon it in this Work, we may be said to have practically exhausted the review of Tea Cultivation. But it may be desirable, nevertheless, to refer to the efforts that are making in still other places to introduce Tea Culture. A very brief Notice, however, will serve to indicate the further directions in which Tea is being experimented with.

We may first refer to Fiji, where the soil and climate appears favorable to the growth of the Tea-plant. Experiments are being made there in Tea Cultivation, on a small scale ; and, so far, with practical success. The following is a Report on some samples of Fiji Teas, by Mr. J. O. Moody, of Australia :—

" The Teas are excellently fermented, but the firing should have been brisker, but beware of burning or smoking. If you can turn out Tea like the samples, you are sure to sell such teas freely, and at good paying prices; anyway, it proves fine teas can be grown in Fiji. The analysis is very satisfactory : the soluble salts in comparison with the mineral ash, are very high. The percentage of theine, 1·73 and 1·86, is also good; some China teas lately tried only went ·43 to ·90.

The appearance of both teas, with their rich tips, is very good.

Fiji Pekoe.—Leaf—handsome, small, even, golden-tipped pekoe, evenly and well fermented. Liquor—very strong, full, rich, and pungent pekoe-flavour, thick with deep-red infusion; an invaluable tea for mixing, and worth about 2*s.* 6*d.* per lb. in bond. *Fiji Pekoe Souchong.*—Leaf well made, wiry, twisted, rich, black tippy leaf ; evenly and well fermented. Liquor—strong, full, rich, and ripe, true Pekoe Souchong flavour, with good, bright-red infusion; a fair tea to drink alone, and worth about 1*s.* 9*d.* per lb. in bond. These teas have the character of good Ceylon growths, and are in every respect suitable teas for general consumption, and such samples are sure to meet with ready sale in Australasia or Great Britain.

Mr. Frederic Dunn, analyst of the Industrial and Technological Museum Laboratory, under date the 12th December, 1882, reported thus on the same samples :—

" Upon analysis they give

	Percentage of Moisture.	Percentage of Mineral Ash	Percentage of Extract (Total).	Percentage of Soluble salts	Percentage of Theine.
Pekoe	9·00	4·36	45·80	2·98	1·73
Pekoe Souchong	8·85	4·40	48·28	3·00	1·86

The percentage of mineral ash and soluble salts found in these teas closely resemble the amount obtained from the Ceylon Exhibition teas. Taking into consideration that the above samples are the result of an experimental trial, the results are highly satisfactory, and the analysis speak well for Fijian teas."

FEASIBILITY OF TEA CULTURE IN NEW ZEALAND.

Considerable discussion is going on in the Auckland district over the question of the feasibility of growing Tea in the northern parts of the Colony. A gentleman has recently supplied many of the settlers with tea-seed, and we hear that action is being taken to put the question to practical test. From a paper supplied to the *Auckland Weekly News* on this subject, we quote the following :—"Both the well-marked and the minor advantages of successful tea-raising are, we think, offered by the interior of Otago and that of all the beautiful province of Auckland. If we institute inquiries, it will be found that the climate closely resembles that of the tea and silk districts of China ; that the thermometer indicates from ninety to a hundred degrees of Fahrenheit nearly every summer ; that as high as one hundred and ten degrees have been noted at Alexandra, on the Molyneux River ; that the mulberry, ailanthus, and castor-oil plant, grow luxuriantly, particularly in Auckland ; and that the experience of tea and silk farmers in other parts of the world has led to the Oriental apothegm, that "wherever the Mulberry grows in profusion, there Nature indicates a suitable spot for Tea." These enquiries would also ascertain that throughout the latter province snow is seldom seen, except upon the mountain tops ; that even slight frosts are necessarily a rarity in a land where the forests are evergreen, and semi-tropical fruits grow with lavish prodigality in the open air ; that moderate and vivifying showers to the extent of forty-seven inches fall during about a hundred and eighty-six days of the year ; that the mean of the coldest month is fifty-one degrees, and that of the warmest sixty-eight degrees ; that the grape-vine and olive may in some districts be seen intermingled with the ordinary fences ; and that the hot blasting winds and sandstorms of Asia and Australia, so inimical to Tea and Mulberry culture, and so deadly to the silk-worm, are unknown. Such are the natural attractions and advantages which invite the Tea and Silk farmer to New Zealand."

How many an Indian planter from the Plains would welcome the practicability of gaining a good livelihood in the lovely climate of New Zealand. Those bent on a few months' holiday might do worse than exploit this portion of Australia, and ascertain whether the chances for Tea Cultivation there are as favorable as the *Auckland News* indicates. The Trip would hardly be a more expensive one than to England, and by a personal visit reliable information could be obtained, the knowledge of which might lead to very satisfactory results, in defining the practical and profitable emigration there of Planters with a small capital.

TEA IN JOHORE.

The following is an extract from a Report by Mr. W. Langley, on Tea Prospects in Johore (Malay Peninsula):—

"I have recently visited the little patch of Tea-trees planted at Johore for His Highness the Maharajah, and was much pleased with what I saw. The little Garden is under charge of a Chinaman, who, however, does not treat the plants as we do in India ; neither is his manufacture conducted on the same plan. The soil is of a reddish-yellow colour, soft, without clay or stone, of a friable nature, through which the frequent showers of rain easily percolate. The growth of the plants, considering their age, is most rapid and luxuriant. The leaf is soft and bright, and most healthy in appearance, the trees being almost entirely free from blight of any description. The jât is a good one—Assam hybrid, I should any, from its appearance ; the seed was sent from Assam by Dr Barry. The climate is apparently all that could be desired for Tea, and during my visit I had no difficulty at all in withering or fermenting without artificial heat. During my stay at Johore I manufactured some Tea, samples of which (Pekoe and Pekoe Souchong) I am sending by this mail to a good firm of London brokers and tea-tasters for their opinion and valuation, and the reports will be sent direct to Singapore. About the Tea I made, I will say nothing at present, awaiting the verdict of the London brokers. I am myself satisfied, however, and have no hesitation whatever in prophesying a successful future for Tea planting in Johore."

THE TEA ENTERPRIZE IN JAVA.

Java labours under many disabilities in respect to Tea cultivation, not derived from soil or climate, for both are excellent, but from disabilities due to heavy taxation. This is perhaps one reason why so little Java tea finds its way to London. Yet some very fine Java teas are produced, and occasionally fetch good prices. The teas are, as a rule, very well made, and attractive in appearance. The liquor is also fairly strong.

By the Sale Reports of July 30th, 1885, we see that a somewhat larger parcel than usual was placed on the London market, and it realized good prices; the quantities were small, only 1,230 packages having been offered and sold at firm to hardening rates. Pekoe and Pekoe Souchongs with tip were sought after by exporters at firm to advancing prices.

