TROPICAL AGRICULTURE.

A TREATISE

ON THE

CULTURE, PREPARATION, COMMERCE, AND CONSUMPTION OF THE PRINCIPAL PRODUCTS OF THE VEGETABLE KINGDOM.

BY

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PREFACE.

About five-and-twenty years ago, after some years' practical experience on estates in the West Indies, having published numerous essays on Tropical Agriculture in the volumes of my 'Colonial Magazine,' and assisted in bringing out an Encyclopædia of Agriculture, I prepared a work for which there appeared to be a demand, treating of the cultivation, manufacture, and consumption of the chief 'Commercial Products of the Vegetable Kingdom.'

The edition being limited, and chiefly restricted to subscribers, the book has long been scarce, and is greatly in request; no other writer having since taken up this general field of description, I have been repeatedly asked to reprint the work; but my various literary engagements and active duties in charge of colonial products at the different international exhibitions have hitherto prevented me from devoting the necessary time and research to the task.

Last year I was requested by the Lords of the Committee of Council on Education to prepare a work on the commercial products of the Animal Kingdom, and, on completing that volume, it appeared to me that a new edition of my work, 'The Products of the Vegetable Kingdom,' would then form a very suitable companion to it. The old book was, however, unsuited to the practice and wants of the day, and such immense strides and improvements have been made in all the branches of scientific culture and manufacture, that I found it essentially necessary to write an entirely new work, merely following, to some extent, the plan and arrangement of the former edition, which had been found useful, and met with general approval. I have introduced many new subjects which have risen into commercial importance, especially the products of the Palm family, and the oils and oil-seeds of commerce; while others, such as fibrous materials (on which many special hand-books exist), I have not touched upon. I venture to believe that the work will be found practically useful on the subjects it treats of, especially as regards the statistics of production and consumption, which have been brought down as closely as possible in all cases to the date of publication.

The period of a quarter of a century which has elapsed between the publication of the two works has been characterised by remarkable and singular changes, not only in the sources of production of many of the staples, but in improved and largely-increased supplies.

In a paper which I read before the Royal Colonial Institute in January, 1874, on "Colonial Aids to British Prosperity, together with a retrospect of the progress of our dependencies in the last quarter of a century," I pointed out in considerable detail the great value of our colonies in furnishing us with large portions of our food supplies, and the raw materials for our manufactures,—as fields for enterprise and the safe and profitable investment of capital,—as homes for our surplus population,—as large customers for our manufactures,—as affording active employment for our shipping, and as outposts of defence, &c.

The greater part of our distant possessions (India and the Colonies) are situated in tropical or sub-tropical regions, and I may briefly show the progress they have made in this quarter of a century, as evidenced by the latest official returns available:

	1850.	1874.
Population	178,338,667	198,949,223
Revenue	£34,875,307	77,094,042
Shipping, entered and cleared, tons	10,521,526	38,640,935
Exports	£36,855,861	155,192,931
Imports	£34,348,941	154,309,734

If we make a retrospective comparison also of the condition of the United Kingdom, we find, as regards commerce, even more marked progress shown. How much indeed of the world's progress has been affected by the influence of navigation and commercial intercourse; and how much more may yet be carried out before the close of the present century.

The following figures mark the condition of the United Kingdom at the two periods:

	1850.	1875.
Population	27,674,353	33,089,237
Revenue	£52,810,680	74,425,000
Shipping, entered and cleared, tons	14,505,064	46,276,838
Exports	£71,367,885	281,612,323
Imports	£100,460,433	373,939,577

The present work is not exclusively confined to agricultural progress in our colonies, for I have gone carefully over the different fields of production in all foreign countries, so that comparisons may be made. It will be found that we have not stood still in the competitive race, whether as regards the production of sugar, coffee, cocoa, tea, rice, or other staple articles for which there is a demand in Europe. The great increase which has taken place in our imports in some of the principal commodities is shown by the following comparative figures:

		1851.	1876.
ARTICLES OF FOOD, ETC.			
Cocoa	lbs.	6,773,960	20,382,308
Coffee	cwts.	474,402	1,341,378
Tea	lbs.	71,476,421	185,698,190
Sugar	cwts.	8,381,075	15,587,246
Molasses	,,	791,783	496,357
Brandy	galls.	2,930,967	7,953,913
Rum	,,	4,745,244	10,476,503
Wine	,,	9,008,151	19,969,838
Maize	cwts.	7,747,011	39,958,226
,, meal	,,	..	7,706
Rice	,,	744,847	6,485,987
Sago	,,	92,021	360,357
Arrowroot and tapioca ..	,,	16,915	484,230
Cassia lignea	lbs.	267,462	1,200,000
Cloves	,,	253,438	
Cinnamon	,,	530,826	1,339,508
Ginger	cwts.	16,503	62,164
Nutmegs and mace	lbs.	358,320	
Pepper	,,	3,996,295	26,059,030
Pimento	cwts.	36,061	35,710
Currants and raisins ..	,,	982,934	1,714,445
Oranges and lemons ..	bush.	800,000	2,995,328
ARTICLES FOR MANUFACTURES, ETC.			
Oil-seeds	qrs.	712,865	2,457,348
Cotton seed	tons.	..	230,284
Oil-seed cake	,,	55,076	190,225
Cocoanut oil	cwts.	55,994	199,431
Olive oil	tuns.	11,503	23,975
Palm oil	cwts.	608,550	864,472
Coir, yarn, and cordage ..	,,	82,582	219,367
Manila hemp	,,	92,755	300,798
Gambier and cutch	tons.	7,220	26,677
Indigo	cwts.	89,944	88,680
Madder and garancine ..	,,	295,016	74,535

The attention which has of late years been given to the culture of tea in India, of coffee in Ceylon and our Indian empire, of tropical fruits for export—the orange, the pine-apple, and the grape, &c., of oil-seeds, and other products, is very remarkable.

In some cases, as in cotton seed, palm-nut kernels, ground-nuts, and other oil-seeds, new industries have sprung up of great importance to our commerce and manufactures.

Finally, I may state that having long been extensively identified with commercial literature, and thoroughly conversant with all colonial products, I have studied to accumulate facts and useful information on the various subjects treated of, so as to make the book a reliable and standard work of reference, useful alike to the planter and producer, the merchant and broker, as well as to the general public, who are the consumers.

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BIBLIOGRAPHY.

Works consulted on the subjects treated of.

Cocoa and its Manufacture. By John Holm. London, George Rivers.

Histoire Naturelle du Cacao et du Sucre. Amsterdam, 1720.

A Manual of Coffee Planting. By W. H. Middleton. Adams and Co., Natal, 1866.

An Historical Account of Coffee. By John Ellis. London, 1774.

Coffee and Chicory. By P. L. Simmonds. London, Spon.

Coffee Planting in Ceylon—Past and Present. By G. C. Lewis. Colombo Examiner Office, 1855.

A Manual of Coffee Planting. By W. H. Middleton. Adams and Co., Durban, Natal, 1866.

Du Café, son Historique, son Usage, son Utilité, &c. Par A. Chevalier. Paris, 1862.

Report on Coffee Cultivation in Dominica. By H. Prestoe. Trinidad, 1875.

The Coffee Planter of Ceylon. By Wm. Sabonadière. London, Spon, 1870.

Breves Consideracoes sobre a Historia e Cultura do Cafeiro e Consumo de seu Productos. By Dr. N. J. Moreira. Rio Janeiro, 1873.

Handbook for the Cultivation and Manufacture of Tea in Java. By J. J. L. L. Jacobson. ('Journal of the Agricultural and Horticultural Society of India,' vol. xiii., Part III.)

Prize Essay on the Cultivation and Manufacture of Tea in Cachar. By H. A. Shipp. (From the 'Journal of the Agricultural and Horticultural Society of India,' vol. xiv. Supplementary number.)

Prize Essay on the Cultivation and Manufacture of Tea. By Lt.-Col. E. Money. Calcutta, Wyman and Co., 1874.

Remarks on the Pruning of Tea. By George King, M.B., &c. ('Journal of the Agricultural and Horticultural Society of India,' vol. iii., Part I.)

The Tea-Bug of Assam. By S. E. Peat, Esq. ('Journal of the Agricultural and Horticultural Society of India,' vol. iv., Part I., N.S.)

A Short Guide to Planters cultivating Teas in the Himalayas and Kohistan of the Punjab. By Dr. Jamieson.

Ball on the Cultivation and Manufacture of Tea.

Fortune's Visit to the Tea Districts of China and India, 1852. 8vo.

Papers regarding the Tea Industry in Bengal. Calcutta, Secretariat Press, 1873.

Tea Cultivation in India. By Col. W. Nassau Lees, LL.D. London, 1863. 8vo.

Étude Économique sur le Maté ou Thé du Paraguay. Par le Dr. A. Demersay. Paris, 1867.

De la Culture de la Canne et de la Production du Sucre à l'Ile de la Réunion. Par M. Malavois. Paris, J. Louvier, 1861.

Guide pratique de la Culture de la Canne à Sucre, du Cafier et du Cacaoyer. Par Bourgoin d'Orli. Paris.

Guide pratique du Fabricant du Sucre. Par N. Basset. 3 vols. Paris, 60 Rue Madame.

Ensayo sobre el Cultivo de la Cana de Azucar. Par M. Alvaro Reynoso. Madrid, 2nd edicion, 1865.

A Treatise on the Manufacture of Sugar from the Sugar-cane. By Peter Soames. London, Spon, 1872.

Notes on the Sugar-cane and the Manufacture of Sugar in the West Indies. By A. W. Anderson. Trinidad, W. Herbert, 1860.
Notice sur la Culture de la Canne et Fabrication du Sucre en Louisiane. Par B. Dureau. Paris, 1852.
Recherches sur le Jus de la Canne à Sucre. Par Dr. Icery. Mémoire présenté à la Chambre d'Agriculture de l'Ile Maurice, 1865.
Annales de l'Agriculture des Colonies. Paris.
Art de l'Indigotier. Par G. S. Perottet. Paris, 1842.
Catalogues des Produits des Colonies Française aux Expositions de Londres, 1862, et de Paris, 1867.
L'Olivier, sa Culture et ses Produits. Par H. Raibaud-L'Angé, 1861. Paris, Veuve Bouchard-Huzard.
The Olive and its Products. By Lewis A. Bernays, F.L.S. Queensland.
Monografia sulla Fabricazione degli Olii d'Uliva. By Domenico Capponi. Genoa.
Classification de 160 Huiles et Graisses Végétales. Par M. Bernardin.
État actuel de l'Algérie. Alger, Bouyer, 1862.
Manuel d'Agriculture pratique Algerienne. Par Émile Cardon. Paris.
Journal de l'Agriculture des Pays Chauds. Par Paul Madinier. Paris, 1860–67.
L'Agriculture de la Guyane, Réunion, &c. Par Dr. Sagot. Paris, 1869–74.
La Guyane-Française. Par J. F. H. Mourie. Paris, 1875.
Classification de 250 Fécules. Par M. Bernardin. Gand, C. Annoot-Braeckman, 1874.
Lecture on the Edible Starches of Commerce, their Production and Consumption. By P. L. Simmonds. Journal of the Society of Arts, vol. xxi. p. 346. 1873.
Report on New Starch Substances. By Dr. Van Den Corput. Bruxelles, Weissenbruch, 1857.
La Production Animale et Végétale. Études faites à l'Exposition Universelle de 1867. Paris, E. Dentu.
Observations on the Vegetable Products of Ceylon. By W. C. Oondatje.
Proceedings of the Conferences held by the India Committee of the Society of Arts, 1869.
Economic Products of the Punjaub. By Baden Powell.
Simmonds's Journal of Applied Science. 8 vols.
Simmonds's Technologist. 6 vols. London.
Sorghum and its Products. By F. L. Stewart. Philadelphia, Lippincott and Co., 1867.
Statistical Abstract of the Colonial and other Possessions of the United Kingdom. 12 numbers to 1875. London, Eyre and Spottiswoode.
Papers relating to Her Majesty's Colonial Possessions. London, Eyre and Spottiswoode.
Tahiti. Recherches sur les Principales Productions Végétales de l'Ile. Par G. Cuzent. Rochefort, C. Theze, 1860.
Statements exhibiting the Moral and Material Progress and Condition of India for the Years 1873–74–75.
Statement of the Trade of British India with British Possessions and Foreign Countries for the Five Years ending 1875. London, Eyre and Spottiswoode, 1876.
The Indian Agriculturist. Calcutta, 1876–1877.
Agricultural Gazette of India. 3 vols.
Useful Plants of India. By Col. H. Drury. London, Allen.
Le Dattier, sa Description, son Histoire, &c. Par G. Dechevalerie. Gand, C. Annoat-Braeckmann, 1873.

COMMERCIAL PRODUCTS

OF THE

VEGETABLE KINGDOM.

SECTION I.

PLANTS YIELDING SEEDS, LEAVES, AND OTHER SUBSTANCES EMPLOYED IN DOMESTIC USE FOR THE PREPARATION OF DIETETIC BEVERAGES, ETC.

No substances are so essentially necessary and useful to mankind, and form such important articles of commerce, as those which I propose first to consider, Cacao, Coffee, Tea, and Sugar. The consumption of these in all civilized countries is immense, notwithstanding that in many they have been fettered with heavy fiscal duties. The description of the culture of the plants from which they are obtained, the manufacture of the products, and the statistics of commerce, are the subjects to which it is intended to give most attention, glancing only incidentally or occasionally at their early history.

COCOA.

Botanical Description and Chemistry of Cocoa.—The cacao, or cocoa, of commerce is the seed of an evergreen tree, the *Theobroma Cacao* (Lin.), growing from twelve to twenty feet high. There are nine or ten other species, however, enumerated by botanists, of which I may name *T. angustifolia*, Dec., and *T. ovatifolia*, Dec. (the Soconosco), of Mexico; *T. bicolor*, Humboldt, of New Granada; *T. Guianensis*, Aublet, of Guiana; *T. Caribæa*, of the West Indies; and *T. microcarpa*, Mart.; *T. ovatifolia*, *speciosa*, Willd., Para; *T. subincana* and *sylvestris*, Martius, of Brazil.

The fruit, or pod, resembles a short, thick cucumber, and contains from twenty to forty seeds enclosed in a pulp, somewhat like that of a water-melon. This pulp is frequently used for food and sweetmeats; vinegar is also made of it. In the Brazilian collections at the various International Exhibitions, spirits, liqueurs, jellies, &c., made with cocoa, have been shown.

When Cortez and the Spaniards entered the vast empire of Montezuma, they found the use of cocoa or chocolate as a beverage common. The emperor, however, alone drank it flavoured with vanilla from a golden cup. A legend surrounds with religious veneration this sacred beverage, and when Cortez sent to Charles V. the principal products of the New World, he did not omit cocoa as the most healthy of the beverages which Spain obtained by its conquests. The conquerors were not slow to appreciate its excellent qualities, and introduced it into Spain.

Spain, however, for some time depended on the colonies for the manufactured article, but when the art of preparing it was conveyed there, the raw material was also imported. The Spaniards, by jealously guarding as a secret the mode of manufacture, were able to retain the monopoly of the trade in chocolate for many years.

The value of chocolate was speedily appreciated by the physicians of Europe, and Hoffmann wrote a monograph treating of it, entitled 'Potus Chocolati,' in which he recommends it in many diseases, and instances the case of Cardinal Richelieu, who, he states, was cured of general atrophy by its use.

It was probably more than a century after the introduction of cocoa into Europe before the English became acquainted with it. According to Mr. Hewett, the earliest mention of its use appears in a newspaper called Needham's 'Mercurius Politicus,' dated the 16th of June, 1659. For many years England continued to import all the chocolate she consumed in its manufactured state; but I believe about the commencement of last century several persons commenced the manufacture in this country. There is very strong reason to believe that a knowledge of the mode of preparation was brought into England by Sir Hans (then Dr.) Sloane.

Cocoa or chocolate is, without exception, of all domestic drinks, the most alimentary, and the Spaniards esteem it so necessary to the health and support of the body, that it is considered the severest punishment to withhold it, even from criminals; nay, to be unable to procure chocolate is deemed the greatest misfortune in life. The signs by which good chocolate or cocoa is known are these. It should dissolve entirely in water, and be without sediment; should be oily and yet sweet in the mouth, and if genuine and carefully prepared, should deposit no grits or grounds.

The bean of the cocoa owes its properties in the first place to an azotised substance, theobromine, and next to the ternary compounds oil and starch. It also contains a large quantity of phosphate of lime, which adds no doubt to its qualities as food. The quantity of volatile substance it contains is small, though it may, to some slight degree, be increased by roasting.

The chemical composition of cocoa is shown in a table printed at page 4, which gives the different analyses of any importance that have been made.

The results given are not very flattering to chemical science, the analyses being of the most contradictory character, and containing discrepancies which cannot be at all reconciled with each other. It appears to me that the analysis prepared by Dr. Playfair is the most correct, while those of Tuchen and Muter are the least so. We thus see that, taking the most important constituents, cocoa contains:

	Parts.
Cocoa butter	50
Albuminoid substances	20
Starch, sugar, &c.	13
Salts	4
Theobromine	2
Other substances	11
	100

Examining these in the order of their importance, we first notice the fat, or cocoa butter, which forms about half the substance of the nibs. It is a hard, fatty material, which, when clarified, is of a dead white colour. Its melting point is about 100° Fahr., which, being the heat of the body, renders it of great value for therapeutical purposes. This fat never becomes rancid, however long it may be kept, a quality peculiar to itself. It is hardly necessary to point out how valuable this property is, for it places cocoa butter first in the list of the fatty class of our carbonaceous or heat-giving foods. The albuminoid constituents form about 20 per cent. of the nib. These are classed amongst the nitrogenous principles of food, and their presence renders cocoa one of the richest flesh-formers we have. The starch, gum, and sugar present, like the cocoa butter, belong to the non-azotised principles; they form about 13 per cent. of the whole. The alkaloid of cocoa, *theobromine*, is very similar in its physiological effects to its analogues, *theine* and *caffeine*, from which it differs but slightly in chemical composition.

ESSENTIAL ALKALOID PRINCIPLES.

Yielded by	Name.	Composition.	Proportion.
Cocoa	Theobromine	$C_7 H_8 N_4 O_2$	2 per cent.
Coffee	Caffeine	All identical $C_8 H_{10} N_4 O_2$	1 to 5 per cent.
Tea	Théine		
Guarana	Guaranine		
Maté	Theine	..	In less quantities.

In regard to these alkaloids, it is interesting to note that throughout the world the instinct of man has led him to seek some substance that contains one of these principles, which owe their value to the specific influence they exert on the nervous system, stimulating it and checking waste of tissue. *Theobromine*, when extracted, presents the form of a white crystalline powder of almost amorphous character, differing from *caffeine* and *theine*, which have a very beautiful crystalline appearance.

In most of the analyses of cocoa the existence of a volatile oil has been overlooked. It is probably present only in small quantities, and appears to be developed by roasting; but upon it depends the flavour and aroma which exist in cocoa.*

* Mr. John Holm "On Cocoa and its Manufacture," 'Journal of the Society of Arts,' vol. xxii. p. 356. 1874.

Percentage Analyses of Cocoa.

	Lampedius.	Tuchen.	Payen.	Johnston.	Playfair.	Miller.	Boussingault.	Mitscherlich.		Muter.	Average of several other Analyses.
Fat (cocoa butter)	53·10	36·97	52·00	51·00	50·00	56·00	44·00	45·00	49·00	42·67	50·00
Albuminoid substances ..	18·70	..		..	..	17·00	..	13·00	18·00	..	..
Albumin	..	..	20·00	..	20·00	..	20·00	..	..	..	18·00
Fibrin	..	..		..	..	..	..	..	..	..	
Gluten	..	30·20	..	20·00	..	..	..	..	..	12·21	..
Extractive matter	..	4·14	..	..	..	..	..	..	..	..	..
Sugar	..	..	..	..	..	..	..	0·60	..	..	..
Starch	10·91	0·55	10·00	22·00	7·00		..	14·00	18·00	19·03	10·00
Gum	7·75	0·69	..		6·00		6·00	..	..	6·40	8·00
Lignin	0·90	..	..	..	..	22·00		..	..	..	..
Cellulose	..	30·00	2·00	..	..		13·00	6·08	..	5·95	..
Woody fibre	..	..	..	..	4·00		..	..	..	..	..
Colouring matter	2·01	6·61	traces	..	2·00	..	..	3·05	5·00	3·96	2·60
Water	5·20	6·01	10·00	5·00	5·00	..	11·00	5·06	6·30	5·98	6·00
Theobromine	..	0·56	2·00	2·00	2·00	1·50	2·00	1·02	1·50	0·90	1·50
Salts	..	3·00	4·00	..	4·00	..	4·00	..	..	..	..
Ash	..	..	..	..	..	..	..	3·05	..	2·90	3·60
Humic acid	..	7·25	..	..	..	..	..	..	..	..	..
Parts unaccounted for ..	1·43	1·02	..	..	..	3·50	..	9·14	..	..	0·30

Mr. Charles Heisch, F.C.S., in a paper "On the Composition of Various Kinds of Cocoa,"* observes: "It is well known that different varieties of cocoa fetch very different prices; but as far as I am aware, no careful examination has been made to ascertain if these variations are caused by any difference in their composition regarded as articles of food, or if they be due solely to differences in flavour, which, after all, may be only matters of taste. In none of the published analyses of cocoa which I have seen is any mention made of the kind of bean analysed, it is therefore not surprising that the results published vary very considerably. Thus, while in Dr. Hassall's book we are told that cocoa contains albuminoid matter 16·7 per cent.; in Dr. Parkes' Practical Hygiene it is stated to contain from 13 to 18 per cent. of protein substance. In neither case is it mentioned whether the bean was examined raw or after roasting. Having through the kindness of a friend obtained samples of various cocoa beans, both raw and roasted, which he assured me were unmixed, I made a number of analyses of the roasted beans. The results are shown in the following table. They are not so complete as I had

	Percentage of Husk.	Result of Examination of Roasted Bean after Removal of Husk.								
		Fat.	Nitrogen.	Albuminoid substances.	Ash.	Ash soluble in water.	Ash soluble in HCl.	Phosphoric Acid in Ash, calculated as H_3PO_4.	Moisture.	Starch. Gum, Cellulose, &c.
Caracas ..	13·8	48·4	1·76	11·14	3·95	2·15	1·80	1·54	4·32	32·19
Trinidad† ..	15·5	49·4	1·76	11·14	2·80	·9	1·90	·93	3·84	32·82
Surinam ..	15·5	54·4	1·76	11·14	2·35	·80	1·55	1·23	3·76	28·35
Guayaquil..	11·5	49·8	2·06	13·03	3·50	1·75	1·75	1·87	4·14	30·47
Grenada ..	14·6	45·6	1·96	12·40	2·40	·60	1·80	1·35	3·90	35·70
Bahia ..	9·6	50·3	1·17	7·40	2·60	·90	1·70	1·26	4·40	35·30
Cuba	12·0	45·3	1·37	8·67	2·90	·95	1·95	1·13	3·72	39·41
Para	8·5	54·0	2·00	12·66	3·05	1·40	1·65	1·00	3·96	26·33

† I am inclined to think that the Trinidad sample was not of the finest quality.

hoped to make them, but they comprise the more important constituents. In the first column of the table is noted the proportion of husk in the several varieties. This difference appears to be mainly due to the husk in some kinds being much thicker than in others; in all cases these thick husks separate more readily from the bean in the process of roasting, and can be taken off with much greater facility. The other estimations are made on the roasted bean after removal of the husk. The albuminoids are calculated from the total nitrogen found by combustion with soda lime; the nitrogen contained in the theobromine is thus included, but in the roasted bean this is so small that the difference is hardly worth consideration; hereafter I hope to estimate the theobromine in the different varieties, as well as the starch, gum, cellulose, &c. It will be observed that in none of the above samples do the albuminoid substances reach the amount mentioned by Hassall or Parkes, but as neither of them give the method by which the albuminoids were ascertained, no attempt can be made to account for the difference. The amount of these substances in

* The 'Analyst' for Oct. 31, 1876.

Para cocoa, which is about the lowest-priced variety, is, with one exception, the highest in the table, so that, viewed as an article of food, it is superior to some of the more expensive kinds. The soluble ash consists, to a great extent, of phosphate of potash, the phosphoric acid in the portion insoluble in water being mostly, if not entirely, combined with magnesia."

The cocoa production of the world may be set down as follows, according to the latest returns:

	Lbs.
Brazil	7,000,000
Venezuela	7,000,000
Equador	28,000,000
Trinidad	11,000,000
Grenada	2,419,424
Dominica	189,782
St. Lucia	255,614
Jamaica	50,512
French Guiana	66,000
Guadaloupe	206,000
Martinique	686,000
St. Vincent and Hayti	550,000
Mexico	2,000,000
Celebes	250,000

Production and Consumption.—Cocoa and chocolate are comparatively little used in this country, compared with the other articles employed for dietetic beverages. The quantity taken for consumption last year (1875) was nearly 10,000,000 lbs., or rather more than a quarter of a pound for each person of the population. Still, it is gradually on the increase, as will be seen by the following statistics, showing the annual quantity consumed, and the percentage of consumption per head of the population in the kingdom.

When we consider that the imports of cocoa into this country in each of the years 1873 and 1874, were over 18,000,000 lbs., there was an abundant supply to fall back upon, had there been a commensurate demand. Looking at the small consumption here, and that there is only the Continental market to depend upon, there is but little encouragement to our colonial planters to extend the production.

The value of the cocoa imported annually into the United Kingdom is about 500,000*l.* The quantity now received here ranges between 18,000,000 and 19,000,000 lbs., one-half of which is kept for use in Great Britain.

The following gives the quantity of cocoa annually retained for consumption in the United Kingdom, and the average consumption per head of the population :

Year.	Lbs.	Lb.	Year.	Lbs.	Lb.
1840	2,041,678	0·08	1848	2,919,591	0·10
1841	1,928,847	0·07	1849	3,206,746	0·12
1842	2,246,569	0·08	1850	3,080,641	0·11
1843	2,547,934	0·09	1851	2,978,344	0·11
1844	2,589,977	0·09	1852	3,328,527	0·12
1845	2,579,497	0·09	1853	3,997,198	0·15
1846	2,951,206	0·11	1854	4,452,529	0·16
1847	3,079,198	0·11	1855	4,383,023	0·16

Year.	Lbs.	Lb.	Year.	Lbs.	Lb.
1856	3,634,135	0·13	1866	4,053,133	0·14
1857	2,647,470	0·09	1867	4,228,554	0·14
1858	2,860,034	0·10	1868	5,115,943	0·17
1859	3,013,859	0·11	1869	5,701,880	0·19
1860	3,230,978	0·11	1870	6,153,981	0·20
1861	3,407,672	0·12	1871	7,252,035	0·23
1862	3,622,433	0·12	1872	7,791,763	0·24
1863	3,712,231	0·13	1873	8,284,260	0·26
1864	3,862,273	0·13	1874	8,854,690	0·27
1865	3,826,425	0·13	1875	9,957,610	0·30

Culture in Trinidad.—The distance at which the trees should stand apart will be modified to some extent by the altitude at which they grow, and by the different habit of growth or the different varieties—the trees usually being smaller and of more compact habit as altitude increases, some varieties have an erect, and some a spreading habit—but it will range from ten to thirty feet.

The first pruning should consist of removing all weaker branches which happen to cross each other closely, and the branchlets (smaller branches) to such an extent as to leave the principal branches free of each other, and as much as possible, radiating regularly from the centre of the tree.

The smaller of the principal branches should also be removed where they are crowded; and in larger trees, all branches which have a downward tendency, so that a regular canopy of branch and foliage may be formed overhead, supported on fruitful column-like stems.

The growth of every tree over four or five years old will be at least two feet in the spread all round in one year, until the full dimensions are reached.

The best months for pruning in the West Indies are March and April, but pruning of large branches may be done in August and September, should the branches have no young fruit to sacrifice. The model form of a cocoa tree, and which should always be kept in view by the grower—either with regard to trees to be renovated or young plants—is this; a straight single stem up to three feet from the ground, and dividing into two or three as it grows higher; each of these again dividing into two or three branches, make up the framework or principal branches which terminate numerously in the leafy branchlets regularly disposed into a well-formed head. The tree uninterfered with from the beginning will assume to itself more or less accurately this mode of growth—termed trichotomous by botanists—which being innate with it, the model is of very easy attainment, and ensures the greatest possible production of fruit in the least possible space.

The cocoa tree is a deep rooter, and therefore soils of the second class, and those of the valleys—especially where they are much broken—are best suited to it.

Aspect is a most important consideration in the culture of cocoa in all countries, and it does not thrive in valleys of easterly and northerly aspect. In Trinidad the quality of the produce is modified by various modes of treatment when prepared for the market.

The best quality irrespective of treatment is produced by the Criollo cocoa of the Spanish inhabitants, who almost monopolize this cultivation, and it is getting scarce. The pods are smaller than those of the better varieties of other kinds, but the seeds are thicker, shorter, and almost globular. The interior of the seed is of a pale crimson, toning down into pink, and the taste slightly bitter.

The Forastero kinds are here much prized; there is the Cundeamar of two kinds, one with yellow, the other with red pods. The former are sooner fit for drying; it has the largest seeds, which are easily fermented and prepared. They are of a pale crimson, approaching the Criollo.

The Amelonado comes next, and then the Calabacillo, which is the lowest kind; its seeds are small and very bitter, and the crimson pigment is so dark that it is very easily distinguished from the other varieties by this mark alone.

The fruit after being picked is either left under the trees in large heaps unopened, or opened at once and brought to the fermenting and drying houses. In the former case a sort of fermentation begins in the fruit, and some planters consider it a good process. The pulp surrounding the seeds contains abundance of saccharine, which causes or rather feeds the fermentation. In many establishments the seeds are fermented in barrels, in others they are merely heaped in a close room. According to the quantity of seeds the planter wishes to obtain, and according to the quality of the seed, this fermentation is continued from three to ten days. The best Forastero cocoas require less time than the other qualities, but more than the Criollo, which completes the process in three days.

The influence of the fermentation is twofold; first it destroys the pulp, which surrounds the seeds and the saccharine matter, which would interfere with the drying process; and, further, it produces a sort of sweetness and flavour in the seed, accompanied by a change from violet to brownish-red or cinnamon colour. Some hold that fermentation lessens the bitterness of the berry, but on this point doubts are admissible. Cocoa must of course be fermented to prepare it for drying, but the process is attended with some risk in wet weather, when the berries are prone to blister.

Not very many years ago fine red cocoa, that is cocoa having a very clear skin of a reddish colour, fetched the highest price in the English market, and no attention was paid to the flavour of the kernel. The opinions of buyers have since changed, and the samples that now fetch the highest prices are all highly fermented. Red cocoa is, however, still in favour, probably on account of the small percentage the manufacturer loses when the berry is clean. Trinidad manufacturers and consumers prefer the light-brown kernel, irrespective of the colour of the skin. The substance of the kernel itself is not changed by fermentation; the starch is left intact, and suffers no loss in weight. A great deal depends upon the weather for curing the cocoa for shipment.