A very fine invoice from the Parakan Salak Estate, closely resembling Indian growths, attracted attention, and sold well; good useful teas were also offered from the Dramaga and Tendjo Aijoe Estates. We quote the following :—

Parakan Salak—	*Pekoe*	1s. 11d.	*per lb.*
"	*Broken Pekoe*	1s. 6¾d.	"
"	*Pekoe Souchong*	1s. 0½d.	"
"	*Souchong*	9d.	"
Tendjo Aijoe—	*Pekoe..*	1s. 0¼d. *to* 1s. 6¼d.	"
"	*Broken Pekoe*	10d.	"
"	*Pekoe Souchong*	9¼d.	"
"	*Souchong*	8½d.	"
Dramaga—	*Pekoe*	1s	"
"	*Broken Pekoe*	1s 1¼d *to* 1s. 1¾d.	"
"	*Pekoe Souchong*	1s.	"
"	*Souchong*	8½d *to* 8¾d.	"

But the Java Planters are very downcast at the restrictions placed upon their Enterprise by the Government there. Java planters contrast their unhappy position in this respect with that of India, but they are probably not acquainted with the many drawbacks under which Tea-planters in India also labour.

The disadvantages of Tea-growing in Java are thus set forth in a Petition to the Second Chamber of the States General, by several leading tea-dealers in Holland, against additional import taxation on that article :—

"The undersigned having great interest in Tea, owing to their direct importations of that article from Java into Amsterdam and Rotterdam, most respectfully bring under notice that both with surprise and regret they have heard of the proposal made by the Minister of Finances to raise the import duty on Tea in the Netherlands from the excessively high rate of 25 guilders per 100 kilogrammes, at which it now stands in our tariff, to the amount of 40 guilders. Our surprise of hearing of it arose from the same suggestion having twice before been brought forward by former administrations, but each time it proved fruitless owing to strong representations from Java and the Netherlands against the scheme, while the present proposal is unsupported by any evidence whatever showing that what in two different years has been rejected as unadvisable, has now become fully advisable. They view it with regret, because, as victim of this purely fiscal measure, one of the principal products of our East Indian possessions has been selected, the cultivation of which could hitherto be only carried on by the utmost exertion. In fact, planters in Java have to bear, besides the import duty in this country, five additional and different taxes in that Island, while their rivals in British India, now so formidable, though they have to pay in the mother country a higher import duty than that now suggested here, are, on the other hand, wholly free and untrammelled in their planting operations. The British authorities follow a sound policy regarding Tea-growing in their Colonies. They levy duties on the consumer, but leave the producer wholly untaxed, and even energetically encourage production. The Dutch Treasury not only taxes the product but the producer as well, and now that this burden threatens to become heavier still, the Undersigned protest against it. Moreover, the present time is an unfortunate one to choose for laying on Tea heavier charges than those now prevailing. In 1868 and 1876 the proposed increased duty could have been more justifiably imposed than now. The average price of Java tea was then $77\frac{1}{2}$ and $62\frac{1}{2}$, but now it is no higher than 40 cents per half kilogramme. Naturally, the increase suggested would now press much more heavily, and that too on Java tea in particular, than then. As the tea sold here consists half of that from Java, and only the inferior qualities of it are available to consumers in the Netherlands, while the few better kinds are exported to the Levant, the increase of the import duty would drive most of the Java tea out of our markets, if it does not make the production of the same impossible to many of our Java planters. Tea from Java is so seldom classified among the better qualities of that article that some planters there can realize not more than 20 cents per kilo for their product. Such persons will thus be burdened with a duty of 100 per cent. in the mother country! More probably they will abandon the cultivation of the product. Those, however, who endeavour to defend the suggested enhanced duty by pointing to Britain,that pre-eminently tea-drinking country, where the import duty amounts to about 67 guilders per half kilogramme, will simply bring out more prominently into notice the sounder policy of the British in taxing consumers only, while the Netherlanders tax both consumers and producers, to which arrangement the undersigned have objected above. In Java, the tea-planter pays no less than five imposts, namely, ground-rent, assessment, poll-tax, license-tax, and export duty. In Assam, on the contrary, land is granted to tea-planters on 99 years' leases, free of quit-rent on one-fourth of the area during the whole of this period, and on three-fourths during 15 years, and on payment, then, for the ten following years, and the remaining 74 years, of amounts respectively equivalent to $59\frac{1}{2}$ and $68\frac{3}{4}$ cents per bouw. The land leased under these conditions amounts to 338,000 acres, or 221,000 bouws. Moreover, 403,825 acres or 230,000 bouws have been made over to the tea-planters in free ownership at prices of from $1\frac{1}{2}$ to 5 rupees per acre, on the express understanding that the State would never demand any land-tax on the same. Finally, tea-planters there are exempt from the license-tax. When it is also borne in mind that, besides the 100,000 acres under cultivation in Assam, ten times that quantity are available to the planters, and that fresh estates are continually being laid out, the difference of the conditions under which planters work in Assam and Java truly becomes strikingly evident. A few years ago many of the now flourishing tea-estates in Java were unproductive forest, unsafe for the whole population, from beasts of prey harbouring therein, while at the present time work and wages are abundantly given on them, to women and children especially. Yet planting enterprize of this kind has to bear heavy taxation both in the colony and mother country. The satisfactory results of the British system are clearly manifest; when Java in 1858 produced two to three million kilogrammes of tea, the production not having since risen much above these figures, British India yielded 350,000 kilos. What the yield there is now may be inferred from the fact that in 1882 it amounted to 27 million kilos. Against this untaxed competition the taxed planters of Java have now to carry on their cultivation."

The petitioners, in conclusion, point out that the suggested enhanced duty is the more unadvisable now, owing to the danger impending over Tea-growing in Java from the increasing production of Tea in Assam, and that the abandonment of the cultivation of that article in Java would be a great loss to the people, from the prosperity it spreads wherever it is established. Hence they pray the States General to withhold sanction from the proposal to increase the import duty on Tea in Holland to 60 guilders per hundred kilogrammes.

One of the best Books of the kind we have ever read on Tea Cultivation is that written by an author signing himself *Java Planter*. The Book is very well known in India, we believe, and many of our practices in Tea Cultivation and Manufacture have been imitated from the Work referred to. Those who have not read the Book should try and obtain it. It was some time since on sale in Calcutta, and probably may be so now.

THE CULTIVATION OF TEA IN NATAL.