The Criollo red-skinned cocoa, abundant in Caracas, requires but little fermentation, as it is naturally of a much finer flavour, but its produce is small, and the tree is said to be a slow bearer, and easily destroyed by disease or bad weather.*

So many new cocoa walks have been planted, and small established ones enlarged in the last three or four years, that the supply in a year or two should much more than balance the falling off in exhausted plantations. A considerable amount of good fresh land has of late been taken up for, and laid down in, cocoa in the country south of and between Arima and the East coast—sufficient to enable planters to keep pace with the increasing consumption at home. They are commencing to plant the cocoa tree in the East Indies, but it will be some years before a crop is reaped, and whatever is gathered will, for many years, suffice only for eastern consumption, including that of Australia. Jamaica is talking of reviving her long-abandoned cacao cultivation, and Dominica will do well to follow her example, having rich soil in sheltered dells, well adapted, to all appearance, to favour this delicate plant. But the islands to the north of Trinidad must take into their calculation a risk from which that island and Grenada are almost free—that of hurricane blasts. The quality of Trinidad cacao maintains its reputation. We hear of extensive irrigation improvements on Mr. Needham's fine property at the head of Santa Cruz, well known as San Antonio.

Exports from Trinidad.—In Trinidad cocoa is the second great staple of production, and although the annual crop necessarily fluctuates, according to weather and favourable seasons, yet it will be seen the shipments have doubled in the last quarter of a century. The following figures give the annual export crops:

	Lbs.		Lbs.
1851	5,552,437	1863	7,484,941
1852	6,823,695	1864	5,090,017
1853	4,904,719	1865	6,760,287
1854	3,379,159	1866	5,991,673
1855	4,547,060	1867	8,016,237
1856	4,575,000	1868	7,614,947
1857	4,942,600	1869	6,339,022
1858	5,403,600	1870	7,470,028
1859	5,893,400	1871	6,422,038
1860	4,135,921	1872	7,182,404
1861	6,530,906	1873	9,238,141
1862	3,849,223	1874	11,191,431

Taking decennial periods the shipments have been as follows:

	Lbs.		Lbs.
1821	1,214,093	1851	5,552,437
1831	1,888,852	1861	6,530,906
1841	2,493,302	1871	6,422,038

There is a singular discrepancy between the returns of shipments, as published by the Colonial Office, which I have given above in detail from the twelfth number of the 'Statistical Abstract for the several Colonial Possessions,' and those published in the island papers, for

* The late Mr. Herman Cruger, Colonial botanist, in the Trinidad Catalogue of Products shown at the London International Exhibition, 1862.

instance, the 'Trinidad Standard' gives the shipments for the last few years as follows:

	Lbs.		Lbs.
1869	6,269,920	1872	7,019,160
1870	6,862,600	1873	7,695,520
1871	6,447,380	1874	10,342,206

And states that the crop shipped in 1861, 8,472,302 lbs., was not far short of double the preceding ten years' average, double the shipment of the year next following, and that the average of the ten years, 1862–71, was about 6,357,400 lbs.

The season begins in October, and if the shipments were noted from the first of that month instead of the 1st January we should have a truer statement of the relative crops.

The exports in the years, ending September 30, have been, in 1872, 7,062,320; 1873, 7,484,520; 1874, 9,794,220; 1875, 6,130,306. There is little doubt the unusual quantity exported in 1874 was made up, to some degree, of cocoa sent from Grenada for reshipment, and which it is to be feared went home as Trinidad produce, lowering the character of the ordinary cocoas of that island. Cocoa is prepared in two different ways, according to the market for which it is intended. If for Europe, the seeds are covered with dry leaves and a light layer of earth, and left for six or eight days to ferment. Treated thus they lose much water, and their very bitter and astringent principle. The seeds become lighter, of an agreeable and mild flavour, are of a handsome cinnamon colour, and the husk or envelope separates easily from the bean by a slight pressure between the fingers. It is in this condition that the seeds are most sought after, and make the best chocolate. To England, where cocoa is principally consumed in infusion, it is sent without any preparation. The seeds are then of a red colour, their envelope is clean, smooth, adhering to the interior almond, which is of a purple colour, with an astringent and bitter flavour. In this condition it is quite unfit to be manufactured into chocolate. According to Mr. H. Prestoe, colonial botanist, the chief object in claying the beans is to preserve them, but in the French market there is a decided preference for clayed kinds, without apparently much regard being paid to the quality of the interior. The qualities characteristic of the best cocoas are these: A clean reddish-brown or "chocolate" coloured interior. Dryness, so as to render the bean crisp all through, and the "nibs" or plates of the kernel readily separable from each other, and from the shell or skin. The colour of the "nibs" outside is a dull purplish, slightly brown. The fracture presents a fine glaucous purple-brown. Chewed, the nibs reduce and dissolve in the mouth readily, and the flavour is a fine full chocolate, slightly warm and astringent. The consistence is much like that of finely-prepared dessert "ground nuts." There should be no trace of mildew. The process of fermenting consists in collecting the seeds, when taken from the husks or pods, into barrels or troughs, or into heaps, nicely covered with plantain leaves or sacks, within the curing house for two, three, or four days; the house, meantime, is kept closed.

The first object in fermenting is to reduce the mucous covering of the seeds, and the second is to tone the colour of the kernel to a fine purple-brown. On being removed from the fermenting process, the beans are well rubbed with a small quantity of a fine red earth, and then spread out evenly to dry. The beans have to be frequently stirred about in drying, but a very hot sun is avoided during this part of the operation. The whole process is very simple, but it requires considerable practice to produce the desired effect of the fermentation with nicety. The drying or curing house consists of a strongly-built span roof, fixed with wheels running on iron rails, laid along a stout framework, which supports a strong platform underneath, and upon which the beans are manipulated and dried. The gathering of the cacao pods is accomplished by means of an instrument called a "cacao hook," and upon the proper use of which the goodness of the future crop very largely depends. It is most essential that in removing the pod by a clean cut through its stem, its base or the part of the stem or branch from which it proceeds, be not cut also; as at that point other flowers and fruits develop, and therefore it should not be damaged. The pods of the cacao being very persistent, to remove them by pulling is not only laborious, but it tears the fruitful portion of the bark situated immediately at its base, and thus prevents fruitfulness.

Other West Indian Islands. — In 1649 only one cocoa tree was known in the Windward Islands, planted for curiosity in the garden of an Englishman at St. Croix. In 1655 the native Caribs showed to M. du Parquet trees of the cocoa growing wild in the woods of Martinique. A Jew, named Benjamin, first began to cultivate the trees; but it was not till about twenty-five years after that any great progress was made with the culture.

The cultivation of cocoa in Dominica, although long established, dating from some thirty years back, is yet in its infancy as regards proper and systematic culture.

The trees have been planted so close, from two to four feet, that, being overcrowded to excess, they are killing each other in the struggle for light and air before they are large enough to bear fruit. There does not appear to have been any attempt at thinning or pruning, or clearing the ground, since they were planted. In 1838, 2354 lbs. of cocoa were exported; in 1842 it had risen to 19,264 lbs. It then fluctuated between 30,000 and 100,000 lbs.; and the shipments in the last few years have been as follows:

	Lbs.		Lbs.
1869	225,422	1872	204,773
1870	135,439	1873	186,688
1871	203,433	1874	189,782

This is wholly shipped to Martinique and Barbados, either for partial consumption in those places, or for shipment to England, France, or America. The process of preparing the cacao beans for the market by fermentation, and subsequent claying, seems scarcely to have been heard of in Dominica; but it should be known by all growers that this process, properly performed, raises the value of the article from 20 to 30 per cent.

In St. Lucia there are about 430 acres under culture with cocoa; and the following statistics show that the exports are almost stationary:

	Lbs.		Lbs.
1839	75,952	1868	258,799
1849	104,912	1869	271,968
1859	198,567	1870	257,543
1864	221,759	1871	
1865	289,097	1872	246,811
1866	192,885	1873	280,473
1867	286,170	1874	255,614

In Grenada there are at least 4000 acres planted with cocoa. The shipments were, in

	Cwts.		Cwts.
1864	9,462	1869	17,718
1868	14,861	1870	21,602

The export duty on cocoa in the West India Islands is as follows:

	s.	d.	
Trinidad	0	$11\frac{3}{4}$	per cwt.
Grenada	0	6	„
St. Vincent	0	8	„
Dominica	1	$1\frac{1}{2}$	„

In Jamaica some little attention is again being directed to cocoa culture. 1023 cwts. were shipped in 1872, and 451 cwts. in 1874; there being 40 acres under culture with it.

The culture of cocoa, which had long been neglected in Guadaloupe and its dependencies, is again coming into favour. The plantations are formed from plants imported direct from Caracas. The quantity exported from Guadaloupe in 1872 was 206,000 lbs.

In 1727, owing to some disease, the whole of the cocoa trees perished in Martinique; the inhabitants, half ruined, after having tried several remedies, resolved at last to plant coffee. Of late years the cultivation of cocoa has however been resumed, and greatly extended in Martinique, and the quality is much esteemed. In 1872, 686,000 lbs. were shipped.

The land under culture and the production of cocoa in the four French colonies in 1870 were as follows:

	Hectares of $2\frac{1}{2}$ Acres.	Kilogrammes of $2\frac{1}{5}$ lbs.
Martinique	628	262,300
Guadaloupe	463	125,131
French Guiana	255	54,556
Reunion	21	3,750
	1,367	445,737

The value of the cocoa received in France in 1870 from her colonies is given at 16,000*l.* only.

The cocoa of French Guiana, dried in the sun or by a current of air, presents unctuous qualities, which render it sought for to mix with the perfumed but drier kinds grown in Caracas. The export in 1874, from French Guiana, was but 66,000 lbs., and there are 231 hectares under culture, which is little more than the produce in 1836 from 197 hectares, when 55,400 lbs. were shipped.

A little cocoa is grown in the Mauritius. Some small quantity is still produced in Reunion, of a good quality, the Caracas sort. Cocoa used to be grown in the island in connection with coffee.

Production in Venezuela.—Venezuelan, or, as it is generally termed, Caracas cocoa, has ever been considered the best of all that is produced upon the American soil; although it was from Mexico that the bean was first imported into Spain, large quantities of it were subsequently exported from the Venezuelan port of Maracaibo to the Mexican port of Vera Cruz. The cocoa tree flourishes best when planted in a damp, level soil, and begins to produce fruit when about five or six years old, its yield being usually about one pound at that age; it does not, however, attain its full bearing capability until it has attained its eighth year, at least in the neighbourhood of the sea coast; and in some places, such as the Guique districts upon the Lake of Valencia, in the neighbouring province of Carabobo, it does not attain its full yielding power until it has reached its ninth year. Experienced planters residing in the capital (Caracas), however, state that, with proper care, it may be made to cover the expenses of its cultivation from its sixth year.

The regular periods for gathering in the crops are in June and December, denominated the "crop of St. John" and "Christmas crop;" but when the plants have attained maturity, the gathering of scattered pods is carried on almost daily.

The production of cocoa has not only greatly diminished in Venezuela, owing to the perpetual civil warfare prevailing, but its quality has materially deteriorated owing to the introduction into the country of seed, commonly termed "Trinitario," from the island of Trinidad, which, although infinitely more prolific than the native seed, produces a bean somewhat bitter in taste, and very inferior, as regards essential oil and richness of flavour, to that produced from the latter. The difference between the two can indeed be detected at once by the most casual observer, and the scale of prices at once confirms it.

Ineffectual efforts were made to guard against the deterioration of the native cocoa, enjoying so high a reputation in foreign countries by the introduction of the Trinidad seed, to the extent of a proposition being made by the Minister of the Interior and Justice to the Congress, in the year 1850, that any person detected in introducing the same into the eastern ports of the Republic in constant communication with the island of Trinidad should be subjected to corporal chastisement.

Some interesting statistical information connected with the cultivation of the cocoa tree in Venezuela in former times was supplied by a Caracas newspaper, in the year 1838, which obtained its data on the subject from a pamphlet, also published there in the year 1765, by a commercial association formed in the Basque Provinces of Spain, under the name of the Guipuzcuanian Trading Company, and which states that the export of cocoa from Venezuela during thirty years, viz. from 1701 to 1730 inclusive, amounted to

643,215 fanegas (the fanega consisting of 110 lbs.); in the following eighteen years (up to 1748) to 869,247 fanegas; and in the fifteen years following (up to 1754) to 887,191 fanegas; the first period giving 21,440, the second 48,291, and the third 55,449 fanegas as the annual average; the exportation last alluded to being thus divided:

	Fanegas.
To Spain	503,721
,, Canary Islands	76,141
,, Vera Cruz	279,074
,, San Domingo, Porto Rico, and Havana	28,255
	887,191

From the same work, it appears that in the year 1728 the Dutch sold the cocoa which they imported into Spain at from 70 to 80 dollars per fanega, the price in Caracas at that period being from 7 to 10 dollars; whilst the Guipuzcuanian Trading Company, which was established in the same year (1728), sold their cocoa in Spain for from 45 to 50 dollars, having, after the war of 1738, lowered the price to 30 dollars, which was the highest price they ever paid for cocoa in Caracas up to the year 1765. In the year 1730 the produce of the 759 cocoa estates, which then existed in Venezuela, was calculated at 60,000 fanegas annually; and in the year 1765 it was computed to have attained the amount of 130,000 fanegas annually. From the year 1770 to 1774 the Guipuzcuanian Trading Company declared its total exports of cocoa from the provinces of Caracas and Maracaibo to Spain amounted to 179,156 fanegas, giving a yearly average of 35,830 fanegas.

Lizarruga, a respectable Biscayan planter of the neighbourhood of Caracas, writing in the year 1830, on behalf of the agriculturists of the country, estimated the former annual yield of cocoa of the whole of the republic of Venezuela at about 150,000 fanegas, which, at the medium price of the time, 20 dollars per fanega, amounted in value to 3,000,000 dollars; but at the date of his writing he calculated the yield at but 75,000 fanegas. M. Mollien, a French traveller in Venezuela during the years 1822–23, states, upon the authority of a report sent in to the Spanish Viceroy Samana by Señor Jove, an enlightened public functionary, the approximate amount of the annual export of cocoa from the Venezuelan provinces to have been, during the six years anterior to 1810, 100,000 fanegas, at an average rate of 20 dollars per fanega. The Trinitario seed is, at the present time, the staple of cocoa from the districts of Güiria, Maturin, Carúpano, and down the eastward, or windward, coast as far as the Rio Chica; but the native or genuine "Creole" plant is still cultivated upon some few estates. The Trinitario seed is also sown to some extent in the valleys of the Tuy, near the capital, although the majority of the estates there are sown with Creole seed, and thus good cocoa can still be procured from thence. From the port of La Guayra, running westward towards Puerto Cabello, and particularly at Choroni, Ocumare, Turiamo, Patanemo, and Borburato, lie the districts where the best Venezuelan cocoa is now produced; and the choicest of all at an estate called Chuao, near Choroni, the property of the University of

Caracas. From the neighbourhood of San Felipe, the capital of the state of Yaracuy, a very superior unmixed cocoa is sent to Puerto Cabello, to the amount, including a small quantity from Barquisimeto, of about 4000 to 6000 fanegas annually. The Trinidad seed has, since 1854, been introduced into Chichiriviche, formerly one of the finest cocoa districts on the western coast. Many cocoa plantations were damaged, and some entirely destroyed, by the great drought which prevailed in the country in the year 1868–69.

From what has been above stated, it will be seen that it is from Cape Codera down to Puerto Cabello, following the coast-line, that the Caracas cocoa is principally cultivated; and on some estates on this line, where the Trinidad seed had been introduced, it has fallen into great disrepute, and some of the planters even import the red soil of Chroni, in order to impart a better colouring to their bean.

I am indebted for the following observations to Mr. Alderson, an English gentleman, who has recently returned from inspecting his cocoa estates, situated within the seaboard tract of country denominated the "Valleys of Barlovento," extending from Capaya and Caucagua to Rio Chico, the population of which region is put down at 20,000, all blacks with the exception of about one hundred whites, and the inhabitants all Indian, and amounting to about two thousand, of the village of Capaya:

"In the almost total absence of statistical information," says Mr. Alderson, "it is difficult to say what these valleys produced in the year 1820, which may be called the last of the War of Independence, when Venezuela remained definitely severed from the mother country; but it may be safely said that, at the close of those ten years of devastation and destruction, all agriculture was virtually extinguished. The progress of reconstruction, as may be supposed, would be naturally slow; and I think, without error, it may be stated that it was not until 1840 that the valleys of Barlovento attained their highest degree of cultivation and prosperity, continuing to yield an average crop of cocoa of from 30,000 to 40,000 fanegas, or half the produce of the whole Republic, until the year 1854. In the spring of that year agriculture generally, but the cultivation of cocoa especially, was all at once checked, and for some time deranged, by the sudden and unlooked for liberation of the slaves. The sugar planters recovered from this blow by adopting the system of 'medianeros,' that is to say, the labourer cultivated the soil in the character of partner in its yield —a system that can scarcely be adopted upon cocoa estates, and they, in consequence, sensibly and progressively declined till 1858, when the great civil war of the Federation broke out. When that bloody and unhappy struggle terminated in 1863, the havoc, destruction, and unavoidable neglect had been so excessive, that of the magnificent cocoa estates in the valleys of Barlovento, which had been one of the chief seats of the war, scarcely a vestige remained; and I have no hesitation in saying that at that period their production did not exceed 5000 fanegas. As a proof that I do not exaggerate the combined effects of the sudden emancipation of the slaves and of the five years' civil war, I will cite one or two examples of the many for which I can personally vouch. Three of the finest cocoa estates in Barlovento belonged to General Arizmendi, Don Antonio Palacios, and my father, Mr. John Alderson. The two former were situated in Caucagua, and each one yielded an average yearly crop of 1000 fanegas, but are now abandoned by their owners, and rented as uncultivated lands for an almost nominal sum of about 300 dollars (or 46*l.*) a year. My father's estate, situated in Curiepe, gave from 700 to 800 fanegas a year; at present it produces from 200 to 250 fanegas; and since the drought of 1868–9, considerably less even than that; the richness of the soil and other local circumstances prevented its entire destruction and abandonment, such as happened in Caucagua. When in 1863 peace was again restored, all the pastoral and agricultural inhabitants of the country devoted themselves immediately to the reparation of their losses with the determination and energy of a people worthy of better rulers. Notwithstanding that several large properties continued to be abandoned by their owners from various causes, the remainder began gradually to progress, whilst at the same time a multitude of young plantations sprang up, under the personal exertions of an equal number of small proprietors, many of them formerly slaves. Industry prospered, and the yield of several sections of Rio Chico, Curiepe, Tacarigua, Capaya, and Caucagua, which together form the valleys of Barlovento, had probably increased from 5000, which they yielded in 1863, to 7000 or 8000 fanegas; and gave promise of attaining, before long, their former yield and prosperity, when the terrible drought of 1868 and 1869 again threatened the cocoa estates with extinction. Portions of many estates were destroyed by fire, and many thousands completely burnt up by the drought, whilst the remainder were so debilitated that little or no crop could be expected from them for a few years. The cocoa estates on and near the river Tuy were an exception to the general ruin; so much so, that the soil being rich and humid in the extreme, the drought had upon them the effect of drainage, and their crops have since been remarkably abundant. The introduction of Trinidad seed has, doubtless, had a bad effect upon the reputation of 'Caracas' cocoa; but the conviction that is daily gaining ground of the unadvisability of introducing the 'Trinitario' on the one hand, and on the other the great improvement that takes place in the bean produced from the seed in the lapse of time, lead me to conclude that the period is not far distant when 'Caracas' cocoa will have re-established its good name."

Señor Basilizo Mayz, a gentleman from Cumaná, estimates the product of cocoa in the eastern states of Cumaná and Maturin at 40,000 fanegas, and 40,000 more for the rest of the Republic, or 80,000 fanegas altogether, reckoning home consumption as well as exportation. He distributes and classifies the eastern crop thus: Carúpano, Rio Caribe, principally "Trinitario"; Taguaraparo, Yrapa, somewhat less "Trinitario," average selling price 18 dollars per fanega; Güiria, Soro, the greater part good cocoa. Maturin, mixed, does not yield much; average price, 36 dollars per fanega.

Mr. Brandt, a gentleman formerly deputed by the Venezuelan Government to inspect the custom-houses of the eastern provinces of the Republic, states that the annual exportation of cocoa from the port of Carúpano alone is from 15,000 to 20,000 fanegas. Mr. Brandt having been unable to proceed further in his inquiries, owing to the opposition he experienced, the amount of export from the three other ports in question is unattainable.

According to Señor Mayz, it was his father who, whilst residing in Trinidad as a patriot refugee in 1820, first sent the seed of the cocoa from that island to the mainland, at the request of General Arizmendi, a famous Venezuelan general of the War of Independence, to plant upon his estate at Caucagua; the bean produced from this seed, as before stated, is bitter to the taste, but the plant is much hardier, yielding at the third or fourth year, and giving double the quantity of the Venezuelan seed, or about two pounds per tree annually.

Señor Mayz adds, that in Trinidad there were two or more estates producing good cocoa from the Venezuelan seed, planted by some of the Royalist families from the mainland, who had sought a refuge in the island; and it is thus worthy of observation that, whilst a Venezuelan patriot first introduced the cocoa seed of Trinidad into his country, the Venezuelan seed was introduced into the island in question by persons who had remained faithful to the Royalist cause.

Don Juan Antonio Guardia, for some time Minister of Finance in this Republic, and partner in the house of Gutiérrez and Guardia, of La Guayra, one of the principal houses for the consignment of cocoa at that port, expressed to me his opinion that the production of cocoa has remained stationary during the last twenty years; the decrease which has taken place in the valleys of Barlovento, Tuy, and on the coast to the west of La Guayra, where large plantations have been lost, being, in Señor Guardia's opinion, compensated by the number of small estates that have sprung up of late years in Carúpano, Güiria, and Yaguaparo. Señor Guardia also calculates the yearly crop at from 70,000 to 80,000 fanegas, the exportation of which he distributes as follows:

	Fanegas.
La Guayra, from	35,000 to 40,000
Puerto Cabello	12,000 „ 15,000
Maracaibo	8,000 „ 9,000
Carúpano	15,000 „ 16,000
	70,000 „ 80,000

This cocoa is produced in the following districts:

	Fanegas.
LA GUAYRA.—Comprising Barlovento, from Nayguatá to Cabo Unare, composed of the valleys of Rio Chico, Tacarigua, Curiepe, and Capaya, and part of that of Caucagua, gives	16,000
SOTAVENTO.—From Cabo Blanco to the valley of Turiamo, where the finest kind of cocoa is generally produced, known in Europe as "Caracas"	5,000
CARACAS.—Including the valleys of the Tuy, and part of Caucagua and Capaya	7,000
CARÚPANO.—Partly from Carúpano, Yaguaparo, Güiria, and Yrapa	9,000
PUERTO CABELLO.—From San Felipe, Güigüe, and Barquisimeto	3,000
	40,000

The 15,000 fanegas, classified as Puerto Cabello, come from Barquisimeto, San Felipe, Güigüe, and from some places on the coast of Coro. The 9000 fanegas, classified as Maracaibo, belong to Mérida, Trujillo, and Cúcuta; and the 16,000, exported from Carúpano, belong to various districts along the coast of Güiria, Yaguaparo, and within the Gulf of Paria. About a third part of the product of these districts is embarked from the port of La Guayra.

The introduction of the Trinidad seed has been very injurious to the credit of the Venezuelan cocoa, formerly so highly esteemed, and, as before stated, the difference is very palpable; the Creole bean being soft, triangular (having three sides), agreeable to the taste, and oily; whereas the "Trinitario" is hard, with two sides, dry, and bitter. The difference between them depends in some degree upon the soil, and its effect upon the reproduction of the seed.

In Trinidad, the high cultivation bestowed upon the native seed has improved its original nature; and in the Gulf of Paria, and other places where it has been cultivated for many years, it has improved so as to be almost equal to the "Creole" or Venezuelan cocoa, a result owing entirely to the superior quality of the land, and the improvement of the seed from the lapse of time, the cultivation being of the most simple description.

Señor J. B. Medina, one of the principal cocoa planters of Ocumare (on the coast between La Guayra and Puerto Cabello), a locality which produces the greatest quantity of the best cocoa, stated the production of that district in 1870 to be 6400 fanegas, distributed thus:

	Fanegas.
Puerto La Cruz, Sepe, and Chichiriviche	300
Chuao	500
Choroní	1000
Cuyagu	400
Cata	600
Ocumare	1500
Turiamo	600
Patanemo	500
Borburata	500
San Estevan, Goaiguaza, Moron, and Alpargaton	500
	6400

This product, Señor Medina thought, would be doubled in the course of five or six years, when the new plantations began to bear, and remarks that although very little of the Trinidad seed had been introduced into the district referred to, that little would soon disappear, the planters having become convinced that although the yield is much greater it does not compensate for the higher prices obtained for the true "Creole cocoa," and in some parts of the district in question the Trinidad plants are being uprooted. The accompanying table of exports bears out Señor Guardia's estimate of production, if 15,000 fanegas be taken as the amount of home consumption, inasmuch as in twenty-five years (twenty-four averaged) once only have the former equalled, and once only exceeded, his maximum of the yearly crops—80,000 fanegas.

	Per Annum. Fanegas.
1831 to 1836 (five years) averaged	50,124
1836 „ 1841 ditto „	64,570
1841 „ 1846 ditto „	80,752
1846 „ 1851 ditto „	64,709
1851 „ 1855 (four years) „	83,756
1859 „ 1860 (one year)	65,220

If, then, the first twenty years represent those of large, or the largest, yield and export, and the four following (1851 to 1855) a period of increased production and export, checked by the years of disorder and warfare from 1856–7 to 1863, the shipments of 1859–60 might be taken as a fair standard, against which Señor Guardia's will not hold out, except under the supposition referred to regarding home consumption; anyhow, however, one cannot but arrive at the conclusion that Venezuela, with respect to cocoa, one of its richest and most valuable productions, has actually fallen from the point it had attained just one century ago under the Guipuzcuanian Company. This Company shipped in 1770, from the then province of Caracas, not including Cumaná and other eastern districts, 41,997 fanegas, whereas the whole of Venezuela, it is calculated, will not this year (1870) produce more than from 35,000 to 40,000 fanegas, at an average price of $31\frac{66}{100}$ dollars per fanega, the crop being but a conjectural one of mixed, good and inferior cocoa, against an actual, positive export, all of the pure, excellent quality that, at the time referred to, ruled the markets of Spain.*

The following have been the shipments of cocoa from Venezuela:

	Lbs.		Lbs.
In 1855	4,791,856	In 1857	4,309,007
„ 1856	4,078,713	„ 1875	6,961,703

From Puerto Cabello, in 1874, 505,000 lbs. were shipped nearly all to the continent of Europe.

The cocoa is largely exported to Spain. The production is about 1000 cwts. a year. Venezuelan cocoa is generally dearer than other kinds, and is in great request.

The first-quality cocoa (which is almost entirely absorbed by the Spanish and French markets, whilst the inferior qualities go to England and Germany) is produced almost exclusively in the coast districts, being thus commonly termed "cacao de la costa"; the seed within the pod, of a rich dark-brown colour, being larger, richer, and of a more oily quality than that produced anywhere inland; the "cacao mezelado," or mixed cocoa, is that grown upon estates where such of the original first-class "criollo cacao" trees as may have died out, have been replaced by others raised from Trinidad

* Report of Mr. Consul-General C. Middleton, on the production of Cocoa in Venezuela, September 1870.

seed; such amalgamation somewhat depreciates the quality of the produce, notwithstanding that a decided improvement in the quality of the Trinidad seed has been attained in some districts, owing to the favourable nature of the soil. The best or first quality was fetching in the close of 1875, thirty-five to forty venezolanos (dollars) per fanega of 112 lbs.; the second quality twenty to twenty-five venezolanos the fanega; and the third, termed "Trinitario" (the seed having been originally brought from the island of Trinidad), only sells at from twelve to eighteen venezolanos per fanega. This Trinidad cocoa came into favour some years ago on account of the more robust nature and greater productiveness of the plants, but is now universally held to be of an inferior quality.*

An old black letter treatise in French, which I have in my possession, contains a most interesting and useful description of the cultivation, preparation, and uses of cocoa in the Spanish main. Its title is 'Histoire Naturelle du Cacao.' Second edition. Published anonymously at Amsterdam, 1720.

The following description is translated from an account furnished by M. P. Madinier, to 'Des Annales de l'Agriculture des Colonies':

The tree is grown in almost all the provinces of Venezuela, but more especially in those of Maracaibo, Tachera, Varinas, Yaracuy, Carabobo, Cumana, and Caracas; and these remarks will apply chiefly to this last province and to the estates situate on the eastern coast, in the canton of Rio Chico. This canton is watered by four navigable rivers, of which two, the Tuy and the Rio Chico, communicate directly with the sea, and facilitate the transport of produce.

The land is in general well suited for agriculture, but so low that it is exposed to inundations with any considerable rise of the rivers. The climate is at the same time very humid and warm; the thermometer occasionally marking 71° Cent. The vegetation is so vigorous that the sugar-cane, which in the valley of Caracas requires eighteen months to ripen, is here cut after ten months, and attains occasionally the height of 27 feet.

The system of irrigation is not practised, firstly because it is costly, and secondly because the lands seem to retain their moisture in the height of summer. In later years it may possibly be requisite, but at present this country seems to possess all the elements necessary for the successful culture of this crop.

When commencing a cocoa plantation, the first step is necessarily the clearing and preparation of the ground. This is generally done in the summer, which is here the months of January, February, and March, so that all may be terminated before the first rains of winter commence, in April and May. Rows of plantains are then set to give shade to the young cocoa trees until the "bucares" (species of *Erythrina*) are advanced enough to form shade trees.

The plantains are set at stated distances so as not to crowd the young trees, but a great deal in this depends on the nature of the soil and the species of cocoa planted.

* Mr. Middleton's Report on the 'Commerce of Venezuela,' 1875.

In a virgin soil, where the tree is likely to attain a good size and the "Creole" species is planted, the trees are placed 14 or 15 feet apart, so that in a space of $12\frac{1}{2}$ feet square there would be one at each angle of the square. This distance is reduced where the soil is poorer. Some planters, by a system of false economy, plant their trees closer; but this is a bad system, for though there may be a greater number of trees to the acre, the production and vigour will be less from want of air, the trees will shoot up thin and weak, and produce less fruit.

The species known as Trinidad cocoa is rather larger and hardier, and requires more room, but it is usually planted in poor or impoverished soils. It is a native of Trinidad, or of Campano, a province of Cumana. It has degenerated much, and is now chiefly distinguished from the Creole cocoa by its greater resistance to atmospheric changes, and by the character and treatment of its fruit.

If the ground is to be planted with bananas, as soon as it is possible trenches are made to draw off the water. Nature can best be followed in this by affording facilities for carrying off the excess of water arising from the heavy rains. In this consists the principal work of the planters of the Rio Choco, and it entails the heaviest expense, because many insist that there should be a trench to each row of trees to ensure good crops and the healthy durability of the tree. The more it is intersected with channels for drainage the more prosperous will a plantation be.

When the land has been planted with its rows of bananas, and furnished with its water channels, the next step is to plant young trees of bucare (*Erythrina umbrosa* and *E. velutina*).

The cocoa tree requires the protective shade of another tree to thrive, and the younger it is the more it requires shade, hence the banana or plantain suffices at first, but the bucare protects it during its after life. This shade tree is planted either by suckers or seeds in the interval between every three cocoa trees, or about 25 to 35 feet apart.

At the same time that the operation of preparing the plantation is going on, the nurseries or seed-beds of young plants should be attended to, so that they may be ready for moving when about eight or ten months old. The work of transplanting requires great care, so as to have a ball of earth round it, and care must be taken not to injure the roots, for if these are damaged the plant dies off. The younger the plants are transferred the better they succeed.

It is better to form a plantation from seeds, if the necessary care can be given to the young growing trees without too much expense. In forming seed-beds the finest fruits are chosen fully ripe; they are opened with care so as not to injure the seeds, which are set a foot apart in furrows about two inches deep, and slightly sprinkled over with earth and then covered with plaintain leaves. After fifteen days the leaves are removed, as the seeds will have sprouted. From this time to transplanting all the care necessary is to keep down weeds, which might choke the young plants.

The tree requires to be kept free from weeds and ants, which are fond of its young leaves, and boring grubs, which attack the bark.

At three years the trees begin to flower, and a year after they produce some fruit; but it is not till seven or eight years that it gives any good crop. The age of fruiting varies; in the interior of Central America, it is about eight years; in the vale of Guapa, seven; and about Equador and the banks of the Rio Negro, five years.

When the trees begin to ripen their fruit they are visited every fortnight, to gather the pods which are ripe and to trim the tree a little. This is done by females and children. The women detach the fruit-pods with a knife or chopper mounted on a long stick, and the children collect and carry them to the store, where the seeds, some twenty-five to thirty-three in each fruit, are extracted. The fruit-pods are of different forms and sizes, some nine inches or more in length are called cows' tongues, others shorter and rounder, but on the whole larger, are called *angolitas:* these, the most common, are a reddish colour, dark or light. The first kind are considered the best, because the husk is thinner and the fruit contains more seeds. It is generally a light red, but sometimes white at first and turns a palish yellow when ripe.

When the seeds have been removed from the pod they are placed in a closed storehouse, in order that the viscous pulp may be separated. In dry weather a single night will suffice for this, but in wet weather they may be left for two or three days without inconvenience. They are then dried in the open air, exposed to the sun in a courtyard or on drying frames, being turned about from time to time with a rake. Eight or ten hours of sun is generally sufficient; when this cannot be obtained the operation is repeated on the following day, and they are housed at noon when the sun is at the hottest. They are left in the store to steam or ferment for a day or two.

If the cocoa is the Trinidad variety, it requires four days or more to ferment, when it assumes the odour, colour, and taste, of Creole cocoa; otherwise it becomes violet-tinged, and acquires a sharp and bitter flavour. Some growers expose the seeds on large sheets to dry, so that they can be quickly and readily housed in case of rain occurring. When properly treated and dried the cocoa assumes in the interior a blackish tint, or somewhat of a deep brick colour; its characteristic aroma is well developed; the taste is agreeable and unctuous; the interior of the seed assumes the colour of the Corinth raisin, and if it is opened with the nail traces of the fat are seen.

This kind of cocoa was that formerly so much cultivated in these provinces and considered the choicest, being especially demanded of the planters by the Guipuzcuanian (Biscayan) Company. It is not exactly the kind which is now sought after by shippers, who have a prejudice in favour of red cocoa of a natural or artificial colour. This is given either by red earth, brickdust, and occasionally by vermilion.

Between the appearance of the fruit and its ripening there is an interval of nine months. The average yield of a tree may be taken to be one pound of cocoa, although some assume it to be one and a quarter pound. In a rich virgin and favourable soil the tree will last thirty-five or forty years, in poorer soil only twenty or twenty-five.

The exports of cocoa from Equador—which is the largest producing State—have been as follows:

	Cwts.		Cwts.
1857	149,624	1866	247,602
1858	202,972	1867	201,278
1859	136,119	1868	
1860	167,155	1869	173,092
1861	213,384	1870	234,744
1862.	166,714	1871	184,572
1863	147,722	1872	181,973
1864	122,620	1873	251,812
1865	113,666	1874	247,493

Cocoa besides being cultivated in all the gardens of Moyobamba, the eastern territory of Perú or the Montana, grows spontaneously, and is met with in abundance and of various kinds in the woods of the province.

Production in Brazil.—The culture of cacao was first begun in Bahia in 1780, plants being brought from Para, where it is indigenous to the districts of Valencia, Camanü, and Ilheos. Since then the culture has steadily increased, and the quantities exported have been as follows:

1830	1,788 arrobas of 32 lbs.	
1840	7,244 „ „	
1845	13,332 „ „	
1849	20,261 „ „	
1855	34,764 „ „	
1856	7,362 bags.	
1857	7,152 „	
1858	8,465 „	largest crop for twenty years.
1860	8,171 „	
1870	1,215,684 kilogs.	
1873	1,201,642 „	

The total shipments of cocoa from Brazil were, in arrobas of 32 lbs., as follows:

1841	139,249	1861	270,974
1851	262,670	1863	313,152

The exports since are given in kilos. of $2\frac{1}{5}$ lbs.:

1868	3,884,427	1871	3,181,471
1869	2,801,970	1872	3,181,471
1870	2,858,018		

The production has diminished in quantity, but increased in value. The quantity exported is subject to great fluctuations owing to the frequent overflows of the river Amazon, which stops the gathering of the fruit.

The tree is indigenous in Para, being found in great abundance on the banks of the large rivers of that province, and from Para come five-sixths of the exports of Brazil. It is, besides, grown to some extent in Bahia, and in small quantities in Maranhao and in Rio

Janeiro; requiring but little labour and capital, it is well worthy of more attention.

The mode of forming a plantation in Brazil is as follows: after having cleared and burned off the suitable land near the bank of a river, small holes are made in the ground and a seed placed in each; in order to keep down weeds and to shelter the young plants from the sun and winds, bananas (*Musa*) are planted throughout the grounds.

At the end of three years the tree is well grown and begins to produce fruit. These are ripe about June and December, and are knocked off the trees with the aid of long forks. They are then piled in heaps on the ground or under shade, and allowed to ferment for three or four days, after which they are cut open and the beans or seeds removed, which are spread on the ground or on mats to dry.* The tree flourishes well on the banks of the rivers Madeina and Salimoes. There are two harvests yearly, the first in December and January; the second, which is the most abundant, in May and June. The tree, whether in its wild or cultivated state, is not injured by the overflowing of the rivers, even when the trunk is deeply submerged during the inundations. In the provinces of Amazonas and Para it grows naturally without culture, and the trees produce freely, requiring no care except the collection of the fruit, which in those localities forms the fortune of the daughters of the cultivators.

Para.—In the ten years ending 1862 the shipments of cocoa from Para amounted to 2,094,119 arrobas, being an average of about 6,700,000 lbs. per annum.

Though in many cases carelessly cultivated, it grows for the most part spontaneously. The tree with moderate care will continue to give two yearly crops for fifty or sixty years. The towns in this province which send cocoa for shipment to the capital are Cameta, Gurupa, Obidos, and Santarem.

The exports from Para were in

	Arrobas.		Arrobas.
1864	267,968	1867	366,838
1866	94,966	1869	158,975

nearly all goes to France.

Besides this chocolate the Brazilians prepare another sort from the fruit of the cupuassu (*Deltonea lactea*). This is limited to the province of Para and a few manufactories, the principal of which are in Belem, the capital.

Culture in the East.—The experiments on the cultivation of the cacao tree on the Neilgherry Hills is still a subject of attention with the Government of India. It is some years since a large number of the young trees were introduced into the Budliar Gardens, and their cultivation was so far a success that about four years ago two cases of seedlings from the gardens were sent as specimens to Calcutta. The Government recently inquired whether seedlings of another species would not be acceptable, and a case of the new variety was to arrive

* Scully's 'Brazil.'

by one of the ships daily expected at Calcutta, it being the desire of the Government that the seedlings should be planted in the Budliar Gardens, where the results of the first experiment had been so satisfactory.

The cocoa tree was introduced into Celebes by the Spaniards between 1560 and 1570. About 1500 piculs were produced in 1854, and since then the production has greatly increased; the yield there is about 5 or 6 lbs. per tree.

Culture in the Philippines.—The cacao tree was first imported into the Philippines from Acapulco, either, according to Camarines, by a pilot called Pedro Brabo de Lagunas, in 1670, or, according to Sámar, by some Jesuits during Salcédos' government, between 1663 and 1668. Since then it has spread over the greater part of the island, and although it is not cultivated with any excessive care, its fruit is of an excellent quality. This cacao of Albáy, if its cheapness be taken into consideration, may be regarded at least equal to that of Caracas, is so much prized in Europe, and which, on account of its high price, is generally largely mixed with inferior kinds. The bushes are usually found in small gardens close to the houses; but so great is the laziness of the Indians that they frequently allow the berries to decay, although the native cacao sells for a higher price than that imported.

At Cebu and Negros a little more attention is paid to its cultivation; but it does not suffice to supply the wants of the colony which imports the deficiency from Ternate and Mindanáo. The best cacao of the Philippines is produced in the small island of Maripipi, which lies to the north-west of Leyté; and it is difficult to obtain, the entire crop generally being long bespoke. It costs about one dollar per litre ($1\frac{3}{4}$ pints), whereas the Albáy cacao costs from two to two and a half dollars per ganta (three litres). The Indians generally cover the kernels just as they are beginning to sprout with a little earth, and placing them in a spirally rolled leaf, hang them up beneath the roof of their dwellings till required for planting. They grow very rapidly, and to prevent their being choked by weeds are planted out at very short distances. This method of treatment is probably the reason that the cacao trees in the Philippines never attain a greater height than eight or ten feet, while in their native soil they frequently reach thirty, and sometimes even forty feet. The tree begins to bear fruit in its third or fourth year, and in its fifth or sixth it reaches maturity, when it usually yields a "ganta" of cacao, which, as before mentioned, is worth from two to two and a half dollars, and always finds a purchaser.

The profits arising from a large plantation would therefore be considerable, yet it is very rare to meet with one. The great obstacles in the way of large plantations are the heavy storms which recur almost regularly every year, and often destroy an entire plantation in a single day. In 1856 a hurricane visited the island just before the harvest, and completely tore up several large plantations by the roots; these catastrophes naturally caused much discouragement to the cultivators.

In 1727 a hurricane destroyed at a single blast the important cacao plantations of Martinique, which had been created by long years of extraordinary care. The same thing happened at Trinidad.

Travellers in America say that a well-kept cacao plantation is a very picturesque sight. In the Philippines, however, or at any rate in East Luzon, the closely-packed, lifeless-looking, moss-covered trees present a dreary spectacle. Their existence is a brief one. Their oval leaves, sometimes nearly a foot long, droop singly from the twigs, and form no luxuriant masses of foliage. Their blossoms are very insignificant; they are of a reddish yellow, no larger than the flowers of the lime, and grow separately on long weedy stalks. The fruit ripens in six months. When it is matured it is of either a red or a yellow tint, and is somewhat like a very large, rough gherkin. Only two varieties appear to be cultivated in the Philippines, although eighteen kinds are spoken of.*

According to F. Engel, a flourishing cacao plantation requires less outlay and trouble, and yields more profit than any other tropical plant; yet its harvests, which do not yield anything for the first five or six years, are very uncertain, owing to the numerous insects which attack the plants. In short, cacao plantations are only suited to large capitalists, or to very small cultivators who grow the trees in their own gardens.

GUARANA.

A product, allied to cocoa in some respects, may be incidentally mentioned here, made from the seeds of a Brazilian plant, and highly esteemed there, although it has not appeared much in European commerce. This is guarana, the product of a tree, the *Paullinia sorbilis*, Mart., belonging to the order *Sapindaceæ*. The tree grows abundant in the province of Amazonas, along the banks of the Tapagos, Rio Negro, &c., as well as in Guiana and Venezuela. The genus indeed is a large one, and it is probable that the seeds of *P. Cupana* of the Orinoco and many other species are used for a like purpose.

It is manufactured by the Muras, Mondrucas, and other tribes of Indians. The fruit, scarcely as large as a walnut, contains five or six seeds; it is gathered when ripe, and roasted intact. The seeds are then taken out, and, after being pounded between stones or mallets, are formed into a thick paste with water, and moulded into cakes, fanciful shapes, or cylindrical rolls, something like a large sausage, and then finally dried in the sun or by the fire, when it becomes extremely solid and difficult to fracture. In this form it will keep good for any length of time, and is always ready when required.

Guarana is used extensively in Brazil, Guatemala, Costa Rica, and other parts of South America, as a nervous stimulant and restorative. It is included in the French Pharmaceutical Codex, and also among the non-officinal substances of the United States Dispensatory. Besides its medicinal properties, this substance has a reputation for affording a refreshing beverage, similar in its effects to tea and coffee.

* Jagor's 'Travels in the Philippines.'

Grated down, it is very like powdered cocoa in appearance. Two spoonsful of the powder, mixed in a tumbler of water, is regarded as a stimulant to the nerves, and, like strong tea or coffee, is said to take away the disposition to sleep.

The active principle is an alkaloid, first discovered by Von Martius, and called by him guaranine, but since shown * by Dr. Stenhouse to be identical with theine. Guarana contains more than double as much of this alkaloid as good black tea, and five times as much as coffee; the proportions being 5·07 per cent. in guarana, 2·13 per cent. in tea, and about 1 per cent. in coffee.

The same alkaloid is found to the amount of 1·25 per cent. in maté or Paraguay tea, the produce of several species of *Ilex*. It is rather a singular coincidence that the same alkaloid should prevail in all the principal substances employed in a similar manner as beverages in different parts of the world.

In addition to theine, guarana contains a colouring matter apparently analogous to the tannin in cinchona bark, and also a fatty matter, which, like cocoa butter, does not appear to become rancid by keeping. The Indians of Brazil stain their faces with the colouring matter.

There is exported annually from the city of Santarem about 16,000 lbs. of guarana, valued at 8*d.* or 9*d.* per pound; near the Rio Negro it sells for very much less, but on the continent of Europe it has been sold occasionally, for its alleged medicinal properties, at almost fabulous prices—in France sometimes at 20*s.* per ounce.

COFFEE.

After tea there is scarcely any other staple of commerce used for dietetic beverages that has made more rapid progress in the world, or gained for itself more general acceptation with all classes, than coffee. Its constantly increasing consumption as a beverage, as seen in the statistical tables given, clearly proves that it may be regarded not only as one of the necessaries of life, but also as a very important one. The continued increase in the demand for coffee, irrespective of climatic influences, will of necessity extend the present area of its cultivation largely into those belts of land which are favourable to the production of the plant. These lands are found lying principally between the isothermal lines of 25° north and 30° south of the equator. It has been ascertained that the plant cannot be grown to advantage in places where the thermometer descends at any time below 55°.

Besides the existing countries where coffee is cultivated, there are many other places where it might be extensively grown, such, for instance, as the western coast of Africa generally, the interior ranges of Natal, the mountain ranges on the northern coast of Australia, from Moreton Bay to Torres Straits, &c. Soil and climate are the circumstances which chiefly affect its commercial value. The cultivation of coffee is now widely diffused over all tropical parts of the world. It is found in most of the West India Islands, in the provinces of Central

* 'Pharm. Journ.' vol. xvi. p. 212.

America, Cayenne, Peru, Bolivia, and especially Brazil, the greatest market of all. It is widely spread over Arabia, the western coast of India, Ceylon, Sumatra, Bourbon, Mauritius, Java, and other islands of the Eastern Archipelago and various parts of Africa.

Coffee Production of the World.—Few people have even an approximate idea of the magnitude of the coffee trade of the world; the value of the coffee crop, according to an Amsterdam authority, as purchased from first hands, was set down recently at nearly 25,000,000*l.*, but this is far too low; for, taking the production of the world at present at 13,000,000 cwts. (which is certainly much within the mark), and estimating it at but 60*s.* per cwt. on the spot, we arrive at a total of 39,000,000*l.* Our imports into the United Kingdom in 1875 of under 1,600,000 cwts. were valued at 7,500,000*l.*

Let me now trace the aggregate progress of coffee production as shown in the last fifteen years.

	1861.	1870.	1875.
	cwts.	cwts.	cwts.
Brazil—Rio	3,610,400	2,841,200	7,142,000
,, Santos	359,100	714,100	
,, Bahia	72,000	121,100	
Costa Rica and Guatemala	54,200	180,200	354,260
Laguayra and Porto Cabello, Maracaibo and Guayaquil	295,000	263,800	410,650
Porto Rico, Cuba, and British West Indies	100,200	148,100	377,000
St. Domingo	314,600	470,500	24,500
Java	1,117,100	1,497,500	1,400,000
Padang	203,900	145,300	161,000
Menado	16,300	46,800	20,000
Sumatra, Macassar, &c.	9,700	40,200	35,000
Ceylon	593,900	1,019,200	967,700
British India and Manila	173,100	290,100	446,420
	6,919,500	7,778,200	11,338,530

The Brazilian production for 1875 is calculated by adding one-fifth for local consumption to the total actual shipments; for all the other countries, the mere exports are given irrespective of what may be locally consumed. Africa and the African islands and Arabia might be set down for a few thousand cwts. more.

Consumption in the United Kingdom.—If we examine closely the statistics of coffee consumption in this country, we find that in the first four years of the century it was only an ounce per head; in the five years ending 1809 it averaged three ounces; it then increased, in the next quinquennial period, to six ounces, at which proportion it remained steady till 1825–29 when it advanced to eleven ounces; increased in the next five years to fifteen ounces, averaged about a pound per head for the following ten years, and then kept steady at about a pound and a quarter till 1861, since which period it has been gradually declining contemporaneously with the increased consumption of tea, and notwithstanding a reduction of duty. The following shows the consumption of coffee in the United Kingdom, and the average quantity consumed by each individual of the population during the present century:

Years.	Quantity, lbs.	Population of the Kingdom.	Average per Individual.
1801 to 1804	1,013,854	16,093,000	0·1
1805 „ 1809	2,897,401	17,147,000	0·3
1810 „ 1814	7,218,374	18,295,000	0·6
1814 „ 1819	7,969,189	19,765,000	0·6
1820 „ 1824	7,816,725	21,335,000	0·6
1825 „ 1829	15,284,597	22,907,000	0·11
1830 „ 1834	22,972,933	24,328,000	0·15
1835 „ 1839	25,429,063	25,653,000	1·0
1840 „ 1844	29,377,326	27,023,000	1·1
1845 „ 1849	35,993,207	27,929,000	1·5
1850 „ 1854	34,596,676	27,699,000	1·4
1855 „ 1857	35,037,880	28,007,000	1·28
1858 „ 1860	35,011,922	28,586,000	1·22
1861 „ 1863	34,138,967	29,191,000	1·17
1864 „ 1866	30,832,219	29,760,000	1·03
1867	31,282,023	30,157,000	1·04
1868	30,356,818	30,381,000	1·00
1869	28,839,100	30,611,000	0·94
1870	30,629,710	30,829,000	0·98
1871	31,010,615	31,048,000	0·97
1872	31,650,192	31,836,000	0·98
1873	31,930,928	32,124,000	0·99
1874	31,252,368	32,426,000	9·96
1875	32,048,016	32,737,000	0·90

General Consumption.—Coffee may be said to form almost the exclusive dietetic warm beverage of 100,000,000 of the human race.

The principal countries using it largely, besides Turkey and Egypt, are the Austrian and German Empires, France, Holland, Belgium, Switzerland and the Scandinavian States, Great Britain and the United States. In some of these, as the Zollverein, Belgium, Holland, Norway, Sweden, Denmark, and the United States, &c., the consumption is from 7 to 14 lbs. per head.

The statistical department of Denmark recently compiled a statement of the consumption of the chief dietetic articles in several European countries, taking the period 1860–71 (except for the Zollverein, which rests on data of 1850). The following were shown to be the proportions of coffee then used per head of the population:

	Lbs.		Lbs.
France	2·32	Norway	6·30
Great Britain	0·95	Sweden	3·28
Belgium	8·60	Denmark	4·90
Zollverein	3·94		

Taking, however, the latest year's complete return we have at command of the imports of coffee retained for consumption, we arrive at the following results, showing the gross and individual consumption, which are somewhat different to those given above.

Estimate made up for the year 1873 from the official returns of articles imported and retained for consumption in the various countries; chiefly from the "Statistical Abstract for Foreign Countries," second number:—

	Total Imports of Coffee taken for Consumption.	Average per Head.
	lbs.	lbs.
France	98,635,000	2·73
Belgium	49,771,000	13·48
Switzerland	18,779,500	7·03
Russia, European	14,740,920	0·19
Sweden	26,555,213	6·11
Norway	17,636,080	9·80
Denmark	26,035,652	13·89
Holland	72,395,800	21·00
Hamburg	178,715,936	..
Austria	76,876,576	2·13
Greece	2,131,367	1·42
Italy	28,511,560	1·00
United Kingdom	32,330,928	1·00
United States	293,293,833	7·61

The following table, recently published in the French 'Annales du Commerce Exterieur,' gives the assumed general consumption of coffee in 1874, in tons:

United States	124,500
Germany	95,000
Holland and Belgium	43,000
France	44,000
Austria and Hungary	25,000
Portugal, Spain, Italy, and Greece	25,000
United Kingdom	18,000
Sweden, Norway, and Denmark	20,000
Switzerland	9,000
Russia	7,500
Canada, Cape Colony, and Australia	9,000
Total	420,000

This estimate takes no account of the consumption in the producing countries, nor for Turkey and the African States.

Varieties of the Plant.—Botanists have enumerated about sixty species of the genus *Coffea*, spread over various countries in the eastern and western hemispheres. Most of these must be mere varieties resulting from accidents of soil, climate, or cultivation, produced subsequently to the naturalising of the plant, for we know that all the coffee trees now grown in America and the West Indies are the progeny of one plant introduced in the year 1714, and yet botanists have individualised as separate species the following:

In Brazil—*C. Australis, biflora, jasminoides, gardenioides, magnoliaefolia, major, meridionalis, minor, nodosa, parquioides, parvifolia, porophylla, sessilis, stipulacea, truncata, viburnoides.*

In Guiana—*C. Guianensis, paniculata, laurifolia, stipulacea.*

In Mexico—*C. Mexicana, obovata*, and *rosea*. In New Granada—*C. spicata*. In Peru—*C. nitida, racemosa, subsessilis, umbellata, verticillata, longifolia, foveolata, ciliata*, and *acuminata*.

In the East Indies we have, in India, *C. semiexerta, tetranda, Travancorensis, Wightiana;* in Java, *C. densiflora* and *C. Indica;* in the Moluccas, *C. pedunculata*.

In the Sandwich Islands, *C. Chamissonis* and *C. Kaduana*.

In Africa, the original *Coffea Arabica* in Arabia and Abyssinia; *C. laurina* in Sierra Leone; *C. Liberica* in Liberia; and *C. Mozambicana* and *Zanguebarica* in other parts.

Cultivation.—The coffee tree succeeds in countries in which the temperature does not fall below 55°, but is very commonly raised in greenhouses in various parts of Europe and North America. It may be cultivated as far as 36° N. lat., where the mean temperature is about 70°. Within the tropics coffee thrives best at an elevation of 1200 to 3000 feet, and rarely grows above 6000 feet. In Jamaica and Ceylon it is found to withstand cold well in the high mountain ranges, and bears a large, plump, and aromatic berry. It takes its name from Coffa, a south-western province of Abyssinia, of which it is a native, and the common name is almost the same in all languages to which it has spread.

Coffee is now largely cultivated in many of the States of Central and Southern America, in several of the West Indian islands, in different parts of the eastern and western coasts of Africa and the adjacent islands, in the Peninsula of India, Ceylon, and the islands of the Eastern Archipelago and the Pacific.

The trees are usually raised from seeds in nurseries, and afterwards planted out at regular distances, which vary according to the nature of the soil. Plantations are made chiefly on hills and the skirts of mountains, and if possible where the soil is moist and shaded. In dry and gravelly soils the coffee trees seldom grow higher than six feet, and may be planted five feet apart; but in rich soils, where they attain the height of nine or ten feet or more, the plants should not be so crowded, and intervals of eight or ten feet should be left between them. If not pruned they would rise to the height of sixteen or eighteen feet, but they are generally dwarfed to five feet for the convenience of gathering the fruit with greater ease, and also to prevent their running to wood. Thus dwarfed they extend their branches laterally, so that they cover the whole spot round about them. The trees produce fruit when they are two years old, and in the third or fourth year they are in full bearing. The produce of a good tree is from one and a half to two pounds of berries.

With the same infirmities that most other trees are subject to, coffee trees are likewise in danger of being destroyed by the borer and other insects, and by the scorching rays of the sun. In the West Indies and some other parts large umbrageous trees, of various kinds, are planted in rows at intervals throughout a coffee plantation, to afford a shade and shelter to the young plants.

Coffee trees flourish in hilly districts where the subsoil is gravelly, for the roots will strike down and obtain nourishment, so as to keep the tree alive and fruitful for thirty years. This is, however, about the extreme limit at which the tree will bear fruit. Trees planted in a light soil and in dry and elevated spots produce smaller berries, which have a better flavour than those grown in rich, flat, and moist soils. The weight of produce yielded by the latter is, however, double that obtained from the former, and as the difference in price between the two is by no means adequate to cover this deficiency of weight, the interest of the planter naturally leads him to the production of the largest but least excellent kind. It is the usual calculation that each bushel of ripe berries will yield 10 lbs. weight of merchantable coffee.

The aspect of a coffee plantation during the period of blossoming, which does not last longer than one or two days, is very interesting. In one night the blossoms expand themselves so profusely as to present the same appearance which is sometimes witnessed in England when a casual snowstorm, at the close of autumn, has loaded the trees while still furnished with their full complement of foliage. The fruit is known to be ripe when it assumes a dark red or nearly purple colour, and in this state the pulpy covering begins to shrivel. If not then gathered the fruit will drop from the trees. The sweet pulp covering the seeds is in some countries distilled, and in other cases dried and used as a coffee substitute. The fruit or berries are either gathered by hand into bags or baskets, or the trees are shaken and the fruit falls on sheets laid on the ground.

In curing or drying the coffee it is sometimes usual to expose the berries to the sun's rays in layers five or six inches deep, on platforms or terraced floors, called barbacues. These paved barbacues are raised a little above the ground and enclosed with an upright stone ledge of eight or ten inches in height, and divided by transverse partitions, with four or more square compartments, that each may contain a day's gathering. During the first and second days the berries are turned often, that the whole may be more exposed to the sun, but when they begin to dry they are frequently winnowed and laid in cloths to preserve them better from rain and dews, still exposing them to the sun daily, and removing them under cover every evening until they are sufficiently dried. By this means the pulp ferments in a few days, and having thus thrown off a strong acidulous moisture, dries gradually in about three weeks; the husks are afterwards separated from the seeds in a mill.

Other planters remove the pulp from the seed as soon as the berries are gathered by a pulping mill. The pulp is then separated from the seeds by washing them, and the latter are spread out in the sun to dry. It is then necessary to remove the membranous skin or parchment by means of heavy rollers. The seeds are afterwards sifted and winnowed to separate the chaff, and if any among them appear to have escaped the action of the rollers they are again passed through the mill.

In the ten years from 1861 to 1870, the coffee-growing countries produced nearly sixty-eight millions of cwts. of coffee. Of this, Rio alone supplied considerably more than a third.

Production in Java and the Eastern Archipelago.—Although Brazil supplies the largest quantity of coffee to the world, as its shipments go chiefly to the United States, we will commence with the second great coffee-producing country, *Java*, which however stands the first in precedence for the introduction of the coffee tree.

Ceylon is now pushing Java hard for second place in production.

As early as 1650 the industrious Dutch carried the seeds of coffee trees from Mocha to their colony in the far East, enlarged the enterprise rapidly, and were able in 1719 to appear in the great markets of the world with large supplies of coffee from Java. Encouraged by this success, they established similar plantations in Sumatra, Ceylon, and the Sunda islands. The French and the English followed their example, and in a short time the coffee tree had made the voyage round the world. In 1690, Governor Witsen presented a coffee plant to the Botanic Garden of Amsterdam, where it bore fruit, and produced many young plants. From these the East Indies and West Indies have been furnished.

In Java, which is situated six degrees south of the equator, elevated forest clearings, between 2000 and 4000 feet above the level of the sea, are found to be the best suited for the growth of coffee; but it is cultivated in low lands also, although the tree does not last so long, and bears less fruit. Shade trees are used, and weeding is well attended to.

In some places the berries are dried with the pulp, but in the majority of cases it is prepared in the parchment by pulping, washing, and pounding with wooden pestles, and, by experienced planters, with more complicated machinery.

Java coffee has gradually acquired a reputation which its intrinsic value fully merits. The greatest care and attention have been bestowed on the cultivation there, it being not so much the wish of the Dutch Government naturally to increase the present extent of culture as to develop and strengthen the plant, in order thus to improve the quality and enhance the value of the bean. In Brazil, San Domingo, and other places, over cultivation and obvious neglect are doing much to injure the character of the product.

There are three prominent kinds of Java coffee brought into the Dutch markets—Jacatra, usually sold as Java; Cheribon, and Samarang. The first is the best; Cheribon is a little lighter colour, and of somewhat inferior quality. Samarang coffee has yellowish-brown or green flattened beans, but what is generally sold as such is simply a kind of "triage," black beans of a coarse flavour.

The culture of coffee in Java is effected by tribute or partially forced labour. The Dutch Government maintain the old Indian idea of sovereign right to a supreme lordship of the soil. They do not allow freehold possession of land to the people, except where a few foreigners held certain rights before our cession of the island, and also where the native princes have maintained their ancient rights. With these exceptions, the Government have a monopoly of the land, and each family holds its farm on the stringent condition of having to plant and maintain in bearing 650 trees, of which they must harvest and deliver the produce, say 2 cwts., into the Government warehouse. For this they have to leave their villages and camp in the hills, receiving a payment of about 30*s*. per picul, or 24*s*. per cwt. In such a task the people have naturally more interest in the speed with which they get through their harvesting than in a good result, and much coffee is wasted.

Besides the Government culture there is a good deal of coffee raised by private growers.

The tree bears fruit there in the fourth year, and continues to yield up to the fifteenth year or longer. It blossoms generally three times in the year, so that it may be said there are three gatherings of the berry.

The comparative progress of coffee production in Java is shown by the exports, which were in

	Cwts.		Cwts.
1829	375	1859	1,195,380
1839	1,000,000	1869	3,299,000

The crops were defective from 1864 to 1867. The export has occasionally reached 170,000,000 lbs., and the production is regaining its old footing. The exports, however, include various receipts from the other islands, although shipped under the general designation of Java coffee.