We have referred to the prospects held out for Tea-planting in New Zealand; but there seems even a better field open at the Cape. Mr. Hulett, an old Settler there, has practically experimented with Tea Culture at Kearnsey Tea Plantation, Natal; and he says that he is more and more convinced that Tea-growing in Natal is certain to succeed, and he believes, in fact, that it will prove a mine of wealth to the Colony,—far beyond any gold-mine that may be opened out in the Interior. These are bold anticipations, indeed, and are almost such as to make the Indian Tea-planter's mouth water. But Mr. Hulett does not speak without personal knowledge. He has become a Tea-planter himself, and a successful one, apparently, although his progress has been slow, because for some time he had necessarily to work greatly in the dark. This is what he says, however:

The prospect for the future appears to be exceedingly good. My area has increased from thirty to fifty acres during the past season. Of these fifty acres, only three-fifths of an acre consists of the originally-imported plants put out in November and December,—consequently now nearly five and-a-half years old. My present picking is from $5\frac{1}{2}$ acres, planted out in November, 1880, and three-fifths of an acre unplanted plants, with a slight picking from plants eighteen months planted out. My return from this will, I confidently believe, reach 2,000lbs. by the end of the season in May. To define it more distinctly: say $5\frac{1}{2}$ acres under $2\frac{1}{2}$ years old at 250lbs. per acre—1,375lbs., and three-fifths of an acre ($5\frac{1}{2}$ years) say 500 lbs. (or over 800lbs. per acre), and the balance of 125lbs. from a few plants 18 months' old. Such yield as this, or anything approaching thereto, cannot be surpassed in the world. The Colony possesses thousands of acres of land that may yield an average return, from good culture, of 800 lbs. per acre, and the cost of that tea delivered in London *need not be more than 10d. per lb.* I am certain that tea can be grown in Natal at less than 8*d*. per lb.; that the class we shall produce need not average less than 1*s*. 4*d*. per lb. in bond in London; and that if in the future planters can be certain of 1*s*. per lb. in Durban, the Enterprise is one that means wealth to the Colony. The culture of land will not under any circumstances be over £5 per acre per annum (it should be considerably less). This includes weeding, cultivating, manuring, pruning, and cartage of manure, tools, &c., which, allowing 800lbs. of tea per acre (when five years old and above), will give $1\frac{1}{2}$*d*. per lb., for the annual growth of the tea—total, 6*d*. per lb. This will not include interest on capital, and personal expenses.

From the foregoing, those interested can draw their own conclusions. My opinion is that an Enterprise is before the Colony well adapted to the requirements of those possessing but small capital, from £500 and upwards. Especially is this the case when ten or twelve can grow for a central Factory. The advantages are such that proper appliances erected in a convenient position to receive the leaf as picked, from a radius of three miles, could manufacture Tea of more even and reliable quality than can be done by several individual makers. In India, Estates belonging to large Companies have from 300 to 2,000 acres to pick over. Here, the individual owner of from 10 to 50 acres of Tea can bring such to a position of bearing-power which no large Concern can possibly do, and consequently, by merely picking leaf and selling it at once, a large amount of trouble is avoided. Indeed, I should be very glad to know that ten or a dozen people were disposed to settle down in this neighbourhood for the purpose of Tea-planting. I am quite prepared to purchase their leaf in the green state, and give, until export becomes a necessity, not less than 3*d*. per pound for the leaf direct from the tree, and afterwards a price based upon the result in the English market.

Now, to persons of small capital, tired of Tea-planting life in India, here seems a promising field open for them The climate is all that can be desired, living is cheap, and the country is civilized.

A yield of 800 lbs. of made Tea per acre is almost above that of the best of our Gardens in this country; and if, as Mr. Hulett says, the Tea can be delivered in London at 10*d*. per lb, the prospects are, indeed, remarkably promising.

It might be worth the while of any who may be seeking for "fresh fields and pastures new," and who has a small capital of some £500 or upwards, to put themselves into communication with Mr. Hulett, as he has expressed himself willing to answer inquiries.

TEA-GROWING IN THE UNITED STATES.

Every now and again this subject crops up, and a good deal of "tall talking" goes on. It has never been denied that Tea will *grow* in some of the Southern districts of America,—indeed it *has* been grown; but the question whether it will *pay* has never been satisfactorily answered, and probably never will be. A recent Note on the subject has appeared from one who has tried Tea-cultivation in the South, and this is what he says :—

Perhaps the question of Tea-culture may be considered exhausted in our region (near Summerville, S. C.), when we see the failure of the Government Tea-farm, which, for a while, promised such favourable results. Any one now visiting the neglected grounds would sigh over the miserable condition of the plants: hundreds dead, and as many more leafless and dying. The farm is deserted, as I believe the Government refuses further aid to the scheme.

Let me now mention a few facts with regard to Tea-culture, which cannot be gainsaid :—

Six years ago we obtained from the Agricultural Department, at Washington, some small, delicate tea-plants, which were carefully planted in the poor, sandy soil of our Pineland garden. For a while we were rather hopeless as to their surviving—many of them looked yellow-leaved and sickly; but gradually they assimilated themselves to the uncongenial soil, and put out both buds and flowers. Now, after five years of growth, we have strong, dark, shining-leaved bushes, perfectly healthy, having withstood untouched the terrible killing frosts of the past winter, which have ruined our orange-trees and oleanders, and even affected our roses.

We believe the secret of the culture of the Tea-plant is, that where it is planted, there it must remain, undisturbed. We never dig around our bushes, the soil being so light and sandy, generally removing the weeds by hand, or with a very light hoe.

A neighbour who had his tea-plants long before we got ours has handsome, spreading bushes growing in the same sandy land as ours. Some seeds from his plants have by accident fallen among the debris along the high-road, and have grown into nice plants, which can now be seen there, showing how perfectly easy is their culture.

Here, again, it will be observed, there is no mention of the speculation as a *profitable* one, nor is MANUFACTURE at all alluded to,—we suppose on the principle of "first *catch* your hare, and then cook it." Quite right. And we think Indian tea-planters need not get alarmed. If there were no other drawback to Tea-culture in the United States, the Labour-difficulty would alone prove sufficiently formidable; and when America can have as much as she pleases of our splendid growths at a price so moderate as now obtains, not even our enterprising Cousins are likely to put *this* iron in the fire. It is quite contrary to the practice of Americans to invest their time and their money in speculations which take years to give a profitable result, and if holders of Tea-property in India had to begin again, *they* certainly might hesitate to put money into "Tea." There is an old saying : "What's the good of anything except so much as it will bring:" and this is how people here now look at Tea. It is of all Properties the most difficult to realize.

Americans are not the people to put their money into an Enterprise which will give them no return for four years, and the return from which, when it *does* come, will not be likely to give them any very exceptional profit. It will, therefore, require a very considerable amount of persuasion to make Yankees even "kalkilate" as to Tea enterprize, and a still larger amount of persuasion to induce them to put dollars into.

The prospects as to Tea-growing in NATAL present many features of advantage which are absent in the case of America.