The sales of Java coffee in Holland in 1873 amounted in value to over 5,000,000*l.*

The quantity of coffee delivered into the Government stores at Java of late years, has been as follows:

Year.	Piculs.	Average price paid.	Net sale price in Holland.
		florins.	florins.
1869	962,800	14·95	38·76
1870	986,038	14·48	36·73
1871	446,304	15·97	39·36
1872	985,961	15·47	48·36
1873	773,920	15·80	60·96

The gross price paid to the natives for the coffee is 26 florins per picul, deducting from these the duty of 10 florins.

The number of trees in the Government plantations, irrespective of those in the gardens of the native chiefs, was in 1873, 239,079,225.

According to the report of a Commission of Inquiry submitted to the Second Chamber of the States of the Netherlands in February, 1875, the culture of coffee carried on in Java on account of the Government, has remained stationary for forty years, notwithstanding the large quantity of land and labour available, while the consumption and value of the product have continued to increase during the period.

Sumatra.—After Java, Sumatra is the next island which raises coffee in large quantity, and as it has been greatly taken up by the native cultivators, the island may, when the trees planted come into full bearing, yield a considerable crop. The production at present ranges from 13,000,000 to 17,000,000 lbs. The beans are dark brown, occasionally black, and the last kind is but of poor quality.

In Palembang the production was, in 1872, 9114 piculs; in 1873, 9757; in 1874, 13,000.

In 1872 there were on the west coast of Sumatra 182,500,000 coffee trees planted, of which 126,000,000 were bearing. The production in that year was 90,819 piculs (133 lbs.). The produce of 1874 was 131,474 piculs, there being 4,825,000 more fruit-bearing trees.

The following figures serve to show the progress in a district, Ampat-Lawang, situate between Palembang and Bencoolen, having a population of 22,000 souls, where the cultivation is free, the producers being at liberty to sell their produce as they choose, and not obliged to deliver it to the Government at a fixed price:

	Piculs.		Piculs.
1860	460	1867	7,887
1861	713	1868	5,279
1862	1,697	1869	6,668
1863	2,869	1870	3,953
1864	4,373	1871	8,465
1865	3,530	1872	9,114
1866	4,729	1873	10,050

Even in the higher regions of Bovenland and Padang, where the cultivation is forced and the producers are bound to sell to the Government, the coffee plantations have increased fourfold, notwithstanding the inconvenience of the system. The Malays, finding it conduces to their well-being, have acquired habits of order and labour, and if the Colonial Government improves the means of transport, accords facilities of trade, and improves the moral condition of the people, there is yet a prosperous future before them.

The formation of regular coffee plantations by the natives was commenced in *Celebes* in 1822. By the beginning of 1855 there were more than 5,000,000 coffee trees planted in Minahassa, but not all planted are yet bearing. In some districts the produce is as much as 2 to 4 lbs. per tree, while in others it is only from a half to three-quarters of a pound. The general character of the coffee is not very good, little care being given to the preparation; but the quality of the beans from Menado is better, and of a palish green. The annual forced delivery of coffee to the Government at 15 florins the picul, between 1838 and 1842, only reached about 1,300,000 lbs. per annum.

At *Timor* the Portuguese are encouraging the culture of coffee, and the best results are expected from the plantations made, although as yet the yield is small. The production was in 1862, 183,000 lbs.

Fifty coffee trees are found in the course of four or five years to yield here 1¼ cwt. of coffee; but it is only by purchasing the coffee from the natives that the authorities can get coffee production extended. At Amboyna some 50,000 trees have been planted.

Coffee in the Philippines.—The export of coffee from Manila was in 1864, 37,845 piculs of 1¼ cwt., and in 1874, 45,842 piculs. The value of the coffee exported in 1872 was stated at $869,000,000, and in 1873 at $1,126,000,000. This coffee is quite equal to that of Java; the beans are medium sized, and of a pale-greenish colour.

The plant thrives wonderfully in the Philippines, and its berry has so strongly marked a flavour that the worst Manila coffee commands as high a price as the best Java. In spite of this, however, the amount of coffee produced in the Philippines is very insignificant, and until lately scarcely deserved mention. In the early part of this century the coffee plant was almost unknown there, and represented only by a few specimens in the Botanical Gardens at Manila. It soon, however, increased and multiplied. The Economical Society bestirred itself by offering rewards to encourage the laying out of large coffee plantations. In 1837 it granted to M. de la Gironnière a premium of 1000 dollars for a coffee plantation of 10,000 trees, which were yielding their second harvest, and four premiums to others in the following year. But as soon as the rewards were obtained the plantations were once more allowed to fall into neglect. From this it is pretty evident that the enterprise in the face of the then market prices and the artificially high rates of freight did not afford a sufficient profit.

In 1856 the exports of coffee were not more than 7000 piculs, in 1865 they had increased to 37,588, and in 1871 to 53,370. This increase, however, affords no criterion by which to estimate the increase in the number of plantations, for these make no returns for the first few years after being laid out. In short, larger exports may be confidently expected. But even greatly increased exports could not be taken as correct measures of the colony's resources.

Not till European capital calls large plantations into existence in the most suitable localities will the Philippines obtain their proper rank in the coffee-producing districts of the world. The best coffee comes from the provinces of Laguna, Batangas, and Cavite; the worst from Mindanáo. The latter, in consequence of careless treatment, is very impure, and generally contains a quantity of bad beans. The beans of Mindanáo are of a yellowish-white colour, and flabby; those of Laguna are smaller, but firmer in texture. Manila coffee is very highly esteemed by connoisseurs on the Continent, and is expensive, though it is by no means so nice looking as that of Ceylon and other more carefully prepared kinds.*

Cultivation in Ceylon.—Ceylon is now by far the most important coffee-producing country of the British possessions. It would seem that the tree was taken to that island by the Dutch a little over two hundred years ago, but the first regular estates were only opened in 1824, when Sir Edward Barnes and Sir George Bird commenced planting. The real rush for land dates from 1833, and coffee enterprise was taken up largely in 1837.

Coffee planting had been gradually extending up to 1844, and a considerable breadth of land of what would now be called low country estates, that is, land planted at an elevation from 1600 to 2500 feet, was then in full bearing. Up to this period the English consumption of coffee, restricted by a complicated system of differential duties, had been almost entirely confined to the produce of the British colonies and a small quantity of superior Mocha.

It was known that within the tropics both Demerara and Berbice produced a coffee of highly approved quality in the London market.

* Jagor's 'Travels in the Philippines.'

These countries lying at the level of the sea, a large quantity of the coffee of Jamaica being also grown on the plains of Liguanea, very little above the seaport of Kingston, and Mocha coffee being also supposed to be produced in a dry and hot country,* the effects of temperature or altitude were forgotten or not considered to be a necessary condition. It may be observed also, that elevation and temperature, though they may be on the average the same in two different countries, are still not equal as conditions, inasmuch as soil, neighbourhood of or distance from mountains, combine to form other and varying circumstances, in which few countries can be found absolutely to agree. Whilst Demerara rejoices in a similar temperature, she possesses a rich alluvial soil of many feet in depth, not liable to be removed by the rains, whilst Jamaica has a rich volcanic soil on her lower hills.

The following extract, translated from the records of the Dutch Government by George Lee, Esq., shows the extent of coffee cultivation more than one hundred years since :

"Coffee is a cultivation to which the natives had been with great difficulty induced to attend, and unfortunately, when at last, in 1739, we had brought matters so far as to obtain from this island 100,000 lbs., the supply from Java and the West Indies became so large that our prices here could not be maintained, and we were forced insensibly to let this article of produce slide from us, or at least not to urge it on the natives in any manner whatever, in fact we reduced our cost prices from five to two stuivers, which was scarcely a rate to give compensation for the trouble of growing coffee. The disturbances at Java, however, have had a bad effect on their cultivation, and we have been ordered again to encourage the growth here, and to receive all that is offered us for purchase ; this state of things should be kept up, at least we should never have in store less than what is sufficient for one shipment.—*Memoir left by Governor Schreuder for the guidance of his successor, L. J. Van Eck, in* 1762."

The hill region of Ceylon covers an area of about 4000 square miles, is of a somewhat circular form, and its most elevated parts rise to 8280 feet above the level of the sea. Systematic cultivation is almost exclusively carried on on these hills, although irregular native garden plantations are found everywhere in the south-western portion of the island, even close to the sea-beach. The favourite elevation is between 2000 and 3500 feet, but in a few exceptional cases estates descend almost to the foot of the hills, whilst others are situated at 5500 feet, and even higher. The number of systematically worked coffee estates scattered all over these hills now amounts to 1087, covering an area of perhaps 440,000 acres, of which about 220,000 acres are cultivated, producing nearly 1,000,000 cwts. of clean coffee, worth on the spot, say 3,000,000*l.* sterling, and giving employment to 912 superintendents and assistants, and upwards of 200,000 persons, chiefly Tamil labourers from the coast of India. This is exclusive of about 50,000 acres of coffee grown by natives. In the last five years there has been no abatement in the rapidly progressive rate with

* Mocha coffee, as may be seen by the bean, is grown both on lowlands and likewise on mountain heights, which makes the distinction of greenish small berry and the Patna kind.

which planting operations have been carried on throughout the great forest reserve occupied by the younger and more flourishing coffee districts, Dimboola, Dickoya, and Maskelyia.

Messrs. Ferguson, in their 'Ceylon Directory and Almanac,' furnish the following later and more complete statistics:

"About 15,000 acres of new land have been planted, or felled for planting, since May 1874. In round numbers, the following is considered a close approximate estimate for the position of the coffee, tea, and cinchona industries. Half a million acres of land, chiefly forest land, but including patna or grazing land, are held by estate proprietors, of which one-half is now under cultivation, divided into 1215 plantations, managed by over 1000 resident superintendents, of whom about 950 are Europeans. Of tea, about 1100 acres are planted, or felled for planting; of cinchona, 3000 acres; and, deducting grass lands, 240,000 acres at least are put down for coffee; while in the young districts between Great Western and Adam's Peak, over 7000 acres have been added to the cultivated area since last year, averaging sixty new coffee plantations annually since 1869, equalling 114 square miles, and costing in the conversion at least one and a half million pounds. There is a large extent of young coffee not yet yielding a first good crop, estimated at 54,000 acres of coffee under four years of age, or very nearly equal to the total in bearing in 1856.

Coffee land planted under	1 year	.. .. ..	12,000 acres.
" "	2 years	.. .. ..	29,500	"
" "	4 "	.. .. ..	54,000	"
" "	6 "	.. .. ..	73,000	"

The statistics previous to 1869 being imperfect, it is estimated that about 170,000 acres of the coffee land in cultivation are under twenty years of age, while probably two-thirds of the remainder, or 50,000 acres, are well under thirty years.

"As to labour, authentic returns show that not more than 170,000 coolies were employed during the height of crops in 1871, and immigration returns state that the number of coolies in the island on 1st January, 1875, was about 200,000, and for the next four years it is estimated that about 40,000 more than the above will be required.

"The importations of manures, almost entirely for coffee plantations, are also interesting:

	£		£
1847	10	1868	33,188
1850	2,585	1869	46,603
1857	2,320	1870	73,866
1860	4,050	1871	65,239
1863	20,280	1872	19,042
1865	29,265	1873	33,197
1866	16,776	1874	61,256
1867	25,289		

"In the valuation of coffee properties the usual allowance in full bearing is 40*l.* per acre, and though a great deal of the 196,000 acres put down would not realise so much, yet if we take into account that so much as 110*l.* per acre has been paid in one of the favourite and younger districts, Uva, and counting buildings, machinery, and tools, the datum of 40*l.* per acre is really moderate; and at 30*l.* for young coffee, adding also 130,000 acres in private hands, as available for planting at 5*l.* per acre, we are enabled to arrive at the following estimate:

		£
196,000 acres	full bearing at 40*l.*	7,840,000
54,000 „	young coffee at 30*l.*	1,620,000
130,000 „	forest land at 5*l.*	650,000
100,000 „	patna grass, &c., at 15*s.*	75,000
	Total for plantations	10,185,000
	Add for native gardens at 25*l.*	1,125,000
	Total	£11,310,000

"If to this be added the value of factories, stores, offices in town, &c., the total present valuation of investment in the coffee industry of the island approaches the sum of 13,000,000*l.*"

The coffee estates in the Badulla district are situate in two different directions; those on the Badulla side lie in an easterly direction, and are mostly on spurs running out from Nammanakolie Kande, and those in a south-westerly direction on the Happootelle ranges. The elevation of the estates above the level of the sea is from 2400 to 4800 feet. Those on the Happootelle side are from 25 to 37 miles from the town of Badulla; those on the Badulla side from 3 to 12 miles. Badulla is 156 miles from Colombo, and 84 from Kandy. The heavy blossom appears in August and September. The principal crop is picked from April to July. A small crop, chiefly from young coffee, is picked from September to December.

The crop available for export has already doubled in twenty-five years. It would seem that if the problem is solved, of sufficiently maintaining, by manure and proper cultivation, the bulk of the present estates, so as to continue an average yield, there are resources in Ceylon which ought to carry the crop eventually to nearly double the present export of coffee. It will be a long time before that result can be realised, if it ever comes, but in 1880 there ought to be crops averaging 1,500,000 cwts. of coffee, plantation and native, to deal with. In the five years ending 1875 we get an average annual export of 710,806 cwts. of plantation coffee, which, for 220,000 acres under culture, would give a rate of about 3 cwts. per acre. Of the land planted or tilled, however, it must be remembered that 40,000 acres must be classed as "young coffee," and of this a great proportion has not yet borne a berry. Again, there is a considerable extent of old worn-out coffee land, yielding, perhaps, 2 or 3 cwts. per acre. Making allowance, therefore, for these circumstances, the average yield, even during the last three variable seasons, cannot be much less than 5 cwts. per acre. The native cultivation of coffee has usually been calculated to extend over 50,000 acres, but it varies very much according to the character of the season, the prices of produce, and the cheapness of money. The quantity of native coffee shipped in the five years was 497,080 cwts., giving an average of 124,270 cwts., or a total average of 835,076 cwts.

The progressive increase in coffee production in Ceylon is shown by the following figures of the exports at decennial periods :

	Cwts.		Cwts.
1836	60,329	1866	899,480
1846	173,892	1875	967,700
1856	445,568		

In each of the two years, 1868 and 1870, the shipments exceeded one million cwts.

In commencing coffee planting the first step is the selection of ground. A virgin forest soil on the slopes of the mountains about 3000 feet above the level of the sea is most suitable. A convenient spot should next be chosen for a nursery to be planted with seed or parchment coffee. The forest should then be cut down, lopped, and in five or six weeks burnt. When the clearing and roads are finished, the ground should be lined, holed, and planted with plants from the nursery, which will be then from nine to twelve months old. During the growth of the plants the ground must be kept clear of weeds, and the buildings for machinery, according to a good plan, should be at once commenced. By the time these buildings, together with the machinery, are erected (say three years) the coffee is ready to be picked. The next operation, and by far the first in importance, is pulping the coffee. The machine most extensively used is an Improved Pulper, manufactured by John Gordon and Co., London, who have for many years supplied the Ceylon and Indian planters with this and every other kind of coffee machinery. The coffee is run into the pulper by means of a stream of water. Here the pulp is separated from the seeds, which fall into a cistern, where they remain from eighteen to twenty-four hours without water. After this time has elapsed the cistern is supplied with running water, and all the glutinous matter is by this means washed away. On some plantations a washing machine is used. It is then dried, by a machine made for the purpose, or in the sun. Having been stored away for two or three weeks it is again placed in the sun to finish drying. This is completed if the bean crack freely between the teeth, and it is not until then ready for the peeling mill, which removes the parchment and silver skin from the bean. It is next passed through the fan or ventilator into a sizing machine (about eighteen feet in length), which takes out the broken coffee and separates the beans into different sizes. This not only causes the coffee to roast equally (a quality which raises its value in the market), but also separates the pea-berry, or round coffee, which brings a much higher price.

Mr. W. Sabonadiere, an old planter, speaking of the best elevation above the sea at which coffee should be planted, states that in Ceylon undoubtedly that from 2000 to 3500 feet is the best, but climate has also a good deal to do with it. Coffee grows well at Kaigalle, Kornegalle, and in the Doombera valley between 800 and 1500 feet above the sea. In Ouvah coffee bears well at between 4000 and 5000 feet above the sea, owing to the dry air and climate; while, on the more western side of the island, at the same elevation, it either bears only 2 or 3 cwts. an acre, is a mass of leaves, or gets covered with black bug; the two latter being chiefly caused by the extreme quantity of rain that falls. He sums up with the opinion that a dark chocolate-coloured soil, mixed with small stones, under ledges of rock, and bestrewn with boulders, is the most suitable for coffee trees; and that the best medium elevation is, say 3000 feet above the level of the sea. In forming a nursery one bushel of parchment coffee is calculated to yield about 30,000 plants; so that for a clearing of 100 acres four or five bushels of seed would be required. The placing of the plants in the holes is the one operation that requires the utmost care and attention. The planting season commences in May and extends to the end of November.

Those who intend to embark in coffee culture in Ceylon, should certainly procure a copy of Mr. Sabonadiere's 'Coffee Planter in Ceylon,' published by E. and F. N. Spon, London.

Mr. R. J. Corbet, an experienced coffee planter, thus speaks of manuring and pruning, observations which are worth attention:

"The 'Rothschild estate,' thirty years planted, consists of 927 acres of coffee in bearing; the number of cattle kept was about three hundred and fifty head and nearly one hundred pigs; besides the high road which forms one boundary of the property, two cart roads traverse the whole length of the estate, greatly facilitating manuring operations. From 1865, when the Ceylon Company, Limited, purchased the estate from the Messrs. Worms, to 1871, the crops averaged $9\frac{1}{2}$ cwts. per acre, two out of the six reached $11\frac{1}{2}$ cwts. per acre. One-third of the estate is planted on patna soil; but in Puselawa patna soils are above the average, though still requiring annual manuring. Enough manure was made on the estate, including cattle, pig, pulpers, bazaar, road, and lines' sweepings, all made into a compost, to go over 250 acres. Castor oil poonac (oilcake), bone-dust, or superphosphate of lime, and other artificial manures sufficient for 300 or 400 acres were applied besides, but for the portions planted in patna soil, manuring half the estate yearly, would have been enough to keep up the average yield of between 9 and 10 cwts. per acre.

"The result of my experience on that and other estates ranging from 500 up to 5000 feet, extending as far back as twenty years, have convinced me of the following facts, which cannot be too strongly impressed upon those who may have the lesson to learn.

"1st. That all manures should be applied as *near the surface* as possible without *actual exposure*, and *round* the tree where practicable, but not *too near*.

"2nd. That care should be taken to avoid injuring the main lateral roots as much as practicable.

"3rd. That thoroughly mixing, or incorporating the manures, of whatever nature, in the trench is a *most important point*, a not uncommon method being to throw the manure in a lump into the hole, which is usually about twice the depth necessary, trample it down *perhaps*, and cover it over, upon the principle, I suppose, 'out of sight, out of mind.' There is more money sunk in ignorant and careless systems of manuring, and in severe and injudicious pruning, than proprietors think. Too severe pruning, especially upon the higher estates over 3000 or 3500 feet, has much to do with *short* *crops.* Thousands upon thousands' worth of crop are yearly cut away. Many planters, and experienced ones too, prune their trees to bear to a certain average according to the capabilities of the soil and the climate they have to deal with, oblivious that drought, or excessive rain, or high winds, or some other of the ills coffee is heir to, may deprive the trees of a large percentage of their berries, in almost any stage of development. It is more prudent to prune for a heavier crop, than it is to prune *lighter*, if all the blossoms set, and if apprehensions are entertained of the trees overbearing, they can be backed up in time, but this must be done in May, June, and July, at the latest, with some quick acting manure, such as poonac, superphosphate of lime, and a little guano, or sulphate of ammonia added; a *liquid manure* poured over the compost will be found a good substitute. If all the crop does not come forward, and blossoms do not set well, you have a better chance of securing your average, than if you had pruned heavily, to a *fixed standard.*

" Frequent and judicious *handling* is another very important matter. The usual practice is to handle twice a year, four times would be far more advantageous; but it must be done with much greater care than is customary with some planters; women and children, often with little or no preparatory training, are put to this work. The most essential point to be considered, especially upon *high estates* where wood matures more slowly, is the retention of those shoots you require not only to carry your *next*, but the *following crop as well*, and to strengthen these shoots by giving them all the nourishment possible; you must remove all superfluous ones as they appear. I need scarcely add that the riper the wood the better the chance of crop, but every planter does not know that at elevations of 4000 feet and upwards it takes *two years* to mature wood properly.

" Again, as regards *manuring*, upon the supposition that you have a worn-out or neglected estate to deal with, don't be discouraged if the first application of manure, or even the second, in extreme cases, does not give the results you anticipate. Don't manure too heavily at first in such cases; you force the trees beyond their strength, and you waste money. Recollect that you have to put the trees *into condition.* First of all you have to restore their partially dried-up arteries through which the impoverished sap is only languidly circulating. Your first application will give tone and quality to the sap; the tree will begin to show signs of increased vitality, and throw out wood. Don't allow too great an excess of that; select the shoots you wish to keep for the *next year*, remove the rest, especially the old sickly attenuated wood, but leave rather *more* than less of the new. Follow up with another manuring, of a more stimulating nature, and you may depend upon a crop in nineteen cases out of twenty, but on *no account*, because you have got it, think that you have done enough, that you may rest from your labours, and that pruning and regular weeding will now be sufficient; you are still dealing with an invalid, though convalescent, not cured. Persist in the same course; never leave off manuring, even for one year, it is *ruination*, your patient would lose more in one than it had previously made in two years, under generous treatment; and you could probably never recover the lost ground.

Bear in mind that *high cultivation, once commenced, must be kept up.* I could furnish numerous instances of the disastrous results of starving estates that had been well cultivated, in which the miserable, false, and short-sighted economy practised has cost their owners thousands, aye scores of thousands, let alone the deterioration of properties themselves."

Coffee Pests.—Coffee is a remarkably hardy plant, thriving at various elevations, and under the most different conditions of moisture, soil, and temperature. It is, however, liable to the attacks of certain insects, amongst which the borer is the most formidable. This has been shown by Dr. George Bidie, in a published report, to be the larva of a beetle belonging to the Cerambycidæ, and termed the *Xylotrechus quadrupes.* Hardy as it is, the tree is a dreadful sufferer, and there is scarcely a time when it is entirely free from disease within, or from attacks of enemies from without. Grub, borer, bug, drought, the damp and the leaf disease, are a few of its enemies, and it will be well to touch upon some of these.

Mr. J. Nietner has given in the Ceylon papers an interesting notice of noxious insects to coffee, which it is desirable to republish as furnishing a useful contribution to biographical and economic entomology—a branch of the science which is now being daily more and more appreciated. In judging of apparently trivial passages as well as of scientific technicalities, which occur in the text, this must be borne in mind. To those planters who would wish for more elementary explanations I can strongly recommend 'Westwood's Introduction to the Modern Classification of Insects,' 2 vols., with numerous woodcuts, as a most excellent and exhaustive source of information.

The numerical list given below might easily be doubled by minute research in the outlying districts, and introduction of unimportant species. In fact the brown and white bug, and the black and white grub, are the only universal and important enemies of the coffee tree in Ceylon. The destructions of Arhines, Limacodes, Zeuzera, Phymatea, Strachia, the white ant and the white borer, and the coffee rat, appear to be of a more local and occasional nature, and are therefore of less importance. The rest of the species are nearly all enumerated for the sake of scientific completeness only.

ENEMIES OF THE COFFEE TREE AND THEIR PARASITES.

Hemiptera.

Pseudococcus Adonidum, L. (White or mealy bug.)
  Parasites: *Scymnus rotundatus.* Motch. Et. ent. 1859.
    Encyrtus Nietneri. Motch. loc. cit.
    Chartocerus musciformis. Motch. loc. cit.
    Acarus translucens, N.
Lecanium coffeæ. Walk. List Ins. B. M. (Brown or scaly bug.)
  Parasites: *Scutellista cyanea.* Motch. loc. cit.
    Cephaleta purpureiventris. Motch. loc. cit.
    „ *brunneiventris.* Motch. loc. cit.
    „ *fusciventris.* Motch. in litt.
    Encyrtus paradisicus. Motch. in litt.
    „ *Nietneri.* Motch.
    Cirrhospilus coccivorus. Motch. in litt.

Marietta leopardina. N. in litt.
Chilocorus circumdatus. Schonh.
Acarus translucens, N.

Lecanium nigrum, N. (Black bug.)
Syncladium Nietneri. Rabh. Dresd. Hedwig. 1858.
Triposporium Gardneri. Berk. J. Hort. Soc. Lond. 1849. (A fungus.)
Aphis coffeæ, N. (Coffee louse.)
Parasites: *Syrphus Nietneri.* Schiner in litt.
„ *splendens.* Dolesh.
Micromus australis. Hag. Verh. Wien. z-b. G. 1858.
Strachia geometrica. Motch. in litt.

LEPIDOPTERA.

Aloa lactinea. Cram. pap. ex.
Orgyia Ceylanica, N.
Euproctis virguncula. Walk. loc. cit.
Trichia exigua. Feld. in litt.
Narosa conspersa. Walk. loc. cit.
Limacodes graciosa. Westw. Ent. cab.
Zeuzera coffeæ, N. (Red borer.)
Agrotis segetum. Wien. V. (Black grub.)
Galleriomorpha lichenoides. Feld. in litt.
Boarmia Ceylanicaria. Feld. in litt.
„ *leucostigmaria.* Feld. in litt.
Eupithecia coffearia. Feld. in litt.
Tortrix „ Feld. in litt.
Gracilaria? coffeifoliella. Motch. loc. cit.

NEUROPTERA.

Termes fatalis. Kænig. (White ant.)

DIPTERA.

Anthomyza? coffeæ, N. in Motch. loc. cit.

ORTHOPTERA.

Phymatea punctata, D.

COLEOPTERA.

Ancylonycha spec? (White grub.)
Xylotrechus quadrupes. Chevt. (White or Indian borer.)
Arhines? destructor, N.

APTERA.

Acarus coffeæ, N.

MAMMALIA.

Golunda Elliotti. Gray in Kel. Prod. (Coffee rat.)

DESCRIPTIONS AND OBSERVATIONS.—*Pseudococcus Adonidum* (white or mealy bug). Male: Head rather square, enlarged behind and rounded off at the posterior angles; eyes prominent, black; ocelli two, small, lateral; antennæ nine-jointed, second joint longest, third shortest, four-ninths subequal; mouth externally represented by two black knobs resembling blunted mandibles. Thorax ample, oblong—quadrate, enlarged at the shoulders; wings two, ample, two-nerved, hyaline, strongly iridescent, laid straight down the back, half overlapping each other when at rest. Scutellum ample, transverse, rounded at the apex. Abdomen subcylindrical, of shrivelled appearance, with two long anal setæ, which are slightly curled, and of mealy, brittle consistence. The insect is of light dirty-brownish colour and slightly hairy; it is very minute (very much smaller than the female; only about a quarter line long), and resembles certain small Ephemeridæ or May flies.

Female: Apterous, oval, brownish-purple, covered with a white mealy powder which forms a stiff fringe at the margin (one tooth or tuft to each segment on either side), and at the extremity of the abdomen two setæ. The back is laid out in three longitudinal and a number of transverse corrugations, the latter corresponding with the number of segments, upon each of the three longitudinal corrugations the mealy secretion forms a sort of ridge cap. The feelers, legs, and promuscis, are of light-brown colour and slightly hairy. The former are setaceous, eight-jointed (the last joint being the longest), nearly as long as the legs and porrected. The promuscis is situated between the anterior pair of legs, having a few hairs, but no sucking bristles at the tip.

The larvæ and pupæ of the female resemble the perfect insect, but are on a smaller and less perfect scale. In the male pupa wings and anal setæ are rudimental, in the male larvæ absent. These imperfect males rather resemble young Psoci or Aphides, but they carry the antennæ turned backwards, along the sides of the body. The larvæ and pupæ are active—move about.

The insects, in all stages of development, are found all the year round, the propagation being continuous. It appears to me, however, that the males are most plentiful about June and January than at any other season. They affect dry, hot localities, and are found as well on the branches as on the roots of the trees, to about one foot under ground. The eggs are actually laid and enveloped in a white cottony substance; they are oval and of yellow colour. I am not sure that there are not two species in the island, as I find some communities rather flatter and more densely covered with meal. However, these may be local varieties. The white bug of the Ceylon coffee tree seems to be identical with the species which is naturalized in the conservatories of Europe, and is, perhaps, a cosmopolite. It is closely allied to the cochineal insect. There are several insects in the island, resembling the white bug, but of the size of a sixpenny, and even shilling-piece, these belong to the genus *Dorthesia*, and I have generally found the up-country species upon the stem of a laurel—*Tetranthera Gardneri*, Thw.

The white bug is preyed upon by the larva of *Scymnus rotundatus.*—This is a minute beetle of the lady-bird tribe, as big as a pin's head, black and pubescent. The larva greatly resembles the white bug and might easily be mistaken for it. It is, however, longer, narrower, flatter, and of a yellow colour, but covered thickly with stiff white hair of the same cottony substance as those of the bug. This covering is occasionally renewed, and is especially thick when the metamorphosis is at hand. This latter the larva undergoes in a thin oval cocoon, to which the white covering of the larva remains externally attached. This larva is very active and attaches itself to the under side of the bug. Westwood, Introd., vol. i. 398, mentions the larva of a *Scymnus* feeding upon Aphides, and vol. ii. 443, feeding upon Aleurodes. The larva of the *Scymnus* is an external parasite, and M. de Motchulsky is wrong in stating that I had discovered it "*dans* le Pseudococcus."

The white bug is also preyed upon by the larvæ of *Encyrtus Nietneri* and *Chartocerus musciformis*, two minute Hymenoptera (wasps), the former of a yellowish colour and common, the latter black and scarcer. There is also a very minute whitish translucent mite, which is found mixed up with the bug, and no doubt injures it to some extent. I will call it *Acarus translucens.*

Lecanium Coffeæ (brown or scaly bug).—Male: Head transversely ovate-rotundate, narrowed, and square in front; eyes large, black; ocelli two, small, lateral; antennæ nine-jointed, second joint smallest; third longest, thence decreasing to the tip; mouth as in the male of the white bug; thorax ample, cordiform, narrowed in front; wings two, hyaline, two-nerved, subcostal nerve dark pink, not folded straight down the back when at rest, but half spread out; scutellum as in white bug; abdomen triangular, subcylindrical, of shrivelled appearance, with two lateral points, one central appendage, and two long, thin, white filaments at the extremity. The insect is still more delicate than the male Pseudococcus, of clear, light, pinkish-brown colour, slightly hairy; very pretty.

Female: Apterous, tortoise-like, yellowish, marbled with grey or light brown, suboval, more or less semi-globose according to age; back with one elevated longitudinal, and two transverse costæ, uneven; split behind, at the extremity of a split bifid anal flab of brown colour; eyes marginal, black; antennæ seven-jointed, third joint longest; promuscis with one long sucking bristle. The old individuals are light brown, with a dark margin, smooth, semi-globose, fixed to the branch.

Larvæ of female with two anal filaments, which are lost in after-life. The larvæ and pupæ of both sexes are active, with the exception of the male pupa, which is plentiful on the under side of the leaves, where the long, narrow, oval shell, under which it rests, is easily discovered. This shell is transparent, and composed of nine plates, three central and three on either side. I have occasionally found the entire under side of leaves covered with nothing but male pupæ, all dead. This species of bug affects elevated (above 3000 feet), cold, damp, close localities, where it is found in all stages of development all the year round, the propagation being, as in the white bug, continuous. As in the latter species, the males seem to be more abundant about June and January than at any other season. The eggs, which are oval and of pinkish colour, are not actually brought forth by the female; but when they are matured the parent insect dies, the whole interior forming one mass of eggs protected by the shell.

This kind of bug is closely allied to the lac insect (*Coccus Lacca*, K.) of India.

The brown bug is much infested by parasites, amongst which the following are the most common:—*Scutellista cyanea*, *Encyrtus Nietneri*, *Encyrtus paradisicus*, *Cephaleta purpureiventris*, *Cephaleta brunneiventris*, *Cephaleta fusciventris*, *Cirrhospilus coccivorus*, *Marietta leopardina.*

These are all Hymenoptera of the most minute description, presenting under the microscope the most elegant forms, and, for the most part, the most brilliant metallic colours. The *Marietta*, for instance, is spotted or ocellated all over black and white, like a leopard. They can easily be obtained by putting a bugged branch, cut in convenient lengths, into a bottle, when, after some time, the little wasps will be found flying about inside, having made their escape from the bugs. The mother parasite lays her eggs amongst the bugs; when hatched, the young larvæ find their way easily to the soft under side of the bugs, where they attach themselves like leeches, and, protected and fed by the body of the bug, remain until they reach the perfect state. A bug thus attacked produces, of course, no eggs, and instead of the young bugs, in course of time there escape these little wasps. The shells of the old bugs are frequently found with one or two holes; it is from these that the parasites have escaped. I have seen as many as six larvæ (belonging to different species of Hymenoptera) attached to one single bug. These larvæ can easily be seen on turning up some old bugs with the point of a penknife; they are little white or yellowish, eyeless and footless maggots, some of which can leap to a considerable distance by doubling themselves up and spasmodically extending themselves again to their full length.

On examining old, full-grown bugs, the shells are often found filled, not with eggs, but with a white flaky substance, amongst which the above-mentioned mite, *Acarus translucens*, is seen busy. I have thought that the mite might have been the destroyer of the eggs in these cases, and that the flaky substance was the empty and decomposing egg-shells, but do not feel certain on this subject. The planter has another friend in the larva of a kind of lady-bird, which feeds upon the bug, viz. that of the *Chilocorus circumdatus* (Syn. *Ch. nigro-marginatus*, N. in Motch. Et.). This larva is of ashy-grey colour, furnished with black spots and rows of black spines. The perfect insect resembles a full-grown bug, being semi-globose, light brown, with black margin round the elytra. There is a variety which is altogether dark brown. The larva skin splits, but is not thrown off when the insect assumes the pupa state. When the imago, or perfect insect, issues from its double shell, it is white, turns round (head towards tail of skins), and sits in this position upon its former envelopes for twenty-four hours before it moves off. During this time it gains its proper colouring. It is common at all seasons, but especially from March to September, and in all stages of the metamorphosis, the larva generally fixing itself to the under side of the leaf when its transformation approaches.

White or Indian Borer (*Xylotrechus quadrupes*, Chev.).—This is a longicorn beetle of the tribe of the *Clytidæ*, or wasp-beetles of England (so called from their resemblance to wasps with regard to their system of coloration). Its ravages amongst the coffee estates of Southern India of late years are too well known to need allusion here, more especially as they have called forth the able works of Colonel Taylor and Dr. Bidie, the latter being commissioned by the Madras Government to investigate and report on the subject officially —an honour offered to myself, but which circumstances prevented me from accepting. I therefore confine my remarks to the doings of the insect in this island: for we have it here—but, fortunately, not in great numbers. In fact, the only instance in which I have heard it *complained* of is that of a gentleman in Ouda Puselawa, who, in 1869, wrote to me on the subject, sending me specimens of the insect which are now before me, and leave no doubt that it is the *real white borer*. He said that he had then known it for six years, that lately he had lost *five acres* of coffee by it, and that he kept regular *borer-catchers*. He also informed me that the villagers in the neighbourhood professed to have known it time out of mind and called it "*Panova*." (However, this is a *general* term for wood-boring insects.)

The white borer, in its perfect state, is, like its congeners at home, an active elegant beetle, delighting in hot sunshine and old palings. It is from a half to three-quarters of an inch long, black, with whitish or yellowish bands across the elytra, the three latter of the bands forming the inverted letter V.—The four posterior femora are of pink colour. The insect is thus easily distinguished from other species of the genus which occur in this island.

It is in the *larva* state that it destroys the coffee trees, the perfect insect laying its eggs upon the stem of the tree, whence the young larva find their way into the inside.

The nature of the destruction is the same as that of the red borer, but the *Xylotrechus* is much more numerous, so that *dozens* of the insects reside in one tree, whereas of the former I have never found more than one or two individuals together.

Dr. Bidie writes to me that he thinks *shade* is the only remedy on the South Indian estates. For the last couple of years we have not heard so much about its ravages, which are probably diminishing; but a short time ago the *Xylotrechus* was undoubtedly the most formidable, *tangible* enemy the coffee tree had. Hundreds upon hundreds of acres of coffee were totally destroyed by it in South India, and in fact it was at that time feared that the whole of the coffee estates in Coorg and Wynaad might be extinguished by it.

Arhines? destructor.—This is a beautiful green weevil, two and a half inches long and one broad, oval, narrowed in front, covered all over with closely set but isolated gold-green scales, winged. The head is rather short and blunt; antennæ apical, elbowed at the middle, the part beyond the middle being composed of eleven joints, forming a club towards the end, the third joint from the tip being the thickest; they are brown, hairy beyond the middle; the thorax is plump, subconical; the anterior legs are the longest, the second pair the shortest, the tibiæ and tarsi of all are hairy, the tarsi with hairy brushes underneath, especially thick at the third joint which is deeply two-lobed; the tibiæ of the second pair are long, serrated inside, curved and two-hooked at the apex. The insect varies considerably in size and colour.

This pretty beetle is common during the dry weather, but I have never found it do any injury to the coffee. Mr. James Rose, of Maturatta, who first directed my attention to it, wrote to me:—"The mischief they do to the coffee is really frightful, and if they were as plentiful as the bug, they would be our worst enemies. Five or six acres were completely covered with them, and they consumed almost every leaf. Year after year they appeared upon the same place. In May, when these insects disappear, the logs and rocks may be seen strewed with their bright green elytra."

The family of the weevils is one of the most extensive amongst the beetles, and many of its members both here and in Europe do much injury to agricultural produce. I have seen nearly the whole sweet potato (*Batatas edulis*) crop of the Negombo district destroyed by one of them, the *Cylas turcipennis.* The common rice-weevil (*Sitophilus Oryzæ*) is another instance, and one of the cocoanut destroyers of the low country belongs also to this family, the *Sphænophorus planipennis.*

Acarus Coffeæ.—This is a very minute mite, hardly perceptible to the naked eye, which feeds upon the coffee leaves nearly all the year round, but more commonly from November to April, giving them a brownish sun-burnt appearance. The damage it does is not great in the aggregate, but individual trees certainly suffer from it. It is closely allied to the "red spider" of the hothouses in Europe; oval, naked, light red, abdomen darker, four rows of hair along the back, legs hairy. It feeds on the upper side of the leaves where, amongst the live insects, empty skins and minute red globules are found in plenty. These globules are fixed by a style to the leaf, and are the young in the first stage of existence; the style is the mouth, but the rest of the body is a perfect globule without any appendages whatever. These latter, however, gradually break forth, and when the animalcule is furnished with all it requires, it lets go its hold.

Coffee rat (*Golunda Ellioti*).—This well-known animal does not habitually reside on coffee estates, but comes, apparently, when its food fails, from the jungle to the neighbouring estates to supply its wants there. Hence, estates with much surrounding jungle are more liable to be infested than others, in the same way as the fields adjoining the jungle suffer more than the more remote ones.

With their long sharp incisors they bite off the smaller and younger branches of the trees, beautifully, regularly, and smooth, and generally one inch or so from the stem, so as to allow them to rest upon the stump whilst they are gnawing it through. Should the plants be quite young, just taken from the nursery, they bite them right off a few inches from the ground. Their object in doing this is, no doubt, first to get, like other rodentia, at the bark, which they do not appear to devour entirely, but simply to masticate for the sake of the juice, but probably they act in this respect in accordance with the state of their appetite; and secondly to get the leaves for their nests. These latter are commonly found in hollow trees, whither they also drag the bitten-off branches. They seldom appear to eat the berries. They are destroyed either by poison or by traps, in which latter enormous numbers are said to have been caught. There is hardly an estate that does not now and then receive a visit from them.

A small squirrel, a dark variety of the common palm-squirrel of the low country (*Sciurus three-Vittatus*) is commonly found about coffee estates: this does what the rat apparently does not—eats the berries, which, being indigestible with the exception of the outside pulp, are afterwards dropped and found upon logs and on the ground, in the shape of parchment coffee. Jackals and monkeys occasionally do the same, and a deer will now and then come from the forest and nibble the tops of the young trees; but these are not serious injuries. Far more so, are those arising from the trespass of the buffalo.

The coffee leaf fungus, *Hemilia vastatrix*, is another anxiety of the coffee planters. Leaf disease in coffee has now assumed an aspect so serious that the fullest possible investigation into its cause or causes, nature, effect, and the possible remedies, can no longer be avoided.

Very contradictory are the opinions of planters themselves with reference to this pest of the coffee tree. We have heard from more than one quarter that splendid crops follow severe attacks of leaf disease; from another that short crops are the result. One planter will tell you that trees badly affected one season show little sign of the disease the next, while others say that the trees worst affected one year are similarly circumstanced under subsequent appearances of the disease on their estates. At certain periods of the growth of the tree, young branches seem to be perfectly free from disease, and yet they become affected gradually at a later stage. Further experience of the characteristics of the disease is evidently required before definite conclusions as to its course and incidence can be arrived at, and it would be well to have the results of the observation of experienced planters in order to aid scientific inquiry on the subject.

It would be interesting and useful to know whether the disease is more prevalent in a dry district than a wet one. Whether old trees are attacked by it more readily than young. Whether old coffee that has been manured with cattle manure, or other bulky manures, suffers as much from it as coffee that has had chemical manures applied to it; and whether the aspect of the estate has anything to do with it, &c.

Production in British India.—Passing from the island of Ceylon, we reach the peninsula of India, where, under British enterprise, coffee cultivation is making rapid progress from the greater facility of obtaining labour. It is this insuperable difficulty which has crippled production in our West Indian possessions, and led to the transfer of the culture of many of the leading staples of commerce from the western to the eastern hemisphere.

Coffee is now a much more important article of agriculture in India, Ceylon, Java, and Brazil, than in its native countries. It is not much more than half a century ago that the coffee plant was first introduced into Bengal. The origin of coffee culture in India is due to some refugees from the Philippines, and has been detailed circumstantially by the late Mr. J. S. Buckingham. Suffice it to say that about 1820 an insurrection of the native Indians of the Philippine Islands, against their conquerors the Spaniards, drove almost every white man from that country, and some few of these sought refuge in Calcutta. Among others were two Frenchmen, who had been for some years successful cultivators of coffee at Manila, but who, though wealthy by their possessions there, barely escaped with their lives. A subscription was raised for them by the merchants, money advanced, the requisite land purchased, the coffee plant cultivated on it; and from this source has sprung all the subsequent increase which makes the present production of India about 50,000,000 lbs.

The production of Indian coffee is confined almost entirely to the Madras Presidency, the native states of Travancore, Mysore, and Coorg. The fluctuations of the trade, which are often considerable, are to be explained by the deficiency or abundance of crops, according as the season is unfavourable or the reverse. Crops have often been materially affected too by the ravages of the "borer," by rot, as well also (and this is a large element in the influences which have from time to time affected injuriously the out-turn of the crops) by the want of knowledge of proper conditions of culture on the part of those engaged in the cultivation, both Europeans and natives. The industry has been long established in Southern India, and Europeans have engaged in it for upwards of forty years.

The cultivation has now settled down into a steady and prosperous industry, in which natives are largely occupied as well as Europeans; but, like tea, before attaining this last stage, it went through all the phases of wild speculation. From 1800 to 1863 or 1864, there was quite a mania for the cultivation of coffee. Land was bought recklessly, without regard to its suitability, cleared and brought into cultivation at enormous expense, and, in many cases, ruinous loss ultimately. Great sums of money were wasted in this speculative period, which was followed by the inevitable reaction and depression. This period has long passed, and planters understand now that they cannot hope for the visionary profits of which they were formerly assured; but the cultivation of coffee is, with care and intelligence, a steady and prosperous support to those engaged in the industry.

It is a noticeable fact, as showing the wide range of the plant, that in many of the countries where coffee culture has been introduced, species have been found indigenous, such as *Coffea alpestris*, *grumeloides*, and *Wightiana*, in the Neilgherry hills; *C. Mauritiana*, in Bourbon; and *C. Liberica*, in Western Africa.

Although the coffee tree will not refuse to grow and even bear crop in countries subject to frost and snow, and extreme warmth is not absolutely necessary to its existence, still experience shows that it flourishes and bears fruit abundantly only within the tropics. In Southern India and Ceylon the elevation at which the estates are situated varies considerably, from nearly 6000 feet above sea-level to so low as 400 and even 300 feet. It has been asserted that coffee requires a great deal of moisture; and a humid atmosphere, combined with a warm temperature, will encourage trees to bear most heavily. The latter requirement must not be overlooked, as it is well known that, on very elevated estates, where an almost perpetual mist and frequent rains furnish more than an adequate supply of moisture, but where, however, the air is seldom warm, even when the sun shines brightly, the coffee trees, even in sheltered situations, though they sometimes present a healthy and even luxurious appearance, bear but very little crop. Such situations also prove, in many cases, strongholds of the blight called black bug. Hence few experienced planters would think of establishing a garden at an elevation above 4000 feet; though, if the aspect and soil be exceptionally favourable, coffee may thrive well and yield heavy crops at an elevation of even 6000 feet. In situations between 2000 and 4000 feet above sea-level, the climate and temperature required by coffee will generally be found. In elevations below 2000 feet, the great heat of the climate causes so rapid a growth of vegetation that it is extremely difficult to keep down the weeds, and where, as at a tolerable elevation, one monthly weeding would be amply sufficient, two at a lower elevation would be quite necessary to keep an estate clean. Moreover, the malarious atmosphere of estates in low situations is a condition which, though suited to the coffee plant, is not conducive to human health.

The most suitable soil in the East Indies for the coffee plant is that which grows soft timber. The latest authorities seem to confirm the opinion of Laborie, who observes: "If the first or tap-root finds the gravel, stone, or clay, the tree will not last long; but if it, as well as the roots, find their way through the stony ground, and if there be a good proportion of mould, it suffers no inconvenience, as the stones keep the mould together." The finest estates are said to be of this latter character of soil, and have given consecutively heavy crops, with the assistance of little or no manure; while estates of a lighter soil, having lost nearly all the mould, and having no good subsoil, require to be regularly manured. In a word, a dark chocolate-coloured soil, mixed with small stones, under ledges of rock, and bestrewn with boulders, is the best, and the most favourable elevation is 3000 feet. A level piece of virgin ground, not far from water, where the soil is rich and crumbly, is the most eligible for the construction of a nursery. First, the land must be thoroughly cleared, and all but the largest stumps of the forest trees rooted out; the soil should be dug to the depth of nine or twelve inches, and be made as friable as possible, then divided into beds with narrow paths between them; the seed, in parchment (generally taken from the cistern after being pulped), should be put in, row by row, about six inches apart. A rope, the length of the beds, is used for this purpose, stretched from one end of the bed to the other. The seed, if sown in suitable weather, soon makes its appearance above the surface; so that a nursery made in May or June of one year has plants fit to put out at the same date in the following year. A slightly inclined piece of land is more desirable for a nursery, because the natural drainage would be better; and it is important that care should be taken to prevent damage by heavy rains. One bushel of parchment coffee is calculated to yield about 30,000 plants; so that for a clearing of 100 acres four or five bushels of seed would be required. When the young trees in a nursery have attained a growth and age at which their being planted out as plants becomes rather a doubtful proceeding, with reference to the probability of their succeeding and taking root, it is better to make "stumps" of them; this is done by pulling them up with as little injury as possible to the roots, and cutting them down to about six inches above the roots; then to shorten the tap-root by a careful sloping out; next, to trim the other lateral roots, which are often needlessly extended. Filling-in is the operation that follows holing. It has been ascertained by experience, that leaving the holes open for some time is very beneficial to the soil in a chemical point of view. Filling-in, like every other work on a coffee estate, should be carefully superintended. But of all operations in the formation of a coffee plantation, the actual placing of the plants in the holes is the one that requires the utmost care and attention. Early planting is, of course, desirable, because the trees have the benefit of the entire rainy season, and are sure to give a larger maiden crop. The usual course of transferring the plant is as follows: When pulled up, those with crooked roots should be picked out and thrown away, the roots should then be trimmed with a sharp knife, diminishing the length of the tap-root sufficiently to prevent the chance of its being bent or broken. The plant should not be put deeper into the earth than it was before it was pulled up; it must then be pressed down with the hands or firmly trodden down. A coffee plantation, to be worked effectively, requires to be well "roaded" and drained. Drains, like roads and paths, should be cut as soon as the estate is commenced.

The extension of coffee cultivation in the hill districts of Southern India has been very remarkable. It was commenced experimentally in the Wynaad in 1840, and in 1862 there were 9932 acres under cultivation in that district alone. In 1865 Wynaad coffee cultivation had increased to 200 estates, covering 14,613 acres. The exports in 1860–61 amounted to 19,119,209 lbs., and coffee cultivation has since become a very important and increasing source of wealth. In 1873 the total number of holdings was 6913, of which 195 belonged to Europeans, and 6718 to natives. The estimated produce of the Wynaad for 1873 was 83,500 cwts.

In 1874–5 the extent of coffee cultivation in Wynaad had increased to 32,180 acres. The total value of the land under cultivation was 965,430*l.*, and the amount expended annually in coolies' wages alone was 182,500*l.*; other expenses in connection with cultivation, carriage, and shipment of crops, amounted to 100,000*l.* There were altogether 117 European planters, 16 of whom were in North Wynaad, 74 in South Wynaad, and 27 in South-East Wynaad.

In the mountainous province of Coorg the cultivation of coffee by European enterprise was commenced in 1854, and there are now 73,306 acres under cultivation.

On the Malabar coast some excellent coffee is grown, as well as in the hilly regions of Mysore and on the slopes of the Neilgherries. From these two latter places the finest growths of coffee are now being raised, more especially from Mysore, the prices obtained being considerably more than for Mocha. Very good specimens of coffee have also been produced in the interior of India, as in the district of Chota Nagpore, where the culture might apparently be greatly extended, and be of great benefit for consumption locally. The plantations of Mysore number 23,871, and cover 111,139 acres; of these, 307 belong to Europeans, with 34,377,509 coffee plants on the estates, the rest (23,564) to natives; these are small, the gardens ranging from about 3½ acres, but they have in all 87,779,620 trees.

The quantity of coffee exported in the year 1873–4 was 2749 tons; in the following year the quantity increased to 3316 tons.

With 111,139 acres under coffee, it seems strange that the export from Mysore should be only 66,320 cwts., or a fraction over half a hundredweight per acre. Probably the home consumption of the population of Mysore, which exceeds five millions, is large. The average yield must be very small. The aggregate number of coffee bushes on European and native estates is returned at over 118,000,000. Even if we strike off one-third of the trees as too old or too young to be in bearing, there remain 88,000,000 trees, which, at the Ceylon average of half a pound per tree, ought to yield 400,000 cwts. of clean coffee. Perhaps the coffee bushes in Mysore, while yielding berries famous for their quality, give but few of them, say an average of a quarter of a pound of clean coffee per tree.

The slopes of the hills that rise on the plateau of Mysore are thickly clothed with coffee plantations, and in the Munzerabad and Nugger districts coffee is even planted under the shade of forest trees, to obtain the requisite temperature ; so that there is hardly a spot of land fit for coffee culture that is left uncultivated.

In the Nugger district of Mysore, the Bababooden hills present a bold and rugged appearance, towering upwards to a considerable height, and their crags, slopes, dells, woods, and waters impart a charming variety to the general feature of the country. Near the base of the hills, prettily situated in wooded ravines, are the coffee plantations. The plantations in the Munzerabad district offer a more pleasing appearance to the beholder than those of Nugger, as the country surrounding them is far more picturesque.

The coffee estates in Coorg may be classified into three groups : the Mercara plateau, the Ghat and the Bamboo estates. Each group has its peculiar characteristics, advantages, and disadvantages. The Mercara plateau has an average elevation of 3500 feet, and, in the higher planted portions, rising to upwards of 4000 feet, enjoys a bracing climate, being equally exposed to the sweeping monsoon rains and to the dry east winds. With an average rainfall of 121 inches, extended over almost the whole year, the moisture is ample. The granitic soil consists generally of a red felspar clay, more or less mixed with gritty ferruginous stones, and covered with a layer of humus.

The slope of the land being steep, it is evident that unless cultivation is carried on with due precaution against the "waste" of the surface soil, by terracing, draining, or a judicious system of weeding, the trees will in a few years be deprived of the coolest and most nourishing portion of earth, and the land become sterile. Artificial shade is not required. Sheltered hill sides and gently sloping valley are here covered with the most luxuriant and productive trees.

The Ghat estates extend over both sides of the Sumpaje valley, on the road to Mangalore, and on the Perambady Ghat beyond Verajapet, on the eastern and western declivities of the range of the western Ghats. This group of estates being originally covered with primeval forest, possessed a splendid soil for cultivation, its fertility being heightened by a heavier fall of rain, and by an invariable condition of atmospheric humidity.

The extensive felling of forest, however, combined with a probably faulty system of cultivation, seems to have washed away the best portions of the soil of the steeper plantations, leaving the exposed roots without nourishment, and during successive seasons of drought these fall an easy prey to the boring insect.

The Bamboo district, which comprises the third group of estates, lies between the river Cavary and the Mercara trunk road to Verajapet, and thence to Attur Tittymutti. Its elevation varies from 3000 to 3300 feet. Its annual rainfall amounts to about 65 inches. The nature of the land generally presents undulating slopes, and but few steep hills. The soil is of the richest kind, as the humus from an exuberant vegetation, which annually decays or is consumed by jungle fires, has accumulated for ages without being disturbed by heavy floods. The rainfall is gentle and seasonable, and the growth of coffee throughout the district most luxuriant and productive. On these estates artificial shade is deemed necessary; the local varieties of the fig tree, with jack and toon, seem to answer best. Some of the oldest trees have given, it is said, fully a ton of coffee per acre. Fears are justly entertained that such an excessive production cannot last—that the trees must kill themselves by over-bearing.

The coffee grown in the Madras Presidency is brought down the Ghats from the hill districts of Mysore, Coorg, Wynaad, and the Neilgherries, to be exported from the Malabar ports. Some is also shipped in South Canara and at Tuticorin, as well as from a new port in Travancore. The exports from the Madras Presidency do not show an increase, but much is consumed locally.

The shipments have been as follows:

	Lbs.		Lbs.
1871	31,295,195	1874	40,110,203
1872	52,047,318	1875	33,738,922
1873	39,781,819		

The coffee fields in Travancore may be divided into the northern, middle, and southern districts. The northern includes the estates at and about Peremade; the middle, those near and to the north of the Augustan Peak, and in the neighbourhood of Courtallum; the southern, called also the Assamboo range, includes those between Assamboo in the south, and the Koday river in the north. In the latter districts there are coffee estates covering 10,000 acres, of which 5500 acres are planted, and all this has been done since 1863.

The number of coffee estates owned by Europeans in Travancore in 1870 was fifty, containing in the aggregate about 14,700 acres. This was independent of the estates and gardens owned by natives, both on the hills and plains. Since then a good many hundred acres of forest land have been planted with coffee; but it is even yet in its incipient state of development.

From the following statistics, it will be seen that within a quarter of a century the total exports of Indian coffee have increased from about 5¼ million pounds to an average, in the four years ending 1875, of 43,715,000 pounds.

	Lbs.		Lbs.
1850	5,382,344	1872	56,817,153
1860	14,345,809	1873	42,099,320
1870	36,493,106	1874	41,019,409
1871	33,816,746	1875	34,925,063

Of the total quantity of Indian coffee shipped in 1875 (35,000,000 lbs.), about 33¾ million pounds went from Madras direct, and 1,184,000 *viâ* Bombay. The United Kingdom is the largest customer, 19¼ million pounds having gone there during the year. France took more than 13 millions, Turkey in Europe upwards of three-quarters of a million; more than a million went to the Persian Gulf and Red Sea, and nearly 350,000 lbs. to the Mediterranean ports. The balance was sent in smaller quantities to various other countries.

The average annual exports of coffee from India since 1850 are shown below in periods of five years each :

Year.	Lbs.	Value.
		£
1851-55	7,813,602	94,974
1856-60	8,274,183	135,263
1861-65	24,162,260	555,652
1866-70	33,879,096	784,727
1871-75	41,405,214	1,218,867

As compared with the year 1874 (40,815,038 lbs., value 1,491,411*l.*), the exports in 1875 (34,925,063 lbs., value 1,305,335*l.*) fell off in quantity, though their relative value was larger.

Arabia.—Before leaving the Asiatic continent, we must say a few words in passing on the coffee production of Arabia.

For ages before its use among the western nations, coffee was raised on the famous hills of Yemen, in Arabia, where Niebuhr states the tree was first cultivated after it was brought from Abyssinia by the Arabs. The coffee gardens there are on terraces, which reach an elevation of about 3000 feet. The soil is kept moist by means of small artificial canals, which are made to irrigate the whole by the water falling from the upper to the lower terraces. The trees are planted so close together that the thick foliage shelters their roots from the tropical heat of the sun. The fruit begins to ripen in February, but the most considerable harvest is in May. When the berries are dried and prepared, they are conveyed to the city of Beit al Fakih, when part goes to Mocha and the rest to European markets.

Mr. Ellis, F.R.S., in his account of Coffee, published long ago, observed that the part of Arabia, from whence the Asiatic coffee is brought, is for the most part extremely sandy, dry, and hot. At Batavia the soil is in general wet and deep; and though, like other eastern climates, there is a dry season, yet in the rainy periods the quantity of wet that falls is excessive. The rich, luxuriant state of vegetation in the island of Java, on which Batavia is situated, is a proof of this assertion; and one may safely infer, that a plant brought from a dry, sterile, sandy soil, will assume not only a very different appearance, but its fruit will have a very different quality from that which is the produce of a fertile, moist soil, subjected to equal heat. The drier the soil on which the coffee grows, the smaller is its fruit, and its quality more excellent.

It is certain that in old coffee trees the fruit is smaller; perhaps an accurate taste would discover that its flavour is improved in proportion.

From Mocha, Hodeida, and other parts of Arabia, there used to be exported, a quarter of a century ago, about 10,000 tons of coffee annually, but it is difficult to get at any precise figures as to the production now; it certainly, however, is not one-half of this.

The principal coffee districts are Hinjersia, Tarzia, Oudein, Aneizah, Bazil, and Wusaf. The coffees of the Red Sea are mostly sent first to Bombay by Arab ships, and there garbled and forwarded to Europe. Mocha coffee, until lately, has been much esteemed; the fine sorts continue to be so, but the major part imported into this country is of a very mixed character, in many cases stones and husks forming a good portion of the bulk. Other growths, such as Mysore and fine East India, are rapidly superseding this kind, and unless the quality is much improved the demand in this country must die away; as it is, the greater part is exported at prices actually below those of Plantation Ceylon and other colonial growths. The berry of the really choice qualities of Mocha, when roasted, has a flavour and fragrance which are unequalled by other growths.

Africa and the African Islands.—The eastern and western coasts of Africa, including the islands of Mauritius, Reunion, St. Helena, St. Thomas, and Prince's, produce coffee to the extent of about 2,000,000 lbs. yearly. The island of St. Thomas is progressing in coffee production, the exports having increased sixfold between 1845 and 1864, in which years they had reached 1,750,000 lbs. At Praia Rei, where the culture was commenced in 1854, the produce had reached 130,000 lbs. in 1862 and has gone on advancing. This property, which is one league and a half by three in extent, is divided into three estates, cultivated by about 300 labourers; Monte Cafe, another estate commenced in 1854, by 50 labourers, in the course of eight years had nearly 500,000 trees planted. The seventh year the crop yielded 200,000 lbs., and since 1865 has produced about 550,000 lbs. annually. Alta Douro, another estate, only commenced in 1857, had planted some 50,000 trees in a year or two, and is now a most productive property. The coffee of Liberia and Rio Nunez has a high reputation.

Although attention was prominently drawn by me to the excellence of the Liberian coffee and its prolificness in the first edition of this work nearly a quarter of a century ago, it is only within the last few years that planters and commercial men have begun to duly appreciate its value and importance.

Coffee is also grown in the Cape Verde islands, Mozambique, Madagascar, Angola, the Gold Coast, Gabon, Ambriz, and Madeira. About the villages and settlements of the Sherbro river and Sierra Leone wild coffee trees are very abundant.

There are many varieties of West African coffee from the large and symmetrical pale berries of St. Thomas to the little dark Bembé coffees.

Bourbon or Reunion.—This island was taken possession of by the French in 1649. In 1715 wild coffee trees were found growing in the woods, and in 1718 Mocha coffee trees were introduced.

The former reputation of Bourbon coffee was European, and the island long owed its prosperity to coffee culture, but the hurricanes, decay of the trees used for shade, and the preference given by the planters of late years to sugar cultivation, has caused a great decline in the production of coffee. In 1817 the crop exceeded 7,250,000 lbs., but in 1860 only 530,000 lbs. were shipped, in 1865 less than 470,000 lbs., and in 1875, 467,500 lbs., although in the previous year, 1874, it was 719,400 lbs. The land under cultivation with coffee is only 5200 acres against 121,000 acres under cane, and there are 347 coffee works or buildings. There are five species or varieties of the coffee shrub, known on the island, viz.:

1. Mocha, passing as Bourbon (*Coffea Arabica*), the first introduced into the island and superior to all other kinds, easy to grow, but requiring shade trees for shelter.

2. Leroy coffee (*Coffea laurina*), the Sierra Leone species, a hardy kind, growing readily without shade, and having a seed pointed at one end.

3. Myrtle coffee, a Mocha variety, especially remarkable for the longevity of the tree.

4. Aden coffee (*Coffea microcarpa*), with small regular berries, and a particular aroma, brought from Yemen by Admiral Jehuine; it is the same as the Foucard coffee of Guadaloupe; very little of this variety is, however, grown in the island.