Mr. Sibthorpe, the delegate of the Calcutta Tea Syndicate, reports as follows on some samples of Tea grown in Georgia :—

He says : "I have seen some fine samples of Teas grown and manufactured in the State of Georgia. The black tea resembles tea from Assam, and the green teas imitate closely fine liquoring Moyune teas from Shanghai." At the same time, he adds : "The samples were only experimental, and the high cost of labour in this country will always, I imagine, prove an insuperable bar to the successful production of American tea."

This is what we have always said ; and the rainfall, again, is insufficient to produce a sufficiently large yield.

THREATENED TEA CUTIVATION IN RUSSIA.

The Tea-plant has lately been introduced near Soukgoum Kaleh, on the Black Sea, and the Russians are confident, it seems, that they will soon be able to do without either Chinese or Indian teas. They are naturally irritated at the thought that after all their efforts at direct importation by the vessels of the Volunteer Fleet, London can still supply Russia with tea more quickly and cheaply than can the Russian merchants, though next-door neighbours to the Flowery Land.

The following is an extract from an article which appeared in the semi-official *Kavkaz*, published at Tiflis :—

"Then comes Tea. But what hinders us even now obtaining it from India, where it is prepared by machinery, and not, as in China, by an objectionable use of the feet, as observed by Dr. Pyasetsky, whose testimony will doubtless be confirmed by the Potaniss Expedition, now on its way ? *Even if we were to conquer India*, nobody would give us tea for nothing, and our countrymen would have to pay all the same for this national beverage. Besides, the question of tea-planting in the Caucasus must now be considered settled in the affirmative as far as theory goes, and it wants only enterprise on the part of our capitalists to put it into practice.

TEA-PLANTING IN THE CAUCASUS.

A movement of considerable economic importance is being made with a view to the cultivation of the Tea-plant in the Caucasus, and according to the *Nouveau Temps*, some plantations have already been made at Soukhoum, both in the Botanical Gardens, and in the garden of Mr. Wedensky. The plants of the qualities there grown have matured perfectly, and the question of the possibility of a successful cultivation has been practically solved. It is considered that other portions of the Caucasus are equally well adapted for Tea-growing, and especially in the western part of Trans-Caucasia, in the Valley of Alazan, where the climate resembles that of China. The proper methods of cultivation and preparation are not very well known as yet in the districts, and the Agricultural Society of the Caucasus has therefore requested that a specialist be sent to give instruction in the system. It is somewhat singular, considering the enormous quantity of Tea imported and consumed by the Russians, that no effort has hitherto been made to utilise this Region, for even if the highest classes Tea cannot be grown, it will undoubtedly give a good enough quality for Brick-tea, for which 5,000,000 of roubles are annually paid to China. It is proposed, also, to attract a Chinese immigration to the Caucasus, so as to make certain of a proper cultivation and manipulation.

SECTION XXVII.

TEA MANUFACTURE IN CHINA AND JAPAN.

CHINESE SYSTEM OF MANUFACTURE, &c.
BLACK TEA MANUFACTURE IN JAPAN.
GREEN TEA MANUFACTURE IN JAPAN.

TEA MANUFACTURE IN CHINA AND JAPAN.

Although, of course, all we originally knew of Tea Manufacture was derived from our Celestial neighbours, we have managed in some ways to improve on their practice, although it is to be questioned whether we have much altered or can alter the theory.

It is still a disputed matter whether hand or machine manufacture is able to secure the better results; but we have evidence, in China and Japan Teas, that, by their more careful hand manipulation, they are able to secure better *appearance*. As regards actual *quality*, however, there seems to be little superiority in our hand-made Teas over those made, as is now almost the rule, by machinery.

In the following Descriptions of the Manufacture of China and Japan Teas, the Reader may, still, gather a "wrinkle" or two, which may not be without service :—

TEA MANUFACTURE IN CHINA.

Having had exceptional opportunities of studying the whole Chinese economy of tea-growing, picking, sorting, firing, and packing, it is possible that my experience may be of some use to those who may wish to interest themselves in this Subject.

In the year 1861, when the Yangtse-kiang had just been opened under Lord Elgin's Treaty, and the extensive tea-growing regions of Hupeh and Hunan were made accessible by that great water-route, I was sent by my employers at the opening of the Season to superintend the purchase and manufacture of the first pickings of the Tea, under the impression, not always justified by experience, that the nearer one could approach the source of supply, the cheaper one could buy. Europeans had begun to settle in Hankow, so soon to become a great inland seaport, and there my modest expedition was equipped. After three days and nights of slow but comfortable travel in an empty tea-junk, I landed at a point of a river 100 miles above Hankow, called Sz'ting, my most lively recollection of which is the unspeakable swarm of mosquitoes, which, however, entirely succumbed to the fumes of chemically-prepared touchwood. The journey thence to Yung Lan-tung was over a most interesting mountain track, the path consisting of steps cut out of a precipitous wall of rock, round which the coolies who carried the chairs in which we rode stepped like cats, gripping the rock with their toes, in places so narrow that their bodies only could pass when turned sideways. I doubt if I should have dared to walk on my own legs along such a track, and it was not without considerable trepidation that I allowed myself to be carried on the shoulders of other men, who, far from sympathising with my nervousness, kept up a loud discussion with each other, at the most critical turns, as to how much money they were to receive, and how they would spend it.

Yung Lan-tung is a town of Tea-hongs, in a valley surrounded by Tea-plantations on the hill-sides. The first picking having been finished before my arrival, the sun-dried leaves were being brought into the hongs in baskets, for sale. There is always enough free selling to make a market, but a large proportion of the crop is bespoken by the hong merchants, who make advances to the growers. A Tea-hong is a large solid brick building on the typical Chinese plan, court within court, covering ground measuring 500ft. by 200ft.

The tea-buying is carried on very rapidly The buyer stands on a raised platform, the sellers in the large open court in front. Each seller hands up a sample of his leaf on a small wicker tray for inspection, when the buyer, with a moment's hesitation, fixes the price, and writes it on a slip of paper, which is handed to the seller, who is equally prompt in accepting or rejecting the price offered; and there is no chaffering, time being too precious. If the price be accepted, the leaf is at once carried into the hong, weighed, and the money paid on the nail. There is always keen competition among the buying hongs, and the growers are thus secured a full market price. After the buying for the day is over, the qualities are sorted out, the leaves are slightly fired, and then packed away as tightly as hay in a stack, in dark stalls in the interior of the hong, where the tea is left till fermentation commences. It is then put into the hands of the pickers, women and girls, each of whom receives one katty (equal to 1 1-3lb.) at a time, from which they pick out the brown leaves and stalks. The leaf is then winnowed, to throw the dust off. The fresh leaves which are left are gathered together and fired, which is the most important process of all, as the appearance, character and flavour, depend on the skill and care of the firing. A manager sits up all night watching his hundreds of baskets of Tea slowly baking over charcoal fires. When done to a turn, the charcoal-pans are suddenly removed, and the tea allowed to cool. It is then ready to be packed into the familiar lead-lined chests, for shipment to England. A "chop," or one firing of tea, varies from 600 to 800 chests. The hests are made to order, of uniform size and weight, and the tea is not weighed but carefully *measured* into the chests. An impression used to prevail that the tea was cll picked with chopsticks, but I found that it was only the samples that were put ahrough this process of selection, and much labour and sorrow it entails on both buyer tand seller, in the rejection of chops of tea for being inferior to sample.

James Innes.

TEA MANUFACTURE IN JAPAN.

The tea-leaves are gathered in May, and quickly dried by exposure to air, and carefully sifted so as to separate dust and fragments of leaves. They are then subjected to steaming. This is done by introducing the leaves into a wooden tub, the bottom of which is formed of bamboo meshes, the tub being placed on an iron pan filled with water, and heated from below. After thirty minutes, when the steam rises up, the wooden cover is taken off, and the contents are thoroughly mixed, so as to steam uniformly all the leaves. This done, the tub is covered again with the lid. This process is repeated, and finally the contents are taken out and cooled. There is a tendency in leaves to adhere to the bamboo rod during mixing.

The leaves are now sufficiently softened to be rolled up between the hands by a gentle rubbing, after which the leaves are subjected to drying. This operation is a most difficult one, inasmuch as the quality of the product depends in great measure on the treatment which the leaves undergo during the operation, since it is during drying that fine colour becomes fixed, with simultaneous production of that delicate flavour and agreeable taste which are wanting in the original leaves ; so that it requires excellent workmen, whose requisite skill is only attained after a long practice.

The drying is conducted in a shallow rectangular box, the bottom of which is made of a thick paper, stiffened with starch. The box is placed over a copper-wire gauze supported by iron bars, which are provided across the furnace. The furnace is simply a rectangular box coated with clay.

To begin the operation : first of all a charcoal fire is made in the furnace. The rectangular box is now placed over it ; the leaves are next introduced into the box, and the workman continually rubs them between the hands, alternately tossing them up and letting them fall until they are nearly dried. Thus dried, the leaves are further dried by keeping for a night in the same furnace after the charcoal fire is withdrawn. In large factories numbers of these furnaces are arranged in rows, and, during the drying, each furnace is attended by one workman.

The tea thus dried is, before it is sent to the market, subjected to sorting and sieving. The sorting simply consists in spreading out a certain quantity of tea upon a flat table, and in removing dust, stems, and other foreign matters, by picking them up, which operation is usually done by women and girls. The sorted tea is then sieved.

The sieves of different meshes are distinguished from one another by the numbers 1, 2, 3, &c., and the number of sievings as well as the sieves used vary with the quality of the tea. Thus, in the case of coarse kinds, it is passed twice or thrice through each of 1 and 2, and in the best kinds only once through 2, 3, 4, and twice through 3, which has the meshes of nearly 3 millimetres. The tea thus prepared is preserved in earthenware or metallic pots, in order to preserve it from the moisture.

Black Tea.

In preparing black tea, the leaves from wild tea-plants, or those which are cultivated without much care, are used ; otherwise, there will not be much profit.

The leaves, after gathering, are scattered on a straw mat, and dried by exposure to air. They are then collected, and softened by tossing and clapping between the hands, till they become adhesive. The leaves are made into a number of balls, which are introduced into a large box, which is closed tightly, and exposed to the sun for half-an-hour, when it is brought into the house, and allowed to lie in this state for one night. The balls are then taken out, and subjected to rolling and drying in the same way as in the preparation of green tea. During the operation the workman turns the mass, so as to prevent it from being burnt. This process is continued until the leaves break very easily by simply pressing between the fingers, when they are considered to be perfectly dry. The tea thus produced is freed from impurities and stalks, and separated into different kinds by passing through sieves having meshes of different size.

Tea Firing.

The Yokohama Correspondent of the *San Francisco Chronicle* gives the following account of the tea-firing process in Japan :—" A description of the process of curing or firing the tea will give your readers an idea of the intense heat these women work in, and that for about the sum of eleven cents of American money a day, and a full day at that. These establishments are fitted up with double rows of iron or copper kettles, or rather deep conical pans, placed over furnaces which are kept fired up to the limit of 212 degrees Fahrenheit. Each pan has its attendant operative, who bends to her labour as a women at the washtub, only she bends more, to stir the tea which is being fired. A quantity of leaves, say five pounds, are placed in the pan, and moved rapidly with the hand of the operator for about twenty minutes. Then a little soapstone, finely pulverized, is sprinkled over the leaves, and for twenty minutes more the rapid movement of agitating and stirring them is continued. Then, more pulverized soapstone, or gypsum and tamarak bark, is sprinkled upon the mass, and the stirring process again continued for twenty minutes longer, when the firing process is ended. That the tea may have a finer polish than it has received during this stirring, it is put into a cold iron or copper pan, and constantly rubbed against its sides for another hour ; then it is the tea of commerce, and ready for packing into boxes as soon as it has passed over a series of screens or series of different sieves, that all the dust and stem and refuse may be extracted from it. This process of firing causes a loss of weight of about 10 to 12 per cent. The work must be done over fires at a temperature of 212 degrees. Every thirty minutes the gangs are changed, giving the labourers an opportunity to emerge from the building into the yard attached thereto, for the purpose of bathing."

Green Tea.

The firing and preparation of tea for market, as practised in Japan, is as follows :—The Japanese green tea may be divided into three general classes ; coloured, uncoloured, and basket-fired. The leaf used for all these is from the same plant, differing only in quality, condition, &c. All teas used by foreigners are first fired by the natives in the places where grown. If a grade of coloured tea is to be made, this fired leaf (four or five pounds) is taken and put into iron pans or bowls, which are heated sometimes up to a temperature of 212° Fahrenheit. The leaves are then rapidly stirred by hand against the smooth iron surfaces some twenty minutes. A teaspoonful of thoroughly pulverised soapstone (saponite) and five grains or so of powdered Chinese indigo, are placed in the pan, and thoroughly rubbed into the leaf for about 20 minutes more, when half a teaspoonful of soapstone or gypsum and pulverised tamarack bark (a species of larch) is added, and the stirring and rubbing is continued for 20 minutes more. It is then put into cold pans, and simply cold-rubbed against the iron surfaces until it has the required polish, which is arrived at in from 40 minutes to an hour. This is the ordinary way of preparing coloured tea. Other materials are perhaps sometimes used, but, so far as I can learn, all are as harmless as these mentioned. The different manufacturers, of course, vary the process a little now and then to produce slight changes of colour. The leaf is then run through three to five sizes of sieves, till all the dust and loose colouring-matter is separated. The shrinkage is about 12 per cent. This colouring process is considered beneficial to the leaf, tending to preserve its shape and flavour. There can be no doubt that the Japanese prepared teas is far superior in purity to the Chinese. In colouring Chinese teas various drugs are used that are deleterious to health, unless it be that the heat to which they are subjected renders them innocuous. Prussian-blue is frequently used instead of indigo in their green, and black-lead in their black teas. Uncoloured teas are made in the same way and quantities, and rubbed against the iron pans until the surfaces have the desired polish, and are then sifted until nothing but the whole leaves are left. Basket-firing is done in bamboo baskets, shaped something like our hour-glasses, which are shaken over hot pans. The leaf is put into the upper lobe of the basket and worked into the lower, and so back and forth until finished. The loss of weight is about 3 per cent.