5. Bitter or wild coffee (*Coffea Mauritiana*), an indigenous species, common in the elevated forests of the island, with a pointed seed of a strange form, having a strong and bitter flavour, which intoxicates in infusion, but mixed with other kinds is agreeable.

Liberia.—Coffee is found in a dwarfish state growing wild in all parts of the republic of Liberia, on the west coast of Africa, and is believed to be a distinct species, which has lately been named *Coffea Liberica*, but used to pass as *C. microcarpa*. Some suppose it to be indigenous, others that it was introduced by the Portuguese a few centuries ago. The coffee now being cultivated in Liberia is from plants originally procured from the forest, but greatly improved by cultivation. It is grown both on light alluvial soil near the coast, and on gravelly soils in the interior. From present indications in a few years the export of coffee from Liberia will be considerable, and its rich and superior flavour will secure for it a corresponding demand at remunerative prices. Coffee it has been proved can be cultivated with great ease, and to any extent, in this republic, from being indigenous to the soil and the tree being found there in abundance. A single tree at Monrovia, it is said, has yielded the enormous quantity of 16 lbs. at one gathering. It was estimated some years since that there were about 30,000 coffee trees in one of the counties, that of Grand Bassa, and the quality of the produce was stated to be equal to the best Java. About the villages and settlements of the Sherbro river and Sierra Leone wild coffee trees are very abundant. A good many plants of Liberian coffee have been sent lately from Kew to Jamaica, Southern India, and Ceylon.

This species is now considered to be of the highest commercial importance, being far more prolific than the old *Coffea Arabica*, of much better flavour, and producing berries double the size of that species. Added to these advantages is another, which will commend it to all planters—its being more robust, less subject to disease, and hence can be cultivated where the ordinary coffee will not succeed.

Those who know the plant best assert that it can be cultivated where the ordinary coffee will not succeed. If it has the hardy constitution that is claimed for it, coffee planters will soon be able to pursue their calling at elevations above the fever line. If this species of coffee tree answers all the expectations formed of it, we may expect something akin to a revolution on the estates, not only of Southern India, but of Ceylon also. The Dutch, who have always been most zealous and energetic in introducing and promoting the culture of new plants, are about to send out plants of the Liberian tree to their plantations in Java, and other parts of the Eastern Archipelago.

Coffee is found growing in a wild state in the province of Bambaye, the most eastern part of Fonta Djallon, between the Rio Nunez and the Rio Pongo. The island of Goree is the *entrepôt* for this coffee.

When British settlements and colonies are formed in Eastern Africa, the best coffee harvests there will be in what may be called the coffee belts from 5° to 15° north and south latitude. This would be in the south, that country which was so graphically described in Dr. Livingstone's letters sent home by Stanley, the base ports being Zanzibar and Mozambique; and in the north, the old coffee-growing country of Abyssinia, and the equatorial Nile basin out of Egyptian territory. Both Dr. Livingstone and Sir Samuel Baker describe these countries as those of a terrestrial paradise, the latter speaking of boundless tracts, situated at a mean altitude of 3000 to 4000 feet above the sea-level, with a fertile soil, healthy climate, regular rainy season, and a docile population, eminently adapted for coffee cultivation.

Cultivation in Natal.—Looking at the number of localities on the African continent where coffee is indigenous, there is no reason why, under proper cultivation and judicious management, coffee should not succeed well at Natal. It has been grown there on a small scale, but from want of proper attention and management, and neglect of weeding, or from exhaustion of the soil, the trees have been attacked with fungi, and the crop has latterly failed. In 1870, 2700 cwts. were shipped, in 1874 only 680 cwts.

The samples of Natal coffee, however, shown at the various International Exhibitions at London, Dublin, and Paris, were of good quality, and in view of the demand for coffee outstripping the supply, the more widely the culture can be extended, especially in our own colonies, the better.

The following directions for Natal are from an old and experienced coffee planter :

In eighteen months after being transplanted from the nursery into the field, the coffee trees should begin to bear fruit, and will go on, gradually increasing in quantity, until the seventh or eighth year, when they may be considered to have arrived at their full bearing, although this is not always the case, many trees increasing until their twelfth year.

When the young plants are about to be removed from the nursery to the field, it is by many planters considered beneficial to trim their roots, and cut off the tap-root; and I have myself frequently followed this practice, although I am now inclined to think that the benefits supposed to result are very much to be doubted.

It is very certain that, under any circumstances, great caution should be exercised, and every attention paid to the time of year, quality of soil, and particular season prevailing.

When the young trees have attained a certain height—generally from four to five feet—the West Indian custom is to "top" them, for the purpose of stopping their upward growth, and to cause the trees to expand, by throwing out lateral branches.

This plan is admirably adapted to the peculiarities of certain elevated localities, such as the higher ranges of the Blue Mountains in Jamaica; but I am fully convinced that, under different circumstances, and in lower regions, the practice would be anything but beneficial or proper. Careful observation and considerable judgment are required, even by practical and experienced men, to determine the extent to which this process may be carried; and I am sure that much injury, and consequent loss, is occasioned by an indiscriminate adherence to this custom.

The variation in the practice may be appropriately evidenced in the two systems which I should recommend for adoption in Natal, viz. the Berea and coast lands generally, and the higher lands ranging from Field's Hill upwards. In the former I should not think of topping, or cutting back, my coffee trees, until they had attained a height of from six to eight feet, when they would speedily become large and spreading trees, capable, under judicious management, of bearing a very considerable quantity of really good coffee. In the latter (viz. the higher lands) I should almost invariably keep the trees at about five feet high and no taller.

The difference in produce I should calculate somewhat as follows: Average of full-bearing trees, in the Berea and coast lands, say 20 lbs. per tree, of good mixed quality coffee; and in the higher lands, say 10 lbs. per tree, of superior quality coffee, both cured and ready for market.

I feel assured that time and carefully conducted experiments will serve to verify these opinions; but I am no less certain that, until local experience has proved me to be correct, there will be many persons who will totally disagree with my views on this point.

Twenty acres of land, cultivated in the manner I suggest, would in a short time form a very valuable little property; and when the trees come into full bearing, a large income might be derived from it, as it should then yield 140,000 lbs. of cured coffee, worth 6*d.* per lb.—3500*l.* per annum. This is a large sum, and the system is one so entirely different to that pursued in the West Indies, Ceylon, and other coffee-producing countries, that the most contemptuous incredulity will, I am sure, be exhibited by many experienced and highly esteemed planters, when they first read the principles I am now endeavouring to inculcate. Let anyone, or everyone, however, doubt my assertions to any extent he or they may please; but let the system be fairly tried and I shall have no fear of the result.

To obtain the large returns from each tree, as above estimated, the following rules should be carefully attended to in every particular:

1. Choose a good and fertile soil, containing a tolerable quantity of decayed vegetable matter, and having a generous subsoil, which is naturally well drained. Moreover, be careful that this patch of land enjoys the advantage of the morning's sun.

2. Pick out strong and vigorous young coffee plants, which take up, if possible, without breaking their roots, and with the earth around them; but if this cannot be done, then put the young plants into water, immediately they are taken up from the nursery, and keep their roots immersed until they are planted out in the field. Allow 700 plants to the acre.

3. Let the ground be in a tolerably moist condition, and see that the weather is moderately rainy.

4. Prepare holes (varying from 12 to 24 inches in diameter) with well-rotted vegetable manure, and finely pulverized earth, into which place the young plants carefully, and fill up the holes, so as to leave no hollows wherein water may lodge.

5. Be sure that these young plants are fully shaded, yet enjoy light and fresh air in abundance. As a shade, plantain, banana, or cocoa-nut trees answer admirably, and at the same time their produce is very profitable.

6. During the early stages of their growth the young trees should never be choked by weeds, but should be well attended to, and (whenever appearing) any dead wood must be removed by hand.

7. All suckers and undesirable shoots ought to be destroyed immediately they appear; and when the trees have arrived at a sufficient height their tops should be pinched off to stay their further growth upward.

8. Each tree must at all stages of its growth be kept open, so as to ensure plenty of air and light penetrating throughout every part of it, and consequently no matting of the branches can be permitted, nor the growth of moss on the trunk, or on any of the branches.

9. The trees should be carefully pruned whenever they require it, so as to keep them open, and to preserve that portion of the wood only which will bear fruit abundantly, and of good quality.

10. Dig in manure around the roots of the tree, not close to the trunk, but in a circle as wide as the branches extend, that the roots, as they grow, may find a store of nutriment. The rule must be—manure well, but always dig that manure in about the roots of the plant.

11. The choice of manure must become a study, in order to give those kinds only which will exercise a particular effect on the tree. Highly stimulating manure is sure to occasion the growth of a quantity of useless young wood and numerous cross suckers, which are often denominated gormandizers, and these are both very injurious to the tree. Only that kind of manure is desirable which will supply the requisite material for the formation of vigorous and healthy young

wood, that will produce an abundant crop of sound berries. All portions of the plant itself and its fruit form a manure which cannot be equalled; but as these are rarely to be had in sufficient abundance, green grass, weeds, and other vegetable matter, dug in around the roots, act very beneficially on the plant. Cattle-pen and stable manure may be used with discretion; but bone manure (such as burnt and ground bones, either alone or decomposed by the action of sulphuric acid) constitutes one of the choicest manures that can be applied to the coffee tree.

12. Irrigate in the dry season wherever it can be done, and the increased value of the crop will prove its great utility. It very frequently happens that a long spell of dry weather follows the general blossoming of the trees; and they are so parched from lack of moisture in the soil, that the young fruit is destroyed in setting, and the ground is found to be thickly strewed with the young sets when no larger than very small peas. In this manner the hopes of a whole crop may be entirely dissipated.

Production in the West India Islands.—The rapid decline in coffee production—I may almost say its abandonment—in the British West Indies, since negro emancipation, is remarkable. In 1828 we received from our West India colonies and Demerara 30,000,000 lbs. of coffee; in 1831, 20,000,000 lbs.; in 1841, less than 10,000,000 lbs.; and now under 7,000,000 lbs. reach us.

Coffee was first cultivated by the Dutch, in Surinam, early in the eighteenth century. It was next grown by the French in Martinique, and thence spread to the neighbouring islands, and to Jamaica. The Dutch jealously guarded their early efforts in this direction, and were not anxious to aid other nations in competing with them. There is a little fragrance of romance connected with the first French effort of this kind which was made in Martinique. Louis XIV. who, in spite of all his foibles and vices, was fully able to appreciate the importance of such apparently small matters as a potato tuber or a coffee bean, had in his private gardens a coffee shrub five feet high, which, before his death (1715), bore ripe fruit. Having heard of Dutch coffee plantations in Berbice and Surinam, his ambition was aroused, and he desired to have similar ones in his French West Indian colonies. He entrusted, therefore, a slip from his pet tree to a naval officer, Declieux, with orders to carry it safely to Martinique. Unfortunately the ship in which he served had an unusually long voyage—fierce storms alternating with provoking calms, and at last the water casks were empty. The captain, however, sacrificed his own wants for the sake of the young plant, and shared with it his scanty ration of water. But his troubles were not at an end when he at last reached the island; storms and tempests, men and beasts, seem to have united to threaten the tender shoot, and Declieux had to place a guard over the plant, who, under his supervision, watched it day and night. Fortunately it grew and throve till it became a fine large tree, the ancestor of most of the coffee plantations in the West India islands. It may be safely said that never was tree more carefully tended or more usefully employed.

Although by the extent of its present production scarcely meriting priority of notice, I will give Martinique precedence in my retrospective survey.

Martinique.—The annual produce of an hectare of land ($2\frac{1}{2}$ acres) under coffee in Martinique is from 500 to 1000 lbs. Owing to the attacks of the coffee insect (*Elachysta Coffeola*) impoverishment of the soil, hurricanes, atmospheric influences, and other causes, the production of coffee is declining here. In 1873 there were about 1270 acres under coffee, and new plantations have since been established. There is a large island consumption, and hence the quantity shipped is but trifling. The following shows the crops of late years in kilogrammes of a little over 2 lbs.:

	Kilos.		Kilos.
1868	254,553	1870	169,480
1869	145,575	1873	210,000

The shipments to France direct from Martinique vary considerably and are but small in any year.

Another French colony, *Guadaloupe*, was much indebted for its ancient prosperity to coffee; in 1790 it exported about 7,500,000 lbs., in 1856, 6,943,239 lbs. Of late years the war, hurricanes, and the attacks of the coffee insect, contributed greatly to diminish the production. The shipments in 1861 were 655,290 lbs., and in 1874, 625,200 lbs. Nearly all produced here is sold in France as Martinique coffee. There were in 1873 3588 hectares under cultivation with coffee, the average produce being about 1000 lbs. per hectare.

Jamaica is admirably suited for coffee culture from its elevated mountain ranges, and the island used to produce large crops of a very fine quality. The culture was introduced in 1728; in 1752, 60,000 lbs. were exported, and the average annual shipment in the three years ending 1807 was 28,500,000 lbs. In 1844 there were 671 coffee plantations in the island, and it was estimated that 20,000,000*l.* was invested in coffee estates. But the culture was almost entirely abandoned, the coffee planters of the East having long quite outstripped those of the West Indies by the advantages of capital, labour, and suitable land, with facilities for shipment. Jamaica, among the British islands, is now paying increased attention to the growth of coffee, though the distance from ports of shipment is often greater than it is in the smaller islands.

There were 20,131 acres under coffee cultivation in Jamaica in 1874. The principal parishes in which coffee is grown are St. Andrew's, St. Catherine's, Manchester, Clarendon, and St. Ann's.

The following have been the exports for a series of years:

	Lbs.		Lbs.
1859	5,055,089	1867	6,264,861
1860	6,176,589	1868	7,855,488
1861	6,715,581	1869	5,501,887
1862	5,467,302	1870	9,671,564
1863	8,184,869	1871	5,611,245
1864	4,141,903	1872	9,510,739
1865	6,229,712	1873	7,199,144
1866	8,513,532	1874	10,351,570

Hayti, which owed its former prosperity to coffee, has not yet again attained to the quantity it used to produce when a French colony. In 1789 the coffee crop there was 80,000,000 lbs. The trees were almost entirely destroyed in subsequent years. In 1826 the production had, however, recovered to 32,000,000 lbs.; in 1860 it had advanced to 50,000,000 lbs., and in 1863 to 68,140,752 lbs.; but there appears to be now a retrogression, for the shipments in the year ending September, 1874, were only 54,513,000 lbs.

Cuba was at one time a large coffee-producing island, for in 1847 there were 2064 plantations under culture with this crop. From 1830 to 1840, the annual production was about 2,000,000 arrobas of 25 lbs. From the year 1841 to 1846, the average yearly production was 45,236,100 lbs. In 1851, owing to the fall in price of coffee, and the more remunerative character of sugar and tobacco production, the crop had declined to 13,000,000 lbs.; in 1864 the export of coffee fell far below this, and now Cuba imports large supplies of coffee from Porto Rico.

In *Porto Rico* the coffee crop now averages about 230,000 cwts. In 1839 the shipments were only 85,384 cwts.; in 1861, 129,000 cwts.; and in 1873, 270,895 cwts.

The cultivation of coffee has increased of late years, and might be much extended on land now almost unproductive, on the hills and valleys of the table-lands. The coffee of Porto Rico is of excellent quality; though not well known in the English markets, it is much appreciated in Spain and Italy, and even now exported to the value of 900,000*l.* A considerable quantity is grown in the province of Ponce, but it is also raised in the provinces of Mayaguez, Arecibo, and Aguadilla.

St. Lucia, Dominica, and St. Vincent should be great coffee producers on their mountain slopes, and Nevis and St. Kitts on a lesser scale. St. Lucia used to have 500 acres under culture with coffee, and in 1840 exported 324,000 lbs. In 1829 Grenada shipped 64,654 lbs. In 1796 there were 130 coffee plantations in Trinidad, and the produce there, in 1803, was 358,660 lbs. The export from Trinidad has averaged 24,000 lbs. in each of the four years ending 1875, but it is not likely to attain to the former proportions grown, even with the increased care and attention given to the culture, for the South American competition is too strong.

At the close of the last century Dominica produced more than 2,000,000 lbs. of coffee annually; even in 1833 the shipments were 1,612,528 lbs., and in 1835 over 1,000,000 lbs., but the general effect of the negro emancipation was the entire abandonment of coffee cultivation by the owners under whose care and energy they had hitherto been such brilliant mines of wealth. The estates were appropriated, subdivided, and allotted among the peasantry, who took up the production of sugar, cacao, cassava, and other cultures.

Production in America.—Having passed under review the several West Indian islands, I come now to speak of Central and Southern America, which are extensive and increasing fields of coffee production. The direct imports into the United Kingdom from the States there in the last four years have been as follows, in cwts.:

Year.	Central America.	New Granada.	Venezuela.	Brazil.
1872	133,290	27,063	..	159,194
1873	197,720	16,866	10,685	143,749
1874	151,538	21,724	7,863	200,125
1875	210,979	14,646	2,162	222,375

From *British Honduras* we have received in the past four years increasing supplies of coffee, but whether this is all grown there, or partly Guatemala produce shipped from thence, I am unable to state, as I have no information about coffee culture in that colony. The direct imports from Honduras have been:

	Cwts.		Cwts.
1872	2,635	1874	3,975
1873	1,626	1875	4,777

Costa Rica.—This republic has risen by the culture of coffee to a degree of prosperity unknown by the other Central American States. The introduction of the plant in the vast plain of San Jose, which it now covers, only dates back some thirty years. The principal plantations belong to the families of ~~Monteleagre~~ and Moira. Monte alegre

About 1845, the distinguished Señor Mora, then President of the Republic of Costa Rica, prohibited the raising of plantains for sanitary and other reasons, and caused a governmental decree to be passed encouraging the culture of coffee. "With lingering steps and slow" the hill-sides about Cartage and San Jose were cleared and planted with coffee slips, and to-day a thousand coffee planters are enjoying a competency from the net income of the estates thus compulsorily established. The export of coffee for this year (1876) at Punta Arenas, on the Pacific, I am assured, will fall little short of 18,000,000 lbs.

The coffee plant is a native of this continent, and an impression which some have that it is inferior to the eastern, as, for example, the Java and far-famed Mocha, is erroneous. On the contrary, the coffee raised on the highlands of Nicaragua and Costa Rica is unsurpassed for strength and a delicate aromatic flavour, unknown to the best coffee of the East; and the fruit of the lowlands and medium elevations is far from inferior. I have seen specimens of coffee from the haciendas of Padre Vejil and Don Pampilio Lacayo, grown upon the plains in the neighbourhood of Granada. Although not having the plump form or peculiar bluish tinge which are the characteristics of the excellent coffee of the highlands, it compares favourably with the coffee of Java or the Moluccas. The cultivation of coffee will undoubtedly here engage the attention of many of the first colonists. It is worth noting that in opposite quarters of the globe, Costa Rica and South India lie in the same position of north latitude, and that their respective growths approach one another in fine quality. This line also cuts directly through the Abyssinian coffee districts which of old supplied Persia.

The quality of Costa Rica coffee is considered excellent, and it is principally shipped to Great Britain; the following figures show the exports at decennial periods:

	Cwts.		Cwts.
1845	70,000	1865	99,720
1855	70,709	1875	210,000

The coffee crop of 1874, compared with that of the previous year, was small, the quantity shipped amounting to about 200,000 cwts., or a decrease of 2400 tons on the previous year's export: it was, however, slightly above the average export for the previous five years. Coffee is and must be the principal and almost only staple product of Costa Rica, until a railroad enables it to compete with other countries in sugar, cocoa, &c. The scarcity of labour is one great drawback, for in many parts crops spoil on the trees for want of hands to gather them.

Guatemala.—Some thirty years ago considerable plantations of coffee were made in different parts of this State, but the culture was abandoned owing to the disturbances among the Indians; of late years, however, it has been resumed, and is making good progress. The greater part of the plantations are situated in the neighbourhood of Coban. Coffee will be in future the principal article of export, and to an extent and importance scarcely yet to be calculated. In 1860 only 63 tons were shipped; in 1863 this had increased to 799 tons; in 1867, to 2000 tons.

In *Nicaragua* coffee is grown in the Valle Menier, the plantation of the great Parisian chocolate firm; but very little is as yet exported from this State, some 400 or 500 lbs. only being shipped from Greytown.

In the state of *San Salvador* a fair quality of coffee is grown; the exports in 1865 were to the value of 21,500*l.*, and that of the coffee shipped from San Salvador in 1873 was about 215,000*l.*

In the state of *Colombia*, formerly New Granada, the coffee grown is of excellent quality, especially at Ocama and Ambalima, but the quantity produced is limited, and is chiefly sold for consumption in the country. Our direct imports into Great Britain from New Granada have averaged 20,000 cwts. in the four years ending 1875.

In *Ecuador* attention has of late years been given to the culture, and a very superior quality of coffee is produced. In 1855 only 776 cwts. were shipped, but now eight times this quantity is exported. The crop of coffee in 1874 was 10,652 cwts. The shipments *viâ* Guayaquil were in:

	Cwts.		Cwts.
1861	1,480	1871	4,082
1865	1,810	1873	6,652

Only a little over 1,000,000 lbs. were shipped in 1874.

British Guiana.—In 1752 the cultivation of coffee was commenced in Demerara, and one bag was exported; in 1761, 45 tierces of coffee were shipped, and in 1764, 211 bags. The following were the exports in some later years: 1773, 1001 tierces; 1775, 2317 tierces. In 1796 the colony was taken possession of by the British, and in 1803, 9,954,610 lbs. of coffee were shipped; in 1823, the exports of coffee were 8,008,729 lbs. After this the culture began to fall off; comparing 1829 with 1839, there was a deficiency in the latter year of 2,139,430 lbs. of coffee. The gradual decline in production is shown by the following figures giving the exports:

	Lbs.
1830	9,472,756
1840	3,357,300
1849	100,550

In *French Guiana* coffee was at one time an important staple, the species grown being the Mocha variety, for the cultivation of which the country is especially adapted; it is now chiefly grown as a shade tree to cocoa, annatto, and other crops, but a few Government plantations are maintained. The average production, as shown below, is scarcely 100,000 lbs. a year; the shipments in 1874 were only 2028 lbs., and in 1875 but 752 lbs. This valuable product, the British consul at Cayenne tells us, is not, however, quite lost; although temporarily abandoned, the trees continue to thrive in a wild state, and may be reclaimed hereafter. They attain a height of about fifteen or sixteen feet, with a circumference a few feet from the ground of thirty inches; they are rich in foliage, but do not flower; the coffee tree here also appears to be safe from the ravages of insects, whereas many other trees suffer vitally from this evil.

	Kilogs.		Kilogs.
1861	50,000	1869	135,614
1865	64,436	1870	60,079
1866	73,27	1871	57,433
1867	107,424	1873	40,250
1868	60,463	1874	40,028

In *Surinam* the produce is only about 500,000 lbs.

In *Bolivia* coffee is grown in the whole extent of the Yungas, and of forms and varieties not generally known; it is best when raised on the flanks of the mountains. In the plains the berry increases in size, but loses flavour; when grown on higher elevations it decreases in size, but improves in quality. The Yungas coffee is so highly esteemed that it is considered equal, if not superior, to Mocha.

Peru.—Coffee grows with extraordinary luxuriance in the mountain regions of Peru; the activity of its vegetation is wonderful, the branches are borne down indeed with the weight of the numerous berries.

Venezuela.—The best coffee grows in the cooler portion of the State, and the crop is gathered in October. The production is about 600,000 cwts. annually.

With respect to what may be considered as the yearly yield of coffee per tree in Venezuela, as compared with Brazil and Ceylon, its principal rivals in the staple, up to 1858, it was generally considered that the average might be put down at half a pound per tree; but since that period such has been the neglect of the plantations throughout the country, owing in the first place to the uninterrupted five years' war of the Federation up to the close of the crop of 1853, and to the subsequent state of anarchy and confusion prevailing, the scarcity of capital and labour, and the want of personal supervision upon the part of landed proprietors, that the yield may be said to have diminished by one-half, and thus the general average does not exceed a quarter of a pound per tree. It may be remarked, also, that the coffee plant, though prolific, is most delicate and susceptible, requiring constant attention and careful cultivation, such as circumstances do not admit of its having bestowed on it in this country.

An intelligent American gentleman, many years resident in Brazil, and well acquainted with coffee cultivation in the province of Rio Janeiro, who visited Caracas in 1869, informed the coffee growers that the general average annual yield of coffee for the past twenty years in Brazil had been 4 lbs. per tree, and upon the most carefully cultivated plantations as high as 30 lbs. per tree, whilst upon smaller estates of 200 to 300 acres, with 500 trees per acre, a regular yield of 10 lbs. was obtained. The coffee trees in Brazil are not shaded as they are in Venezuela, which ensures a larger yield, although lessening the duration of producing power, generally estimated at about fifteen years. Improved and more scientific culture would certainly give 2 lbs. per tree as the average in Venezuela, many isolated instances existing of that amount, and even of over 4 lbs. per tree having been obtained.

Production in Brazil.—Coffee having been introduced into the French settlement of Cayenne, by La Motte Aigron, the governor, in 1722, a Brazilian subject, Palhetta, while on a voyage to that colony, managed, not without much difficulty, to bring to the city of Belem (Para) a few of the seeds of this valuable plant; in that province coffee trees were multiplied through the care of Agostinho Domingos, and others. A deserter, it is said, introduced the plant from Para into Maranham about 1770. The judge, Joas Gualberto Castello Banco, appointed chancellor to the high court of the Relacas at Rio Janeiro, took with him with great care two small coffee trees during the vice-royalty of the Marquis de Lavradio, in the middle of the eighteenth century, when sugar and cereals constituted the great fountains of the wealth of the province of Rio Janeiro. The two plants were by order of that notable statesman cultivated in a private garden in the neighbourhood of the convent of Adjuda, and in this manner those two small and humble trees in the course of one century become the first and most important branch of the public wealth.

Mr. Moke, a Belgian, is said to have been the first planter to carry on the systematic cultivation of coffee near the city of Rio, and enormous profits have resulted from the energetic efforts thus made.

The coffee tree having rapidly multiplied, extended itself then over dozens of miles, and was transplanted to Minas Geraes, San Paulo, Bahia, Ceara, &c.

Coffee is now the most important agricultural product of Brazil, and forms the principal staple of its foreign commerce. It constitutes nearly half of all the supply of coffee to the world. The culture extends from the Amazon to the province of San Paulo, and from the coast to the western limits of the empire, a surface exceeding 653,400 square kilomètres (of nearly 5 furlongs each). There are about 530,000,000 coffee trees, which cover an area of 1,400,000 acres. The principal producing provinces are Rio Janeiro, San Paulo, Bahia, Ceara, and Minas Geraes. The shipping ports are Rio, Santos, Bahia, and Ceara, the port of Rio exporting about ten-twelfths of all that is shipped.

The culture in the province of Ceara is rather of recent date, but it is now carried on on a large scale in the mountains of Maranguape, Aratana, Batunte, Araripe, Machada, and Uraburotama. The plantations having been attacked by insects, the production diminished after 1863, but has again recovered.

The productive power of the empire has almost doubled in the last ten years. In 1864, 264,000,000 lbs. of coffee were shipped, and in 1873, 462,000,000 lbs.; the value of the coffee shipped in 1871 was nearly 8,500,000*l.*; the local consumption is calculated to be one-fifth of the total product.

The production in Brazil in 1820 was only about 14,000,000 lbs.; in 1822, 150,000 bags were shipped, but the scarcity of coffee at that period, and the falling off of production in Cuba, stimulated the Brazilian planters so greatly that in 1830 the export from Rio alone had increased to over 64,000,000 lbs.; in 1847 to 299,640,000 lbs., in 1860 to 341,000,000 lbs., representing 2,126,719 bags, weighing about 160 lbs. each, and in 1872 to 3,349,284 bags.

Of the varieties of the coffee tree, no less than sixteen species are indigenous to Brazil, an evidence of the suitability of the soil and climate for the culture, while Peru, Guiana, Mexico, New Granada, and other parts of the continent, have also indigenous species of the tree.

The coffee plant grows in most parts of Brazil, as the medium temperature which it requires is found throughout nearly all the empire. It prospers even in places exposed to the cold, and appears to vegetate with more vigour, but the fruit is not so abundant, nor has it the precocity and regularity necessary to render the crop profitable. As the flowering and fructification take place at two periods, the end of September and October, two gatherings are necessary.

Attempts have been made, but without any resulting benefit, to acclimatise some of the esteemed varieties from other countries. The Government introduced Bourbon plants in 1857, and Java, Mocha, and other species tried have soon degenerated and assimilated to the ordinary Brazilian. The same occurred in Martinique when the Mocha coffee was introduced in 1818, for in a few years the berry was found not to differ from that ordinarily cultivated in the island.

When a plantation has to be made, the sunny slope of a hill is selected, the site of which is not too retentive of the water falling on it. This, after being cleared and burnt off in the usual manner of treating timber lands, is planted over in rows, with year-old plants, previously reared in a nursery. These receive little further care than to keep the weeds down, and to have the upward growth checked by pruning, so as to facilitate the gathering of the crop. In four or five years the trees are productive, and will in general continue so for upwards of twenty years. Its thick clusters of white flowers burst forth in abundance at certain seasons, but the dark green foliage is rarely seen unrelieved by them and by the fruit in all stages of maturity.

The pulp of the cherry that surrounds the bean is sweet and agreeable to the taste, and, like the leaves, partakes of the flavour of the berry.

From its strong flavour Brazilian coffee is improved by age, perhaps to a greater degree than any other coffee, and it is said, if kept for ten or twelve years, would fully equal the best Mocha.

As the flowering and fruiting take place at two periods of the year there are, of necessity, two harvests. It is essentially necessary that, during the drying, the berry does not come in contact with the earth, which would much injure its quality, hence in large plantations paved terraces are formed, or of some other materials. On smaller estates the coffee is dried on bamboo frames or some other substitute. As the paved or stuccoed drying terraces are expensive, it is better, when possible, to employ pulping machines, although these require a fall of water to work them. When the coffee is dry it has to be deprived of its pulp and parchment. The machines employed for this purpose have not much effect on the produce. It is simply a question of time and trouble, more economical than industrial. In fact, nothing can be imagined more simple and primitive than the appliances used in some of the countries which furnish the coffee most esteemed in the European markets.

The berries of the ovoid form of the Mocha found in the markets are derived from the older Brazilian coffee trees, and from the higher branches of the young trees which are more exposed to the solar rays; these are separated by bolters. In Brazil coffee trees are reckoned to yield, from their fifth to their twentieth year, an average of an arroba, or 32 lbs. of clean coffee to each ten trees. From six to twelve years the produce is commonly two and sometimes three arrobas to ten trees, but from the sixteenth to the twentieth year the crops are irregular, and below this average. The common yield of clean coffee is about one arroba to three alqueires or bushels of the fresh fruit. An arroba of clean coffee is obtained from one and a third arroba of dry coffee in the hull, deprived of its pulp, but not of the parchment-like envelope. Whilst the cost of clearing, planting, and bringing into bearing an estate of 150 acres, with only 333 trees to the acre, is far more than that of a similar plantation in Ceylon, the returns are much larger per tree, averaging nearly 10 cwts. to the acre, and the trees bear much longer.