FINIS.

M. S. MEMORANDA.

The following few pages of blank, ruled Paper are inserted for the purpose of entering any NOTES which may be derived from later experience from time to time, in respect to any of the subject-matters treated of in this Volume. The columns are given with the view of entry of the *section* and *page No.* to which any Remarks desired to be made, may refer.

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SPECIALITIES.—American Hammock Chairs to fold, with or without foot rest, Camp Chairs to fold up within space of 20″ × 15″ × 7″. The Automatic Invalids' Chair, Invalids' Table—*Curio* What-nots, &c.

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Orders Solicited.

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THE BEER, WINE, AND SPIRITS DEPARTMENT.

This Department is one of the most important in the Company's business, and the management have made it their especial aim to meet the requirements of the Company's constituents by adding to the brands hitherto imported such as are being asked for from time to time. Champagnes and other Sparkling Wines are received monthly. The services of a gentleman well experienced in the Wine Trade at home has been secured, and who will materially assist the Company in keeping up the stock to the best possible condition, and in perfecting arrangements for the shipment of some very choice brands of Clarets, Sherries, and Hocks.

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Is the most replete of its kind in the country, and a perusal of the catalogue of this Department will show that the prices are as reasonable as they possibly can be when duly considered in regard to quality. The stock is renewed by shipments from the FIRST English Purveyors, by each Overland and Suez Canal Steamer, thus ensuring perfect freshness.

The Cheese, Hams, and Bacon, and our Farm-cured Provisions, claim special attention.

INDIAN CONDIMENTS AND PRESERVES,

OBTAINED

Gold Medal and Highest Certificate of Merit,

Calcutta International Exhibition, 1883-84.

Made from the finest picked Fruits.

ALL articles comprised under the head of INDIAN CONDIMENTS AND PRESERVES are prepared at the Company's Farm, with the greatest care and attention to purity, under thoroughly experienced European supervision and warranted free from all deleterious coloring substances. The Company's reputation in this branch of their business is so well established in India, China, England, and the Colonies, that there is no need to advert to it. As "PRESENTS TO FRIENDS AT HOME" (*especially old Indians*) these articles are certain to meet with a grateful acceptance. The Company will have pleasure in selecting and despatching to any address in India or England such supplies as may be required by Constituents. At page 1 of the Company's Catalogue is submitted a list of the Contents of a "Sample Case" intended for "PRESENTS TO FRIENDS AT HOME" and especially put up by the Company as a guide to quantity and cost. *The contents of a case can be altered to suit the choice of Customers.*

THE CONFECTIONERY, TEA, AND CUISINE DEPARTMENT.

The well-known branch of the business comprised under this heading maintains its old-established repute and superiority in successfully executing all orders for Dinners, Weddings, Breakfasts Fêtes, Ball-Suppers, &c., of whatever magnitude. The long Indian experience of the Company's Managers, combined with the engagement of skilled *Artistes* from the most eminent London Establishments is a guarantee that entire satisfaction will be given in the thoroughly efficient carrying out of all orders, whether in Town or Mofussil.

The reputation for choice Teas.—which it has been the privilege of this establishment to enjoy for nearly thirty years—being so widely known needs no special remarks beyond mentioning that this season's importations are equal in quality and quantity to those of former years.

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The unrivalled and carefully-selected stock of goods in the Miscellaneous Department will well repay an inspection.

Every novelty, either useful or ornamental, is sent out by the Company's London Agents (who devote special attention to this) as soon as it appears either in London, Paris, or other Continental Marts, thus rendering the stock the most varied in the country.

The stock of Cigars, Tobaccos and Cigarettes is from Havana and Manilla, America and Cairo direct, and the selection at present on hand comprises the very best and most favourite brands in demand.

THE GENERAL OUTFITTING DEPARTMENT.

Comprises the Millinery and Tailoring Branches, and will be found well stocked with everything in the way of Ladies' or Gentlemens' Wearing Apparel requisite for a large outfit. The Silks and Satins, as well as every other fabric for Ladies' dresses, are of the most *recherche* description; the goods are marked at prices which should command extensive patronage.

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☞ **Catalogue will be forwarded on Application to the Secretary.**

HAROLD & CO.,

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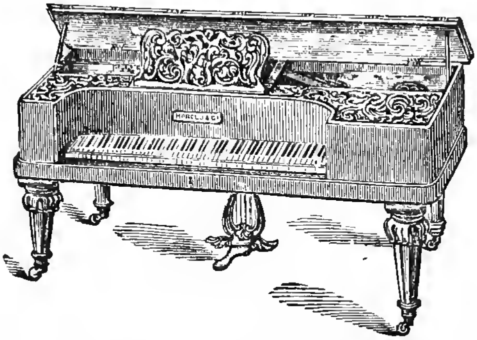

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The "Cantante Resonante" is of solid construction, with an Iron Frame.

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	Description of Class.	Single journey.	Return 3 months.	Return 6 months.
		Rs.	Rs.	Rs.
From Ports of Calcutta, Madras, or Bombay, *vià Brindisi*	1 Class	750	1,150	1,250
	Str. 1 ,, Rail 2 ,,	700	1,080	1,180
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Ditto Ditto, with rail Calcutta, Bombay *viz* Suez, Cairo, Alexandria	1 ,,	862	1,337-4-0	1,437-4-0
	2 ,,	456	783-10-0	833-10-0
	2nd Rl. & 1st Str.	756	1,173-10-0	1,273-10
Ditto Ditto, with rail Madras, Bombay	1 ,,	808	1,255-6-0	1,355-6-0
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For further particulars apply personally or by letter to

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[*This " Weekly Extra" can be* SEPARATELY *subscribed to, if desired.*]

THE

"INDIAN TEA GAZETTE,"

PUBLISHES

During the " Tea Season"

A

WEEKLY "EXTRA"

OF THE

TEA SALES

(CALCUTTA AND LONDON.)

N. B.—This " Tea Sale Extra" not only gives full tabulated detail *of every description of tea sold*, and *respective prices realized*, but also gives the *averages* of each break.