A recent traveller, publishing an account in Belgium of his impressions during a tour through Brazil, thus speaks of coffee cultivation: "A hectare (2 acres) of land will contain 913 trees, which on inferior land will produce 674 kilogrammes ($2\frac{1}{5}$ lbs.) of coffee; in soils of the second class, 1384 kilos., and in those of a superior kind 2022 kilos. An active labourer, working steadily, can keep in order two hectares of coffee trees; the annual result from this would be, 1145f. 80 in the first case; 2352f. 80 in the second; and 3437f. 40 in the third, reckoning the produce at the low price of 85 cents the half kilo. or pound. In a medium hazienda, or plantation, the average return of coffee is about 1074f. per labourer, women, children, and old men included."

The quality has been so much improved in the last ten years that much of the coffee is sent to Europe and sold under the names of Java, Ceylon, Martinique, San Domingo, and even Mocha. At the Paris Intercolonial Exhibition of 1867, Brazilian coffee received from the jurors a gold medal over all other coffees.

Between 1816 and 1820 the planters of Rio abandoned the culture of the sugar-cane, and turned their attention to coffee, the cultivation of which thereafter became the basis of such immense progress, and the accumulation of wealth in the capital of the empire. Although the province of Rio is still the chief producing district, it may be interesting to mark the progress of production in the other provinces, which is fairly indicated by the shipments from the several ports; thus, from Bahia, the exports to foreign markets have increased as follows:

	Arrobas of 32 lbs.		Arrobas of 32 lbs.
1810	3,893	1865	330,063
1830	45,882	1870	12,853,117
1840	52,365	1874	8,483,124
1860	198,604		

The greater part of the Caravillas coffee from this province is sent to Rio Janeiro in consequence of the easy transit during the summer months, when the prevailing winds from the north-east enable the planters to get quick returns for their produce from that important coffee mart.

Passing now to Santos I may state that the exports were in the years—

	Cwts.
1869	487,893
1870	400,464
1871	460,695

Campinas is the coffee capital of this province, and the quantity carried over the San Paulo line was in 1870, 29,720 tons, and in 1871, 41,107 tons.

The culture of coffee is comparatively recent in the province of Ceara, but it is being carried out on a large scale in the mountains of Maranguape, Aratana, Baturite, Araripe, Machado, and Uraburotama. Although the plantations were attacked by the insect, and the production diminished after 1863, it still forms the second article of export of the province. In 1866, 103,330 arrobas were shipped from there, and in 1874, 94,800 arrobas. Agricultural production is, however, just now stationary in Brazil, and likely to recede, owing to the want of labour. Coffee and the cane represent 10,000,000*l.* sterling, out of a total of 17,000,000*l.* The abolition of duty on coffee in the United States, and its reduction from 3*d.* to 1½*d.* a pound in England, came as a timely relief to the Brazilian planter, and with the increased prices for it will enable him for some time longer not absolutely to break down.

The quarters to which Brazilian coffee is shipped may be divided into three classes—1, the United States; 2, Northern European and Channel ports; and 3, Mediterranean ports. The relative proportions to each are shown by the exports of 1871, in bags:

United States	1,354,346
North Europe	689,917
Mediterranean	198,498
Different ports	115,243
	2,358,004

As the United States monopolise the chief supply of Brazilian coffee, it may be interesting to note their aggregate imports of all kinds, which have been as follows:

	Lbs.		Lbs.
1790	4,150,754	1840	94,996,095
1800	7,408,196	1850	144,986,895
1810	5,352,082	1870	282,540,737
1820	13,291,857	1874	295,271,697
1830	51,488,248		

The American consumption of Brazil coffee alone during 1874 was 103,751 tons, or an average of 8646 tons a month. This is the largest consumption of Brazil coffee in the United States ever known, except that of 1870, when 108,502 tons were consumed. The consumption there is about one-fourth of the entire world, and more than any one country on the globe.

In the *Pacific Islands* some attention has been given to coffee culture. Large plantations of coffee trees were made at Tahiti in 1862, with the view of supplying Chili, California, and Sydney. The amount of production there is only about ten tons. In 1868, 78,373 lbs. of coffee were shipped from the Hawaiian Islands.

Java.—The Rev. R. Abbay thus described in the Ceylon papers in the close of 1874 the system of coffee culture in Java:

"The parasites that injure the trees are mostly similar to those in Ceylon, the chief one being a species of *Loranthus.* As to the private coffee estates, there are only slightly over one hundred of all kinds in the whole of Java, less in acreage than one-twentieth of the extent of Government garden; some of them are on low ranges of hills or plateaux, elevated only a few hundred feet above the sea. The systems of cultivation, as well as the size and character of the trees on these estates, vary considerably. On the Merapi, a still active volcano (pardon the Irishism), the trees are topped at four or five feet, and a system of pruning and cultivation is attempted similar to that in Ceylon, but as yet has not been a decided success. Whether the soil is naturally poorer here than elsewhere, or the method adopted is unsuited to the tree or the climate, I am not able to give an opinion, but I am informed, on good authority, that the old plan of leaving the trees to themselves leads to better crops than the new one. My own impression of the cause of the relative smallness of the produce of Java plantations, compared with those of Ceylon before the *Hemileia* *vastatrix* made its appearance (for there is not a shadow of that fungoid disease in Java at the present time), is that the climate, except in reasonably dry years, is far too forcing. The trees appear to produce a great luxuriance of leaf and wood, but only a moderate proportion of fruit, 4 cwts. per acre being considered a very good average crop; but 10 cwts. are sometimes obtained in exceptionally favourable years. No such thing as an average of 8 or 10 cwts. per acre is known; and yet this was not uncommon, I believe, in Ceylon, as long as the trees remained healthy. The lower estates come into bearing much sooner, and produce more than the higher, but they do not last so long, ten or fifteen years being the limit of profitable life for trees at 1000 feet above sea-level; whilst those at 3000 and 4000 feet attain to forty, fifty, or even more, years of age. At Makmedon, some 20 miles south-east of Buitenzorg, and at an elevation of between 2000 and 3000 feet, there are trees still alive, but neglected and bearing no crop, which were planted in 1786. They are now some 40 feet high, with trunks of the thickness of a man's thigh. What care, instead of persistent neglect, might have done for them, it is impossible to say; but I see no reason to think that a centenarian coffee tree must of necessity be an unprofitable one, at least in Java. On the higher estates at present under cultivation, many of the trees reach a height of 30 or 40 feet, and the crop is picked by means of ladders. These trees are planted 25 feet by 25 feet, on terraces 25 feet wide (a row of trees for each terrace), grass being planted at the edge to prevent the friable soil being washed down during the rains. Most frequently the terrace itself is covered with grass, which is either cut for cattle or dug up round the roots of the tree, according to the taste of the planter. The yield of such trees is about 6 or 7 lbs. of prepared coffee per tree, i. e. between 3 and 4 cwts. of this per acre. No pruning, of course, can be done on a tree of this kind, and it is left entirely to the tender mercies of nature and the women who pick the crop and break the branches.

"But I think that instead of a desultory description like the above, I had better give you an account of the estate on which I stayed two days, and where I obtained most of my information on this subject, as you will understand better the daily routine of a planter's life and the method of cultivation than if I gave you a lot of isolated statistics. The estate alluded to is situated on a plateau about 800 feet above the sea, some 12 miles distant from Samarang, and belongs to a Mr. Grave, who is very anxious to introduce all the advantages of the Ceylon method of cultivation into the Dutch system, and for that purpose intends shortly paying a visit to the Kandyan provinces, where I do not doubt he will be hospitably welcomed by his brother planters. The land of the estate was formerly under forest, and the right to cut timber having been sold to an Englishman many years ago, a short lease of the land for the purposes of coffee cultivation was afterwards granted by the Government, at an annual rent of a few guilders per acre—generally from two to six—according to the value of the soil. The teak having been cut down and sold, the clearing is burnt in the same way as in Ceylon, and then laid out with roads in square or oblong plots, about 30 acres each, the nearly perfectly level character of the ground rendering this possible. Holes, 20 inches by 20 inches, and 18 inches deep, are dug in rows 8 feet apart, the holes in the rows being only half that distance from each other.

" These distances are now considered to be too small, and 10 by 9 and 9 by 9 will in future be adopted. The young plants, if grown in a nursery, are then very carefully removed, along with the soil they have grown in, which is taken up in cubes some 6 inches each way, and planted out by women at the rate of sixty or seventy a day, care being taken to cut the tap-root at the point where it emerges from the lump of soil. These plants, when removed, are generally about six months old, at which period they are about 12 inches high, and their growth afterwards is so extremely rapid that many that I saw, though only nine months in the ground, were from 2 to 3 feet in height, and covered with blossom; others only twenty months old were 6 and 8 feet high, and capable of bearing $\frac{3}{4}$ lb. coffee (prepared) per tree. The system of nursery planting is here considered to be a very expensive one, as the beans have to be planted at regular intervals in the nurseries, and small pieces of bamboo put in to mark where each plant is expected to appear. Besides this, the plants have to be regularly watered and kept under shade, and the number that can be put into the ground by each woman, when the clearing is being planted, is only sixty or seventy a day. The other system is to gather the casual plants from gardens on the hills, the plants being removed by loosening the soil with a knife, and then pulling them up by the roots and carrying them away in bundles. They have then their tap-root cut to a length of about 6 or 8 inches, and are planted frequently in the hills by merely making a hole with a stick and pushing in the roots, but sometimes in holes 6 inches square and deep, or else in ordinary 20-inch holes.

" The growth of these plants is considered to be much slower than is the case with nursery plants, but they produce much more hardy and lasting trees. At the same time that the coffee plants are put into the ground, a row of *dadap* or silk cotton trees is planted between every second row of coffee trees, the intermediate space being occupied by a small drain, not so much to prevent wash as to relieve the soil from too much water. All plantations have this rapid-growing softwood tree, and the appearance they present is totally different from that to which one gets accustomed in Ceylon.

" In future the *Albizzia moluccana*, now referred to the Acacias (*A. Julibrissin*, Willd.), will probably be largely planted, as it is a very fast growing tree, and has other advantages over the dadap.

" Indigo is very frequently planted among the young coffee plants, chiefly in order to keep down the alang-alang, but also to be used as a manure for weakly trees, if there are any on the estate. As the tree progresses no attempt is made to check its luxuriance, and it grows up with several small stems from the ground into a native coffee tree, 8 or 10 feet high. It is only pruned when branches show signs of decay, or when the borer, which is very destructive, compels the planter to cut down the stems attacked. The weeds are dug up with mammoties, to a depth of 6 inches, and piled in rows between the shade trees parallel to the lines of coffee. These weeds, among which is the alang-alang, consist chiefly of grasses, most of which are readily eaten by cattle, and furnish fodder apparently quite as good as Guinea grass; indeed, many of the marvellous little horses found everywhere in Java are fed on nothing but these grasses, and yet they are superior in strength and endurance to either Arabs or Australians. When an estate shows signs of decay after ten or fifteen years, the coffee trees are all cut down, the dadap trees being either felled or ringed near the roots, so that they decay gradually and fall piecemeal to the ground, and the process of replanting coffee and shade trees is repeated in the same manner as before. In this way land may be replanted several times, and the later garden be better than the earlier. Nothing, I think, contrasts more the richness of the soil of Java, as compared with that of Ceylon, than this fact. The ground never seems to be exhausted, and when it is partially used up on the surface you have only to go deeper, and you get a richer soil at once. The rainy season, here the north-west monsoon, begins generally about October, and ends in February; and the time for planting is therefore December. The crop is gathered in March and April, and the blossoms appear generally about August or September, though on the hills there are blossoms, green berries, and ripe fruit on the trees at the same time for a considerable part of the year. This past year has been generally a favourable one throughout the island, and the total yield is expected to be about 1,500,000 cwts. The prospects of the coming crop, however, are by no means good. As the dry season has been a wet one, the trees have had no wintering, and the heavy blossoms, which ought already to have made their appearance, are nowhere to be seen.

"As regards the work of the estate, the women alone are employed for picking and preparing the coffee, as they are for putting out the young plants; the amount gathered by each woman, in an average season, being about 13 lbs. coffee (when prepared) per day. The men are meanwhile employed in the field-work, weeding, manuring, &c. After the cherry has been gathered, it is spread on barbecues to dry for several days, after which it is pounded in small bamboo baskets, and the outer parchment and silver skins taken off. The peaberry is then separated from the ordinary beans by a skilful shake of the tray by which it has been winnowed, and the coffee is then ready for the European market. The value of this produce in the coast towns at present is about 74*s.* per cwt., and the cost to put it on board in good years amounts to only about 20*s.* to 25*s.* per cwt.; in bad years to 35*s.* to 40*s.* per cwt. The soil of the estate which I have been describing is of an extremely rich, dark, oily-looking, half-formed clay, crumbling easily in the hand, but sticking in masses to the feet, rendering walking on a wet day somewhat laborious. This soil extends generally to a depth of 20 or 30 inches, when a redder and more gravelly, but still very rich, soil is met with, which seems only to need exposure to the air for the development of its fertility. On the mountain slopes the soil is generally much more friable and liable to be washed away in the monsoon rains, and therefore is protected by means of terraces and a matwork of weeds and grasses on the surface. The labour question here, as in Ceylon, is one of considerable difficulty, but it is a difficulty of a widely different character; on this estate, consisting of about 1600 acres, of which nearly 1000 acres are under coffee, there are thirteen villages or campongs, each with its own headman and plot of land attached to it. Between 2000 and 3000 Javanese occupy these villages, of whom 800 are able-bodied men employed chiefly on the estate, their task (the weeding of thirty to thirty-five or forty trees) being allotted to each man day by day, and the payment for the work (5*d.*) is made every evening. When there is a demand for extra labour, the headmen induce stragglers from other villages to undertake task work, and they are paid in the same way as the ordinary labourers. In this manner the number employed varies from 500 to 1500, according to the demand which the Government is making at the time on their service under the compulsory labour system. This diversion of valuable labour during crop time is sometimes a cause of great loss and annoyance to planters, and certainly has a tendency to make them very discontented with the present system of enforced labour. The Javanese, as labourers, seem in no way difficult to manage, but are very respectful and obedient, in this respect forming a marked contrast to the half-caste Malays and Sundanese in the western part of the island. Of course, like all peasants of the tropics, they will do bad work, if they are permitted; but a European administrator and two or three half-caste overseers are amply sufficient for the working of this large estate, which in Ceylon would require three, if not four, Europeans, besides conductors, &c., for its proper management.

"In conclusion, I may state that at present it is of no use for an Englishman to come to Java as a coffee planter, even though he has capital. By law, he cannot lease a piece of land, but must have a Dutch partner whom he can trust perfectly, for a bond between the two, where land is in question, is of no validity in a court of law, and everything must be trusted to the man whose name is put forward as the owner. The chances of buying a piece of private land are too remote and uncertain to tempt anyone, except a resident in the island, to think of such an investment. The labour is frequently not to be obtained when everything else seems favourable; and lastly, the Government is not inclined to thrust the instruments of success into the hands of the foreigner, if they can by any possibility use them themselves. But, supposing all these difficulties have been overcome, the English planter will find that, however valuable his estate may be, he cannot raise a cent by mortgaging it, because it is still Government property and incapable of being mortgaged; and finally, when all Government obstructiveness and attempts at exclusion have been overcome, if that is possible, he will find that there is something in the nature of the coffee enterprise in Java, whether it be the forcing nature of the climate, or the excessive richness of the soil, or the system of cultivation, I cannot tell, but still something which prevents men amassing fortunes and returning home, as most Englishmen are anxious to do, after a few years in the East."

The coffee crop of Java being taken at 1,500,000 cwts., we are able to obtain an approximate idea of the area under coffee cultivation in the Dutch colony, and, as we have a similar approximation in regard to Brazil, we are now in a position to institute a very interesting and curious comparison between the three great coffee countries of the world—a comparison which will show that if, in the British colony, a portion of the capital in land has been wasted, by the unwillingness of some and the inability of others, to restore to the soil fertilising substances in lieu of produce grown and shipped, yet the colonists are not liable to the charge of using, or rather misusing, the maximum of area to get the minimum of result. Taking Mr. Abbay's estimate, that nineteen-twentieths of the land under coffee in Java is Government land, yielding only an average of 1 cwt. per acre, the remaining twentieth of private plantations, yielding an average of 4 cwts., it follows that in Java the bushes, which yield 1,500,000 cwts. of marketable coffee, are equivalent in acreage to 1,304,000. Something, perhaps, ought to be allowed for coffee locally consumed; but if we reduce the acreage to 1,200,000, ample allowance will be made for this element. The figures for comparison, or rather contrast, will then stand thus:

	Total Yield in Cwts.	Area of Cultivation.	Average Yield per Acre.
			cwts.
Brazil	4,000,000	1,400,000	2·85
Java	1,500,000	1,200,000	1·25
Ceylon..	862,826*	257,000	3·35
	6,362,826	2,857,000	2·48

* Average (adversely affected by leaf disease) of five seasons' crops, plantation and native.

Of course, it will not be forgotten that in the case of Brazil a large quantity of provisions for the labourers is grown amongst the widely-scattered coffee trees; while in Java shade trees seem to be universal. Grasses are grown amongst the coffee; *Lantana* is (and justly) valued for its deposition of humus; while even what the Ceylon planters reckon their most deadly foe, the *Ageratum* (a plant which takes from the soil precisely the elements which the coffee tree needs), is valued for its supposed power of ameliorating the stiffness of clayey soils. But, all allowance made, it is evident that in the British colony alone have the principles of scientific cultivation of the coffee plant been adopted and carried out. Cinchona and tea are now coming in as disturbing elements; but so jealous have a majority of the planters been of allowing any product to dispute possession with the closely-planted and carefully-tended coffee, that they have erred in refusing to allow room enough for grasses in ravines or spare spots for feeding those cattle, without which "permanency," even in its restricted sense of thirty-five to fifty years, cannot be legitimately looked for. The Ceylon planters grow coffee, while India, which sends them labour, supplies also the food of the labourers. The circumstances of both its great rivals are different, but certainly not more favourable; and, as Mr. W. Sabonadiere remarks, if only the *Hemileia vastatrix* would take to itself wings and flee away, they would be able to hold their own against all competitors, certainly against Java, rich as its soil may be. Can a soil be too rich? Mr. Abbay suggests the possibility, and certainly it would seem that the climate is, at any rate in the lower elevations, too forcing. A Ceylon planter might well be pardoned some tinge of envious feeling as he reads of subsoil and top-soil, equally rich; but he may well stand aghast when he learns that on such rich stratum and substratum, coffee trees and shade trees require to be cut down at the end of each fifteen years, the process being possible three times in succession, with the last garden better than the first! Of course the silk cotton trees must yield, at each renovation, a large supply of humus, apart from the natural richness of the soil; but we should like to see the profit and loss account of the plantings and replantings. Were there such soil in Ceylon, the planters would do their best to make the first planting "permanent," at least to the extent of the thirty-five years involved in the three processes; but a climate which renders the use of shade trees universal must have an influence on coffee planting in Java to which we ought to allow due weight, having before our eyes the results of abandoning shade in the case of such low, hot districts in Ceylon as Kurnegala, Kadugannava, &c.

The 'Ceylon Observer' remarks upon this:—"It is quite a new idea, and also a contrast to the general conditions in Ceylon, that the soil on the higher mountain slopes should be poorer than that at low elevations. For the rest, experiments on old Hantane, which we noticed a few years ago, told most favourably of the renovating effects of *Lantana*, the roots of which open up the soil, while its dropped leaves and seeds cover the surface with a moist, warm carpeting of humus. On a fair proportion of our soils, we have no doubt that coffee can a second time be grown after a period of seven to ten years following under *Lantana*. But in general what we look for is this: That with the facilities for manuring, &c., offered by railway extension, the present young and vigorous coffee estates may attain a profitable permanency, of about half a century (Mr. Abbay does not see why a centenarian tree should not yield profitably), and that then coffee should give place to tea, cinchona, and other equally profitable products. Those who ask 'Where will Ceylon and its railway be when coffee goes out?' are looking too far ahead in one sense, while their vision is miserably limited on the other hand. Humanity, human discovery, invention, and enterprise are not likely to stand still, but rather to advance at accelerated speed. A score of years ago and the idea of cinchona in Ceylon had not been breathed; but in ten years from this time we venture to predict that Ceylon will contain more cinchona trees than the rest of the world, old and new, put together. And so the tea enterprise is advancing, and will advance. Cocoanuts and cinnamon are also going ahead. Therefore we may well trust to the future of Ceylon while we do our duty in the present, sending well-pulped, washed and prepared coffee into the markets of the world; and probably by the time Brazil and Java have gone any length in copying our example, the plague of leaf disease may have departed. They had it in Brazil, and it is gone; and if there is no trace of leaf disease in Java, the borer is very destructive. Noticing in passing that the alang-alang of Java is the Ilook grass of Ceylon (*Imperata Kœnigii*, P. de B.), we may, we think, finally adopt the conclusion that, whatever the disadvantages we in Ceylon labour under may be, we are certainly, in many respects, far in advance of our competitors in Brazil and Java, favoured as both may be in large areas of rich soil. We have good land tenures and liberal government, a fairly adequate supply of labour, a climate in most respects unsurpassed for salubrity by any in the tropics; our means of communication, though not yet perfect, are extensive. If Providence will remove the plague of leaf disease, and Government will with energy carry out railway extension, while the breakwater is advancing, we do not know that there would be much room left even for the most typical of Englishmen to exercise his hereditary and proverbial privilege of grumbling."

TEA.

Extensive as the production and consumption of the preceding articles of commerce described—Coffee and Cocoa—are, they cannot be compared in importance with Tea, the consumption of which over the world is enormous, and continually increasing.

The progress of the production of tea in other countries than China is necessarily interesting, as calculated to make the world more independent for its supplies.

Besides India, Java, and Japan, in the East, where it has made good progress, efforts are making to introduce it in parts of Australia, such as Queensland and Victoria, in Jamaica and Mauritius.

From Ceylon shipments are already made. It is said to be also cultivated in the Corea, Tonkin, and Cochin China.

Parts of North and South America afford a vast field for tea culture. And it has long been attempted with some degree of success in Brazil and parts of the United States.

Madeira, Teneriffe, Portugal, Spain, France, Algeria, Italy, Austria, Turkey, and the Crimea, might all grow tea, for their climates are quite suitable; Australia, Tasmania, and New Zealand are admirably adapted likewise, but they have little or no labour to bestow on such a cultivation. Java has long taken up tea culture, and produces seven or eight millions of pounds.

Tea is a very accommodating plant, both as respects climatic range and the nature of the soil in which it is planted. We find it growing from Pekin—which frequently has winters of Russian severity—to Canton and Macao, where the sugar-cane and pine-apple find sufficient heat to render them sure and profitable crops. The plant seems quite capable of withstanding winters of very intense frost, provided the summers are of sufficient duration and heat to mature perfectly the newly-formed wood which it makes. Any country, therefore, having a long and hot summer and a cold winter can grow tea.

So far back as 1844 some success attended the efforts of a private individual, M. Jaunet, in the cultivation of the tea plant in the island of Mauritius. Chinese labourers were employed to assist him in the further culture of this important plant, the expense being borne by the Colonial Government: others were also engaged for a similar purpose in the Botanical Garden.

At a later period Mr. Boyer, of Port Louis, succeeded in raising 40,000 tea trees, and expressed the opinion that if the island of Reunion would give itself up to the cultivation, it might easily supply France with all the tea she requires, which is but little. The black tea that has been produced in that island is of a good quality.

Although those climates where it has been introduced will grow the plant, yet the manipulation of the leaf has hitherto been so little understood that only two of these countries can yet claim tea as among their leading productions. India and Java export quantities, but the bulk is the produce of estates, under managers who very frequently know comparatively little of the industry, and yet make marketable tea.

In Transcaucasus, under a latitude corresponding to the northern parts of Niphon, Japan, good results have been obtained, and a company has been formed to carry on tea cultivation.

In many other quarters the tea plant would be found to grow well, but the difficulty to contend with in most of these is the cost of labour compared with China and India.

Production and Consumption of Tea.—We may note the gradual increase of consumption in Great Britain and Ireland by the following figures:

	Lbs.		Lbs.
1820	22,452,050	1860	76,816,394
1830	30,047,079	1870	117,551,152
1840	32,252,628	1875	145,327,432
1850	51,172,302		

Proportion per head of the population:

	Lbs.		Lbs.		Lbs.
1840	1·22	1861	2·69	1869	3·63
1850	1·86	1862	2·70	1870	3·81
1855	2·28	1863	2·90	1871	3·92
1856	2·26	1864	3·00	1872	4·01
1857	2·45	1865	3·29	1873	4·11
1858	2·58	1866	3·42	1874	4·23
1859	2·67	1867	3·68	1875	4·44
1860	2·67	1868	3·52		

In a paper by my friend, Mr. L. Wray, read before the Society of Arts, in January, 1861, "On Tea and its Production in various Countries," * he enters into some calculations on tea consumption, and says:

"We have no very certain means of estimating the quantity of tea consumed in China, but we may nevertheless draw conclusions from such data as we possess. Taking the population of the country, then, at 400 millions, and considering that the use of tea is universal amongst them; that they drink it from early morning until they

* 'Journal of the Society of Arts,' vol. ix. p. 137.

retire for the night; that in sickness or health, working or resting, travelling or at home, it is the one great national beverage, without which no Chinese family could live and thrive; considering all this, I think I am not overrating it when I set it down at an average of 5 lbs. a head per annum, or a total of 2000 millions of pounds! Others estimate it much lower—Scherzer at 400 millions; Andrie at 500 millions. Now, if we allow 100 lbs. of cured tea as the average produce per acre in China, this will show a cultivation of 20 million acres in tea alone, whereas I am more inclined to estimate it at 25 million acres. Just let us compare this with other cultures in other countries. France, which is not larger than one of the Chinese provinces, and contains less than one-twelfth the population of China, has, nevertheless, five million acres in vines. The Southern States of America have seven million acres in cotton, cultivated by less than one and a half million of negroes; and India, with only half the population of China, has 14 millions of acres in cotton. These comparisons are quite sufficient, I think, to prove that there is no improbability attached to the estimate I have given of the extent of land devoted to tea culture in China. I therefore leave out of the question the area occupied in different countries by such crops as rice, wheat, &c.

"If we allow that the internal consumption of tea in China amounts to 2000 millions of pounds, we cannot but be struck at the comparatively small quantity she exports; for, according to the latest statistics, we find that her total export of tea to all countries does not reach 200 million pounds, being less than one-tenth of her own consumption. Of this quantity the United Kingdom took about 78 million pounds in 1860."

Now, if we carry down the estimates to the later period of the present time, we shall get at some rough estimate of the production and consumption of tea. I assume only half the quantity of tea Mr. Wray allows, for the home consumption of China.

PRODUCTION.

	Lbs.
China, exports, 1873	242,000,000
„ assumed home consumption	1,000,000,000
British India, exports, 1875	21,137,000
„ assumed local consumption and export to Asia	2,000,000
Java, export	6,830,000
Japan, export	12,000,000
„ home consumption	5,000,000
Ceylon, export	320,000
Brazil, home consumption	500,000
Other small producing countries	250,000
Total	1,290,037,000

CONSUMPTION.

Of the statistics of consumption I am not able to furnish any complete details, as only for a few countries are the quantities of tea imported and sold given in their official returns.

The following figures, however, are taken from the Statistical Abstract for the principal Foreign countries, and from other reliable documents, for the year 1873, and dispose of a certain quantity of the tea produced and shipped from the East:

	Lbs.
Russia	26,379,928
Denmark	849,635
Holland	9,625,200
North Germany	2,000,000
United Kingdom	132,022,159
Spain, Gibraltar, and Malta	361,000
Turkey	400,000
France	6,500,000
United States	51,028,904
Dominion of Canada	8,776,781
Newfoundland	599,104
British West India Islands, Guiana, and Honduras	100,000
South American States	1,000,000
South African States	1,000,000
Sierra Leone, St. Helena, Falklands, and Mauritius	30,000
Victoria	10,585,795
New South Wales	5,021,219
Queensland	1,355,575
South Australia	1,678,325
Tasmania	530,500
New Zealand	2,301,308
Total	262,645,433

The consumption of tea, we are informed, increases yearly in the South of Germany, but statistics are wanting to indicate the progress of this increase. Austria, Italy, and many other European States are omitted for want of precise figures as to their tea consumption.

Imports of tea into the United Kingdom, showing the producing countries:

Year.	British India and Ceylon.	China.	Japan.	Total Imports.
	lbs.	lbs.	lbs.	lbs.
1853	551,800	68,639,727	..	70,735,135
1854	530,710	83,301,550	..	85,792,032
1855	470,559	81,560,207	..	83,259,657
1856	692,959	84,795,802	..	86,200,414
1857	1,849,966	60,295,610	..	64,493,989
1858	936,903	73,359,599	..	75,432,535
1859	1,483,101	71,916,833	..	75,077,452
1860	2,707,449	85,295,129	..	88,946,636
1861	1,983,785	92,145,365	1,348,911	96,577,183
1862	1,870,306	109,756,857	2,450,270	114,787,440
1863	2,564,000	127,872,778	1,788,000	138,880,990
1864	3,443,493	83,871,554	2,434,180	124,359,243
1865	2,037,586	112,782,845	4,021,901	121,271,220
1866	5,413,583	130,863,501	1,908,800	139,610,044
1867	7,776,001	117,551,978	1,585,099	128,028,726
1868	9,099,444	142,111,486	1,041,150	154,845,863
1869	11,241,070	126,482,613	704,275	139,223,298
1870	12,923,993	125,593,898	238,005	141,020,767
1871	15,150,958	151,636,036	389,575	169,898,303
1872	16,445,170	160,520,882	93,774	184,927,148
1873	18,471,063	137,246,372	311,849	163,765,269
1874	18,092,673	133,452,693	128,305	162,782,810
1875	25,387,359	170,462,921	54,806	197,505,316

A great deal of scattered information has been published of late years with regard to tea culture, and the Indian Government has devoted much attention to the subject. With the diffuse mass of matter one has to deal with, I find it somewhat difficult to condense into a reasonable compass the conflicting opinions and elaborate details given. The third volume of the 'Journal of the Agricultural and Horticultural Society of India' is mainly occupied with Lieutenant-Colonel Edward Money's and Mr. Watson's elaborate essay on the cultivation and manufacture of tea in India.

The Council of the Society of Arts, a few years ago, offered their silver medal for the best treatise on the profitable production of tea; but, although many essays were sent in, the Indian Committee, under the recommendation of the judges appointed, did not feel justified in awarding this medal, although they commended the essay of Mr. James Macpherson.