In addition to the Local Sales the latest London Sales are given, forming a most important addition to this valuable " Extra." This List is posted each week to Subscribers, by the Saturday morning mail, thus placing in the planter'shands, at *the very earliest moment*, the result and particulars of each *latest Tea Sale.*

This " Extra" offers a great advantage, as it can be filed *separately* for reference.

An additional charge of only six annas per month, or **Rs. 4** for the Tea Season, will be made to "*Tea Gazette*" *Subscribers* for this valuable special Weekly List.

To *non-subscribers* to the "Tea Gazette" the charge will be **Rs. 8** for the Season.

The figures given in this List are absolutely correct, and thoroughly reliable. Copies can be had from first issue of this Season.

10 HARE STREET, CALCUTTA.

BICKNELL'S

PATENT SELF-ACTING TEA DRIER.

Agents: THE TEA PLANTERS' AGENCY,

10 Hare Street, Calcutta.

THIS "Patent Tea Drier" satisfies a want that has been long felt, *viz.* a Tea Drier that combines all the advantages of quick and cheap drying, with a small primary cost, and thus is within the reach of the smallest Tea Concern.

The "Drier," with all its appurtenances, can be erected for about Rs. 75, and the royalty I charge on each Dryer is Rs. 50, so that for the sum of about Rs. 150 Planters can now obtain a "Tea Drier" that can compare in results with the Drying Machines now in use in many Tea Estates in India.

On receipt of the Royalty a model, measurements, and full particulars as to the erection and working of the "Drier," will be supplied.

Orders will be executed in the rotation they are registered. Any information regarding the "Tea Drier" that may be required will be furnished by the Agents.

The following are some of the many advantages of my Dryer :—

1. The Drier is built of Kutcha Brick and Stone.
2. Will dry 200 lbs. of Tea (800lbs. green leaf) per diem, with an expenditure of 100lbs. of charcoal, thus causing a saving of from 100 per cent. to 150 per cent. of charcoal.
3. Can be erected, including all appurtenances, for Rs. 75.
4. No skilled workmen are required for erecting the Drier.
5. Two men with a Drier can dry 200lbs. of tea per diem, thus causing a great saving in labour.
6. The temperature of the room in which the Drier is worked is not sensibly increased, thus causing much comfort to the men engaged in drying tea.
7. Teas dried by the Drier are superior to those dried in the ordinary way, having more briskness and fulness of liquor and better fermentation.
8. There is no danger of fire, as the only heat that escapes is a damp heat.
9. The heat of the Drier can be regulated, and there is no danger of burning tea, except from carelessness.
10. There being no chimney, holes have not to be cut in the roof, or slates removed for the erection of the Drier.
11. The Drier is very neat and handy, and easily worked, and is very popular with the natives.

R. T. BICKNELL.

MARBLE AND STONE WORKING CO., AT CALCUTTA AND CHUNAR.

LLEWELYN & CO.

(ESTABLISHED A. D. 1808).

THE LARGEST ESTABLISHMENT, COMPRISING THE MOST VARIED ASSORTMENT OF

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In Carrara, Vein, Sicilian, and Statuary Marbles, always in hand, and executed to any design.

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In great variety of design. Several handsome Tablets *now on hand*, with Figures in relief, suitable for any Cathedral or Church.

Pulpits, Fonts, and Reredos for Altars, executed in Marble, Alabaster, or Caen Stone, to any design.

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Monuments, Head and Foot Pieces, Ledgers, Slabs, &c.; Table Tops of any size or shape, in Statuary, Carrara, Sicilian, Siena, Black, or Other Variegated Marbles.

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Several Handsome Marble Figures now in stock.

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All work is finely executed under the superintendence of the proprietors, who having worked under the first professionals in the largest establishments of England, and in the Studios of the most celebrated Artists in France and Italy, is a guarantee for all work entrusted to their care being executed in the most artistic manner.

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Marble Clock Cases, or Ornamental Marble & Alabaster Work of any kind, neatly repaired & polished. *Monuments or Vaults in the Calcutta Cemeteries kept in repair at a very moderate annual charge.*

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Sole Agents for and Manufacturers of

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[*A very few copies only remain of this Work, and early application is necessary.*]

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A VOLUME OF SELECTIONS

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AND EDITED BY

THE EDITOR OF THE "INDIAN TEA GAZETTE."

PRICE, HALF CLOTH & CALF, Rs. 9.

PUBLISHED AT THE OFFICE OF THE "INDIAN TEA GAZETTE,"

10 Hare Street, Calcutta.

THE

TEA PLANTERS' AGENCY,

10, HARE STREET, CALCUTTA.

[ESTABLISHED 1880.]

——:o:——

THIS AGENCY proffers its services for the execution of commissions, and purchases, of any and every description, in the Calcutta or London markets.

Goods of every description, Miscellaneous requirements, Personal requisites, Household Stores, Beer, Wines, &c, procured at a commission of 5 per cent. on invoice amount.

The competition in the Calcutta market is now such, that a Firm possessing the knowledge of the local market which this AGENCY possesses, stands to do far better for a constituent than the constituent can possibly do for himself.

Considerable advantage also will be found to result, by the employment of this AGENCY, in respect to economy in forwardal cost, where several articles are required from different tradespeople.

As this AGENCY does not itself import or keep on hand any stock whatever, it has no interest in selecting for Constituents other than the best, freshest, and cheapest goods obtainable.

Careful *personal* selection is made, and there is the guarantee of the freshest goods, as well as of the lowest prices, being sought for *out of the entire Calcutta market.*

This AGENCY, by its great experience, extensive connections, and large purchases in Calcutta for CASH, is able to secure for its Constituents all the advantages of "Co-operative" prices, without the attendant drawback of mistakes, uncertainty, delay, and risk. The necessity, however, will be apparent that approximate Cash amount must accompany orders, if the advantages stated are desired to be availed of.

Ordinary rates, by reason of heavy stocks, or arrivals, as well as from other causes, frequently fall considerably, besides which there is much competition (the nature of which is fully known only to the initiated) even among leading houses. This AGENCY is in a position to obtain all the advantages of such and such like, and to secure, thus, always the *very lowest and best terms*,—more favorable, as a rule, than Mofussil residents, under any circumstances, are likely otherwise to be able to obtain for themselves.

It will be readily apparent that no one up-country ordering haphazard, through the ordinary expensive channels, or from mere Advertisements and Catalogues, can possibly hope to derive the advantages as to selection and price which this AGENCY, on the spot, having so intimate a knowledge of, and influence over, the Market, possesses; and it is found that those who have once used this AGENCY for the supply of their requirements, continue regularly to employ it.

Packages or chests of the choicest Indian *Tea*, as presents to friends at home, can be delivered in any part of the United Kingdom, at the addressee's door, *all charges paid.*

Constituents are supplied by this AGENCY with printed ORDER BOOKS, having a counterfoil for record.

Building Requisites, Garden and Factory Stores, obtained from the local market *on the very lowest terms.* Indents for these to be procured direct from London, when correspondents think this plan more desirable, will be received, and most carefully attended to by this AGENCY and by its London correspondents, and

every regard will be paid to securing lowest terms prevailing in the home market for the best class of goods. The important point of *economy in shipment* receives special attention at the hands of our experienced correspondents at home.

Tea Consignments, for Home Sale:—This Agency has complete arrangements **with London for** shipment of consignments for sale at home, either by public auction in Mincing Lane, or if in semi-wholesale breaks by sale direct to dealers. Advances will be made by this AGENCY up to 75 per cent. of the Calcutta valuation in the case of teas received for district shipment and home sale. Moderate commission charged.

Tea Consignments received for **Local Sale** by public auction, on moderate commission. Advances made on Tea thus consigned, to within 10 per cent. of Broker's valuation.

Agency of **Tea Estates**, whether private or otherwise, undertaken on specially favourable terms.

Sale or Purchase of **Tea Estates** negotiated on moderate terms, no commission being charged unless sale or purchase be effected.

Partnership and other **Accounts** professionally audited and adjusted, and **Arbitrations** undertaken.

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This AGENCY undertakes the disbursement of sums of money, on behalf of constituents, supplying cheque-books for the purpose, thus saving the trouble and risk of separately remitting to several different Firms stamps or notes, or the expense of obtaining money orders. On such business a commission of 1 per cent. is charged.

Current Accounts kept free of charge. Interest at 3 per cent. per annum allowed on the minimum monthly balance, when not under Rs. 100.

Fixed Deposits.—Interest allowed on sums of Rs. 500 and upwards :

For 3 months certain at 4 per cent. per annum.
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JANUARY, 1885.
10, Hare St., Calcutta.

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Agents.

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[CHIMNEY AND ALL CHOOLA IRON FITTINGS £5 EXTRA.]

Excels all others in every respect, being on the correct principle, and the material is at any moment under perfect Control. Is the first and only perfect Witherer. As a Dryer is perfectly equal and rapid for moist tea, or for finishing off. Can neither burn nor stew the Tea. Finishes at the rate of six chests per hour. Two more machines sold to one of the most eminent proprietors in Assam, chiefly for Pucca Battying the Tea left imperfectly dried by several in his possession of the most recent machines, each of which cost about three times the money. Complete factory fitted up with power, shafting, and every kind of machinery, &c. ; plans sent gratis with order. Every machine guaranteed to give the best results as to quantity and first-class Tea.

N. B.—We are entirely devoted to Tea Estate Machinery, and are our own Manufacturers, and give as good value (depending on the kind of machine) at from 50 to over 100 per cent less in price than other makers.

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PRIZE MEDAL AND CERTIFICATE, CALCUTTA EXHIBITION.

JOHN GREIG & CO.,
TEA MACHINERY MANUFACTURERS,
REGENT WORKS, EDINBURGH.

OUR MULTUM IN UNO DRYER, OR THE ECONOMIC, is intended for those who have neither steam nor water-power, and acts by its own natural upward draught of hot air passing below and above a series of 4 Trays inside hot-air chamber. Each section is fitted with a Cast-iron Chamber containing 4 trays, 2 in. deep and about 3 feet square. Each *section* contains 8 Globulous Pipes, and is a complete Drier in itself, and we guarantee one of the *three united stoves* to dry as much Tea and give the lauded malty flavor as any Drier on the same Tray principle, in addition to its being the cheapest in existence. Each section or stove is quite separate from its neighbour, and each has its own current of hot air. No motive power required. Any fuel. £25 per first section or complete Drier; **3 Driers for £65**. [*Enormous outturn of Tea if 5 sections be used; all heated by the same fire.*]

PATENT GREEN LEAF EQUALIZING MACHINE.—Price f. o. b. Glasgow, **£40**.

LINK AND LEVER-ROLLING MACHINE, can be driven with or without Engine power: proved to roll better than by hand. Now fitted with top hand-driving gear: f. o. b. Glasgow, **£55**.

FIRST-CLASS SEAMLESS BAGS, HEMMED AND READY, ONLY Re. 1-0 EACH.

CIRCULAR HORIZONTAL-MOTION SIFTING MACHINE, working with four ordinary sieves, 27 inches diameter, greatly strengthened, **£28**.

First-Class Horizontal Engines, and Upright Boilers, with modern steam and fuel-saving fittings.

Orders per Telegraph Code *free* with the **Tea Planters' Agency, 10, Hare Street, Calcutta,**

From whom all plans, prospectuses, &c., can be obtained.

Inventions by JOHN GREIG, JUN., *for fourteen years General Manager and Engineer of Estates in India and Assam; awarded by the Government of India for his Invention,* 1882, *Rs.* 15,000, *for the best Machine for preparing the Rhea Fibre.*

THE GREIG
PATENT GLOBULOUS PIPES.

The adaptability of these pipes, **for small Tea Estates,** on the score of cheapness, is without question. A splendid stove can be made by merely taking eight of these pipes and placing them in rows, in the form of the letter X, four at each side, and building them into brickwork. By having a long grating between the legs the heat acts directly on the pipes, and as there is a splendid draught, any number of sections or driers can be heated by the same fire. Wooden hot-air chambers and Trays could be made by the local mistree, the same as used in Assam over charcoal fires, so that Planters have no difficulty as far as that goes. The pipes will not burn so long as air is passing upwards through the interior of the same; they are in fact everlasting.

Thus at a ridiculously cheap cost, it is within the power of small proprietors, and small outlaying gardens, to make themselves independent of the use of charcoal altogether, and the somewhat tedious process of drying over charcoal fires. Price per section of 8 pipes £4. Furnace frame, double doors, Furnace-bars in 3 sections, draught-door, smoke damper, and 15ft of Chimney Pipe 9″ diameter in five pieces £6. Total cost for **a first-class Tea Drier,** without top-box or almirah with trays, £10. Working Drawing supplied with order. Full particulars to be obtained from the undersigned.

Price, Packed, f. o. b. Glasgow, **£10.**

THE GREIG
LINK AND LEVER TEA ROLLING MACHINE.

Simple and Cheap.—Can be erected and started to work by unskilled labour in two or three hours; cannot get out of order; has only two frictional parts requiring oil, *viz.*, the journals of the revolving barrel.

Powerful.—Having so few frictional parts, about 95 per cent. of the engine power is developed direct upon the Tea Leaf, and the power of compression upon the bags while rolling by a combination of links and a long lever, is so great that a boy can easily work the Machine. Each Machine is provided with a heavy fly-wheel, which insures regularity of speed and power.

Rapid.—Can be driven at almost any speed without risk of injury to the Machine or its setting; the outturn of Tea is thus greatly increased. Two bags can easily be rolled at the same time.

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