Culture in China.—The tea plant (*Thea Chinensis*, Sims; *Camellia theifora*, Griff.) has a bushy stem, with numerous branches, and very leafy. It flowers with a white blossom, and ranges in height, when fully grown, from three to six feet. It is hardy, and readily grows in Asia from the equator to the 45th degree of latitude; but in China, although grown in most of the provinces, its cultivation is chiefly restricted to the five maritime provinces—viz. Kuangtung, Fukian, Kiangse, Kianguan, and Chekiang, lying in the south-east part of the empire, between the 21st and 33rd degrees north latitude. It is only from these that tea is brought for the great export demand, though it is grown in every other, as far north as 42 degrees for mere local consumption. It is also produced in the Japanese Islands which are north of 35 degrees; in Cochin China, and, to some extent, by runaway Chinamen in Luzon and Java. It has been found to succeed, too, in St. Helena. The climate that seems to suit the plant best in China is that of the country included between the 25th and 35th degrees of north latitude. The plant does not yield a crop under two or three years. A low alluvial soil is not favourable to its growth, a hilly country being decidedly the best adapted to its full development. There is little or none near Canton, for this reason, and also because the climate is too warm. All accounts agree that it thrives best in a temperate climate and upon the sides of hills. The crops are gathered in the spring.

Baron Mueller remarks that it seems very doubtful whether the tea plant is really indigenous in the Chinese Empire, unless in the, to us, largely unknown western districts; for, as far as we are aware, it has been carried from Assam and Cachar, and possibly also from Siam and Cochin, just like the coffee plant, which is not really a native of Arabia, as was so long supposed, but came originally from Abyssinia. The culture commenced, so far as can be historically ascertained, in China, during the fourth, and in Japan during the ninth century, from whence tea was obtained exclusively for every other part of the globe till the time of the present generation.*

Tea grows in every province in China except three or four upon the northernmost Siberian border, but the quality and quantity depend largely upon the locality. The leaves resemble those of

* Lecture at the Ballarat Farmers' Club, Victoria, May 15, 1875.

the willow, and are gathered during the spring and early summer. The annual average yield of a tea plant is about twenty ounces, and too much rain affects the quality as well as the amount. The plants live from twenty to thirty years, and, when old, are frequently cut down, and a young shrub grafted into the old stock. Quicker returns are thus obtained, but the plant does not last so long. The leaves are first exposed in a cool, dry place for a day or two, then rolled into a ball on a table of bamboo slats, and dried in the sun. The rolling is to extract a portion of the juice of the leaves. After they have been dried in the sun, they are put into an egg-shaped iron pan over a charcoal fire, and incessantly stirred until a certain point of dryness is reached. The operator stirs with his hands, thrusting them in all portions of the pan, and practice enables him to dry the leaves almost exactly alike. The raiser superintends this process, and then brings his tea in bamboo baskets to the tea merchant, who adjudges its quality, and buys it at prices ranging from 15 dollars to 20 dollars per picul, of 133⅓ lbs. The merchant mixes his purchases together in a large reservoir, and at his convenience weighs out a number of pounds of tea leaves; women and children spread them upon a large stage, and separate the leaves into grades according to quality. The tea stalks are the lowest grade, and the sorters are paid by the number of ounces of stalks they bring in. Children earn from 2*d.* to 6*d.* a day; the very best workers rarely earn as much as 6*d.* a day. Europeans could hardly live upon such wages, and until other nations can raise tea for 6*d.* a pound they cannot compete with China in its production.

After the sorting each grade is packed by itself in chests or bamboo baskets, the first for exportation and the latter for home consumption. It is ordered by importers abroad through a tea-taster, who receives a high salary.

For Green Tea.—When the leaves are brought in from the plantations they are spread out thinly on flat bamboo trays, in order to dry off any superfluous moisture. They remain for a very short time exposed in this manner, generally from one to two hours; this, however, depends much upon the state of the weather.

In the meantime the roasting pans have been heated with a brisk wood fire. A portion of leaves is now thrown into each pan, and rapidly moved about and shaken up with both hands. They are immediately affected by the heat, begin to make a crackling noise, and become quite moist and flaccid, while at the same time they give out a considerable portion of vapour. They remain in this state for four or five minutes, and are then drawn quickly out and placed upon the rolling table.

Having been thrown again into the pan, a slow and steady charcoal fire is kept up, and the leaves are kept in rapid motion by the hands of workmen. Sometimes they are thrown upon the rattan table and rolled a second time. In about an hour or an hour and a half the leaves are well dried and their colour has become fixed—that is, there is no longer any danger of their becoming black. They are of a dullish green colour, but become brighter afterwards.

The most particular part of the operation has now been finished, and the tea may be put aside until a larger quantity has been made. The second part of the process consists in winnowing and passing the tea through sieves of different sizes, in order to get rid of the dust and other impurities, and to divide the tea into the different kinds known as twankay, hyson skin, hyson, young hyson, gunpowder, &c. During this process it is refired, the coarse kinds once, and the finer sorts three or four times. By this time the colour has come out more fully, and the leaves of the finer kinds are of a dull bluish green.

It will be observed, then, with reference to green tea—1st, that the leaves are roasted almost immediately after they are gathered; and 2nd, that they are dried off quickly after the rolling process.

For Black Tea.—When the leaves are brought in from the plantations they are spread out upon large bamboo mats or trays, and are allowed to lie in this state for a considerable time. If they are brought in at night they lie until next morning.

The leaves are next gathered up by the workmen with both hands, thrown into the air and allowed to separate and fall down again. They are tossed about in this manner, and slightly beat or patted with the hands, for a considerable space of time. At length, when they become soft and flaccid, they are thrown in heaps and allowed to lie in this state for about an hour, or perhaps a little longer. When examined at the end of this time, they appear to have undergone a slight change in colour, are soft and moist, and emit a fragrant smell.

The rolling process now commences. Several men take their stations at the rolling table and divide the leaves amongst them. Each takes as many as he can press with his hands, and makes them up in the form of a ball. This is rolled upon the rattan table, worked and greatly compressed, the object being to get rid of a portion of the sap and moisture, and at the same time to twist the leaves. These balls of leaves are frequently shaken out and passed from hand to hand until they reach the head workman, who examines them carefully to see if they have taken the requisite twist. When he is satisfied of this, the leaves are removed from the rolling table and shaken out upon flat trays, until the remaining portions have undergone the same process. In no case are they allowed to lie long in this state, and sometimes they are taken at once to the roasting pan.

The next part of the process is exactly the same as in the manipulation of green tea. The leaves are thrown into an iron pan, where they are roasted for about five minutes, and then rolled upon the rattan table.

After being rolled, the leaves are shaken out, thinly, on sieves, and exposed to the air out of doors. A framework for this purpose, made of bamboo, is generally seen in front of all the cottages amongst the tea hills. The leaves are allowed to remain in this condition for about three hours: during this time the workmen are employed in going over the sieves in rotation, turning the leaves and separating them from each other. A fine dry day, when the sun is not too bright, seems to be preferred for this part of the operation.

The leaves, having now lost a large portion of their moisture, and having become reduced considerably in size, are removed into the factory. They are put a second time into the roasting pan for three or four minutes, and taken out and rolled as before.

The charcoal fires are now got ready. A tubular basket, narrow at the middle and wide at both ends, is placed over the fire. A sieve is dropped into this tube and covered with leaves, which are shaken on it to about an inch in thickness. After five or six minutes, during which time they are carefully watched, they are removed from the fire and rolled a third time. As the balls of leaves come from the hands of the roller they are placed in a heap until the whole have been rolled. They are again shaken on the sieves as before, and set over the fire for a little while longer. Sometimes the last operation—namely, heating and rolling, is repeated a fourth time; the leaves have now assumed a dark colour.

When the whole has been gone over in this manner it is then placed thickly in the baskets, which are again set over the charcoal fire. The workman now makes a hole with his hand through the centre of the leaves, in order to allow vent to any smoke or vapour which may rise from the charcoal, as well as to let the heat up, and then covers the whole over with a flat basket; previous to this the heat has been greatly reduced by the fires being covered up. The tea now remains over the slow charcoal fire until it is perfectly dry; it is, however, carefully watched by the manufacturer, who every now and then stirs it up with his hands, so that the whole may be equally heated. The black colour is now fairly brought out, but afterwards improves in appearance; the after processes, such as sifting, picking, and refining, are carried on at the convenience of the workmen.

It is evident therefore that the main part of the preparation of the tea is carried on upon the spots where it is grown, and that an increased quantity could easily be prepared without any increase either of machinery or hands for the purpose.

The British Consul at Shanghai, in a report in 1868, stated:—"The difficulty of judging the character of any tea in China has been seriously enhanced by our approach to the tea districts. Formerly this delicate herb required to be so well fired and packed by the Chinese as to stand the long overland journey from the tea districts to Canton, where it often came into the hands of the foreign shipper a whole year after it had been picked. Now, within six months of the time that the leaf was growing, we find the prepared article actually in the hands of the home consumer. A careless manipulation and an insecure kind of packing have thus been gradually adopted by the Chinese, who find all that is wanted is, that the tea should arrive unimpaired into the godown of the foreign merchant, often not three days' journey from the up-country packing house. The fragrant smell of the newly-dried herb deceives the buyer, whose home correspondent comes into possession of a totally flavourless preparation. The subordinate part allotted to the cultivation of the tea plant in China is one of the most striking facts observed by the traveller in the country. When he first arrives in the tea districts he is led to imagine himself still only on their confines; isolated patches here and there meet his eye, in place of the wholesale plantations he had looked forward to, and on inquiry he finds that among the enumeration of taxable lands sent in to the Emperor, tea land is entirely ignored. In fact, until recently, the up-country farmer, who persists in growing an inferior paddy almost on the highest mountain tops, on the theory that each district should, as nearly as possible, be self-supporting, grew a few shrubs in the corner of his garden, or gathered for his own requirements from the wild hill plant. Although of late years the country people have begun to see the value placed on a hitherto almost worthless herb, the cultivation of the high tea plant is still far from being carried on in a really systematic manner, and five or six piculs is a large average yield for an individual farm."

In China tea nurseries are seldom extensive, but every village has its one or two acres devoted to the national product.

Shanghai is the leading tea port in China, not only for shipments to Great Britain, but also to America. To show its progress, I append a few figures of the exports of tea from China to the United Kingdom:

	Canton.	Shanghai.	Foo-chow-foo.	Amoy.	Total.
1851	42	22	..	..	64 million lbs.
1861	41	11	38	..	90 "
1870	17	71	53	1	142 "
1875	20	81	62	..	163 "

In addition to this, the American trade is important. Of the fifty million pounds and upwards sent from China to the United States, Shanghai exports more than half, nearly all green tea, which is much more esteemed by the Americans than by ourselves, as may be shown by the fact that while in the three years ending 1873 we imported from Shanghai an average of nine million pounds of green tea, America took over twenty millions.

A quarter of a century ago the Americans used to take double the quantity of green tea they did black, but now they are beginning to give more preference to black.

The American import of tea at the Atlantic ports, exclusive of California, was as follows in—

	Lbs.		Lbs.
1845	20,762,558	1870	33,964,096
1850	21,757,800	1874	52,424,545
1861	17,482,000		

Russia takes about one-seventh of the foreign exports of tea from China. 290,000 pouds of 36 lbs. go yearly from Canton to Russia. In 1873 the three commercial companies established at Hankow sent to Russia 826,117 cases of tea, of which 10,000 were black tea. Two Russian steamers also loaded with tea at Hankow for Odessa, and 8000 cases were sent by the way of Nikolievsk and the Amoor river, and a good deal by land *viâ* Tientsin and Kalgar to Kiachta.

Quantities of each description of tea exported annually to foreign countries from the fourteen treaty ports of China, in piculs of 133 lbs.:

Year.	Black.	Green.	Brick.
1863	1,053,482	194,340	29,370
1864	768,671	175,752	17,405
1865	967,025	215,680	14,307
1866	947,063	189,790	18,504
1867	1,042,229	223,434	65,277
1868	1,191,497	220,002	53,123
1869	1,214,631	230,945	73,521
1870	1,087,121	227,481	62,896
1871	1,362,634	232,617	83,790
1872	1,420,170	256,464	96,994
1873	1,264,651	260,440	106,875

These figures show an export of about 236,000,000 lbs.

Besides the brick teas forwarded *viâ* Tientsin and Kiachta to Siberia and Russia, considerable quantities are sent from Hankow and vicinity up the Han river to Fan-cheng, where overland carriage is resorted to. No figures are available for the years previous to 1871, but in 1871, 111,062 piculs, and in 1872, 100,920 piculs, were thus forwarded to Siberia and Mongolia.

From the port of Shanghai the following were the exports of tea in 1871, in piculs of 133 lbs.:

Kinds.	To Foreign Countries.	To Chinese Ports.	Total.
Black	435,182	12,622	447,804
Green	220,855	334	221,189
Leaf	146	692	838
Dust	456	74	530
Brick	387	71,680	72,067
Japan (uncoloured)	1,759	11	1,770
„ (coloured)	2,415	2	2,417
Total	661,200	85,415	746,615

The countries to which the shipments were made in 1871 were as follows, in piculs:

To—	Black.	Green.	Total.
Great Britain	416,825	57,393	474,218
Hong Kong	300	3,747	4,047
India	497	3,910	4,407
Straits Settlements	3	2	5
Australia	362	..	362
British America	26	5,017	5,043
Continent of Europe	2,066	..	2,066
United States of America	14,515	150,737	165,252
Amoor Provinces	382	..	382
Japan	206	49	255
Total to Foreign countries ..	435,182	220,855	656,037
„ Chinese ports	12,622	333	12,955
Total	447,804	221,188	668,992

History of Tea Planting in India.—Moorcroft's 'Travels in the Himalayas in 1821,' brought the existence of tea in India to the notice of the Board of Directors of the East India Company. Mr. J. W. Edgar, in an official summary * published in Calcutta, states there have been lively disputes as to the first discoverer of tea in Assam and the date of its discovery. It is probable that a Mr. C. A. Bruce, who commanded a division of gunboats in Upper Assam during the first Burmese war, brought down from Upper Assam some plants and seed of the indigenous plant in 1826, and he actually received a medal from the London Society of Arts. But his claims to have been the first discoverer of tea was disputed by a Captain Charlton, who asserted that the existence of tea in Assam had been first established by himself in 1832. In 1834 a committee was appointed to inquire into and report on the possibility of introducing the cultivation of tea into India.

On the 24th April, 1844, Dr. Royle delivered an interesting lecture at an evening meeting of the Royal Asiatic Society, "On the Cultivation of Tea in the Himalaya Mountains." He mentioned the great difficulty experienced with regard to tea cultivation in obtaining any correct information from China on the subject. It appeared that the tea plant was cultivated in China from 17° to 36° of N. lat.; but the black teas of commerce chiefly from 27° to 28°; and the green from 28° to 31° of N. lat., in soils rather poor than rich, and in a climate subject to great extremes. Dr. Royle then adverted to the relative positions of China and India, and called attention especially to the Himalayan Mountains, as containing the same varieties of climate as was found in the tea districts of China. From the nature of the plants found in the Himalayas, Dr. Royle had long thought that the tea plant could be cultivated there; in 1827, and again in 1831, he recommended to the Indian Government the desirability of making the attempt. In 1832 Dr. Wallich presented a paper to the Board of Control on the subject; and in 1834 Dr. Royle, in the third number of his 'Illustrations of Himalayan Botany,' gave an essay on the cultivation of tea in the Himalayas, which coincided remarkably with a report sent from India at the same time by Dr. Falconer. With the sanction of the Court of Directors, he determined upon making the experiment; and in 1834 a committee was formed, reports called for, and Messrs. Gordon and Gutzlaff were sent to China to obtain seeds, information, and workmen. After visiting the Ankoy Tea-hills, and obtaining seeds, these gentlemen were recalled on the discovery of the tea plant of Assam. The seeds were sown at Calcutta, and the seedlings distributed to the tea nurseries; but only 500 reached Assam alive: 1326 reached the hill nurseries in 1836. In December 1838 Dr. Falconer wrote that the tea plant was thriving vigorously in two, and had flowered in three, of the above nurseries. In 1841, 5000 plants were flourishing; many of them bushy shrubs, about five feet high. In 1842 nine Chinese tea manufacturers, who had been in Assam, were sent to the tea nurseries in Kumaon and Gurhwal, who immediately recognised the plant under cultivation as the genuine Chinese, and of a superior quality to that grown in Assam. In 1843 the Chinamen prepared

* 'Tea Industry in Bengal.'

some tea from the above plants, which was considered, in Calcutta, to be marketable in London at about 2*s.* 6*d.* per pound. In 1843 sixteen canisters of black (Pouchong) tea were forwarded to London, and although somewhat damaged on the voyage, the tea was valued at from 2*s.* 6*d.* to 3*s.* per pound. The appearance and flavour of the best samples were unexceptionable, and fully justified the opinion that the tea shrub in the Kumaon plantations is the genuine China plant.

In 1835 the first attempt was made by Government to establish an experimental plantation in Luckimpore, but it failed, and the plants were afterwards removed to Joypore, in the Seebsaugor district, and a garden established, which was sold to the Assam Company in 1840. This company, which was formed about 1839, was the first, and is still very much the greatest, concern for the cultivation of tea in Bengal. It was not, however, very prosperous during its early years, and in 1846–47 its shares are said by Mr. Campbell to have been almost unsaleable. Its prospects began to improve about 1852, and in 1859 it was reported officially to have a cultivated area of about 3967 acres, with an estimated out-turn of over 760,000 lbs. of tea. Meantime tea cultivation had been commenced in many other districts. In 1850 a garden was started by Colonel Hannay near Debrooghur; and in 1853, when Mr. Mills, of the Sudder Court, visited Assam, he found three private gardens in Seebsaugor, and six in Luckimpore. In 1854 the first gardens were started in Durrung and Kamroop. In 1855 indigenous tea was found in Cachar; and the first garden in the district was commenced in the cold season of that year. In the following year (1856) tea was discovered in Sylhet, but I do not think that any attempt at cultivating it was made for some time after. Attempts had been made to cultivate tea at Darjeeling previous to 1853, when the district was reported on by Mr. Welby Jackson; but I think that the date of the commencement of the industry may be taken as 1856–57. The earliest notice of tea in Chota Nagpore which I can find is in 1862; and about the same time the cultivation was seriously commenced in Chittagong, though experiments had been made in that district as early as 1840. It may be said generally, however, that the foundations of the present tea industry were laid between 1856 and 1859. In the latter year the labour difficulty began to be seriously felt in Assam and Cachar; but although Colonel Jenkins, Commissioner of Assam, recorded a serious warning, no one else seemed able to foresee the formidable dangers into which the too rapid progress of the industry would bring it. Later still, in 1862–63, officials as well as planters seem to have indulged in visions of fabulous prosperity, which only deepened the gloom of the miserable time that was so soon to come on them.

This depreciation of tea property continued during the years 1866, 1867, and 1868, but about 1869 things began to look brighter. It was seen that people who had worked steadily for years with a view to make gardens that would yield a profit had been rewarded, while much of the property of the collapsed companies had turned out well under careful management. In fact, it was again found out that tea would pay, and ever since it has been steadily progressing in popular estimation, and, as a general rule, in profit to those engaged in it. There cannot be the slightest doubt that the industry is in an infinitely better and safer position now than it was ten years ago. The existing gardens are, as a general rule, well filled with plant, highly cultivated, and carefully managed. The amount of tea produced per acre, although falling far short of the sanguine expectations of the first days of tea planting, is satisfactory in all the more important districts, while the prices obtained now show that the average quality must be very good. There is every reason to hope that the labour difficulty is disappearing in Cachar; and in spite of the complaints from Assam, there are evident signs of improvement in that province. In Darjeeling there is at present some difficulty, but the labour question is even now less troublesome in this district than it has been at all times in Assam and Cachar. But while there seems every reason to hope that the industry is now entering on a period of prosperity and stability such as it has not hitherto experienced, it would be most unwise to shut our eyes to some unpleasant signs which seem, when read by the light of past experience, to indicate a recurrence to that spirit of speculation and want of foresight which so very nearly ruined tea planting in former years.

In a report of the Directors of the Assam Company, under date 16th December, 1841, they stated that:

"The total quantity of land fully and partially cleared was 1958 poorahs,* of which the quantity of native tea land cleared, and in actual production, was 780 poorahs.

"The quantity of land contained in our grants was unknown, as the officers of Government had not yet been able to survey them, but of the whole, 25,774 poorahs was the quantity estimated as suitable for the cultivation of tea.

"Of the 780 poorahs of native tea land above mentioned, the number of plants in a poorah was found to vary from 450 to 2400. The average number in a poorah was found to be 1660.

"The average quantity of tea to be obtained from each plant at full produce was estimated at a quarter of a pound annually.

"The total annual cost of cultivating one poorah, and converting its produce into tea, is estimated by the superintendents in Assam at 120 rupees, or 12*l.* The superintendence in Assam, Calcutta, and London, packing, and every contingency, are estimated by the local directors at 100 rupees, or 10*l.* per poorah.

"Thus one poorah containing 1600 plants will produce 400 lbs. of tea, and the total annual charge will be 220 rupees, or 22*l.* The value of 400 lbs. of tea, at 2*s.* a pound, will be 40*l.*, estimating the average value of black and green tea at that price (which, with reference to the actual, and probably improving, quality of the article, the Board consider that they have a right to assume as the average price for some years), and the gross profit per poorah would therefore be 18*l.*, so that the profit on 1000 poorahs would be 18,000*l.*

"In 1845, all the tea lands now actually producing will be yielding full produce."

Now, let us compare the present condition of tea culture in Assam. The following gives the total area taken up in the province of

* A poorah contains 52,900 square feet, or $1\frac{3}{14}$ acre.

Assam at the end of 1874 for tea cultivation, under the following tenures, viz.:

	Acres.
1. Under old Assam rules of 1854	177,981
2. „ ordinary leases	45,384
3. Purchased in fee-simple	172,828
4. Under the old Assam rules, but since commuted to fee-simple	229,802
	625,995

It was estimated that about 100,000 acres were under cultivation with tea, and the yield was 19,000,000 lbs., or only two and a half maunds per acre, which is a very small out-turn, even when the large area of immature plant is taken into consideration.

A chest of tea varies in capacity from one to two maunds, but 100 lbs. weight may be taken as the average. The exports from Cachar and Sylhet in 1874 amounted to 55,119 chests.

The land taken up for tea cultivation in Cachar and Sylhet is about one-third of the tea land of the whole province of Assam; the estimated aggregate out-turn would therefore, on the same basis as the Cachar and Sylhet shipments, come to about 17,000,000 lbs.

Taking the value of tea in Calcutta to be 1*s.* 8*d.* per lb. (which is the average during the last thirteen years), the tea produce would be worth 1,583,333*l.*

Owing to the defective returns submitted to the Governments, it is impossible to give the average yield of the native plant, that is, of the trees upwards of two years old. It is probable, however, that this average is about 280 lbs. per acre. In highly cultivated and well-situated gardens the yield is said to be sometimes as much as 500 lbs., and even 800 lbs., or ten maunds, is said to have been plucked in one year on each acre in one garden.

In 1874 there were employed in the gardens which submitted returns 86,744 labourers, imported and native, of both sexes and of all ages. The area cultivated was 79,402 acres. Allowing a small margin for sickness, &c., this is only one labourer to the acre. One acre produces 196 lbs., and assuming that (as is generally the case) one-half of the labourers employed are adult males, a male labourer and his belongings may be considered to produce 392 lbs., worth say 33*l.* per annum.

The foregoing statistics prove that the tea industry is steadily developing. It may now be considered to be established on a firm basis.*

Planters differ in their opinions of the kinds of soil most suited for the growth of tea; but there can be no doubt that the virgin soil of the dense forests at the foot of the hills, where the climate is hot and moist, and where tea is often found indigenous, is the best. But tea will grow well in every district in Assam.

The use of machinery is steadily increasing, the rolling on many large estates being thus performed. Several machines have been

* India Office Report on the tea operations in the province of Assam, 1873–4. Assam Secretariat Press, 1876.

invented, and it is yet an undecided point which of them is the best. There are some one hundred and forty engines in the province, all of which have been imported within the last five years. The nominal horse-power of these engines is between 400 and 500. There are, however, drawbacks to the use of machinery—some real, some perhaps imaginary—which prevent its more frequent introduction. It is conceded that machinery makes a saving of from 50 to 60 per cent. in manual labour; but there is still a considerable prejudice against machine-rolled tea.

Another objection is certainly weighty, namely, that unless a very large quantity of leaf is brought in at one time, the employment of machinery is no saving at all. There is again an objection urged as to the dearth of qualified native artisans, to superintend the working and repair of machinery. Nevertheless, there is no doubt that a day will soon arrive when all labour-saving machinery will be called into use.

Perhaps one of the most vital questions to the planters of the future is the fuel supply. At present all the "firing" operations are carried on by means of the charcoal obtained from the forest which is cleared for the tea ground, or which grows on those parts of the several grants which are not under cultivation. It is obvious that the destruction of timber must be enormous, and at no distant period it will have to be decided how to manufacture tea with cheaper fuel than charcoal. The invention of such a method would be a great boon.

Tea cultivation is carried on in Kangra, Gurhwal, and Kamaun; and in Assam, Cachar, Sylhet, Chittagong, Darjeeling, and Chota Nagpore. In Dehra Dun there are 11 tea gardens, in Kangra 21, in Kamaun 38; and there are no less than 47 tea companies. In Darjeeling there were 62 gardens in 1871–72, covering 12,305 acres; and the out-turn of tea was 2,665,821 lbs. With a fair chance, Darjeeling tea could drive Chinese tea out of the markets of high Asia. Its growth in Sikkim employs 43 Europeans and 9493 natives. In Assam 31,303 acres were under cultivation, yielding 6,257,643 lbs. of tea; in Cachar 23,081 acres, with an out-turn in 1872 of 5,406,400 lbs. In Sylhet 21,408 acres, giving 4,641,659 lbs.

In 1850 there was one tea estate—that of the Assam Company—with 1876 acres under cultivation, yielding 216,000 lbs. In 1870 there were 295 proprietors of tea estates, with 31,303 acres under cultivation, yielding 6,251,143 lbs. of tea. In 1872-73 the area of land held by tea planters covered 804,582 acres; of which about 75,000 were under cultivation, yielding 14,670,171 lbs. of tea, the average yield per acre being 208 lbs., which is amply remunerative. In Kangra, the Punjab tea district, there are 28 plantations, including 7732 acres, of which 3292 are planted. The average yield per acre is 130 lbs., and the crop of 1872 gave 428,655 lbs. of tea. In the Dehra Dun there are 7801 acres under tea cultivation, yielding 411,548 lbs., and in Kamaun 1395, yielding 285,700 lbs. In Dehra Dun green tea is almost exclusively manufactured for the Kābuli merchants, who supply Central Asia, where only the green leaf is in demand. The trade is increasing, and the Central Asian demand has been a great advantage, as the planters now get at their very doors the same average price as they before obtained in Calcutta, after incurring the risk and cost of the journey.

In August, 1860, the Government of Madras addressed the Secretary of State, transmitting some copies of a useful and interesting report by Dr. Cleghorn, on the suitability of various places in that Presidency to the growth of the tea plant. Under the head of localities, Dr. Cleghorn includes the Shevaroy, Bababooden, Neilgherry, and Pulni hills; Coorg; Nundidroog (a hill in Mysore 4800 feet high); Curtallam, and Travancore. The tea plant, he thinks, appears to prefer a climate probably of 67° to 70° mean temperature. Such is nearly the mean temperature of the hill slopes near Coonor, Kotergherry, and of many of the valleys in the eastern and northern slopes of the Pulni and Neilgherry hills, and also of the Bababooden range in Mysore, and of Kudra Muka in South Canara. With reference to the hardiness of tea shrub, he says the cultivation extends over a great breadth of latitude (from the banks of the Rio Janeiro, 22½° south latitude, to the province of Shansing, in China, 36½° north latitude), and that, as we recede from the equator, the lower latitude compensates for the difference of altitude. The Chinese cultivate on the lower slopes of the hills, whilst in the North-West Provinces the culture is carried on between 2000 and 6000 feet. All that was necessary to secure a successful growth of tea in Southern India, in Dr. Cleghorn's opinion, was the aid of a few practised manipulators.

In the official report on the progress and condition of India for the year ending April 1875 it is stated that—

"The cultivation of tea is rapidly spreading in those districts of Bengal which are suited to the cultivation of the plant. The amount of the out-turn, though falling far short of the sanguine expectations of the first days of tea planting, is now amply remunerative, and the prices obtained in the market show that the average quality is good. The industry is, indeed, in an infinitely better and safer position now than it was ten years ago. The cultivation has enormously extended, and the gardens are, as a rule, well filled with plants, highly cultivated, and carefully managed.

"The native labourers are well treated by the European planters, and are generally contented; the best of them come from Nepal, and bear a good character for industry and aptitude.

"There were twenty-six new gardens opened in the Darjeeling district; the increase of area under cultivation was 3193 acres, and the increase of out-turn was 971,201 lbs. The average yield of an acre was about 325 lbs.; in 1872 it was about 256 lbs. The average quality of the Darjeeling tea was inferior to that of some other districts, but it is believed that this fact has been recognised by many of the leading planters, and that improvement may be looked for.

"The field for expansion of tea cultivation is stated to be indefinitely large in the long tract at the foot of the Darjeeling Hills, and there is also still room for increase in the Chittagong Hills and in Chota Nagpore. No soil that has yet been explored appears to have proved better adapted for the growth of the tea plant than that of the Western Dooars.

"In Madras the tea plant was introduced on the Neilgherry Hills about forty years ago, but it is only during recent years that any real progress has been made in the cultivation, which now covers nearly 2000 acres. The China variety, with which the oldest estates are planted, is the most hardy, but grows slowly, and produces very little leaf; the Assam variety, on the other hand, grows rapidly, and is a large producer of leaf, but it requires a sheltered situation on a rich fertile soil. The cross between the two is the most generally useful.

"The private cultivation of tea in the North-West Provinces progresses; the out-turn for the season was 1,217,975 lbs."

According to the latest returns we possess, there were in 1875 about 488,000 acres of land under tea in India, viz.:

	Acres.
Assam and Bengal	457,000
North-Western Provinces	17,200
Punjab	9,805
Madras	3,640

But these figures are not quite of recent date, and the extension of cultivation since they were obtained requires that some addition should be made to them. There are certainly not less than half a million acres under tea in India at the present date, and probably the area exceeds that figure. Of the tea produced in Assam and Bengal, the North-Western Provinces, and the Punjab, that portion which is meant for shipment is, with but slight exception, brought down to Calcutta, and shipped from that port almost entirely to England.

The growth of the tea industry in India has been almost unexampled in the history of its trade. The following figures represent the value of the annual exports during the fourteen years that ended on the 30th April, 1875; and there is every reasonable prospect of a continued progress, which will ultimately give Indian tea a foremost place among the productions of the country:

	Quantity.	Value.
	lbs.	£
1861–62	1,473,270	130,283
1862–63	2,253,773	178,128
1863–64	2,420,232	220,282
1864–65	3,457,430	275,055
1865–66	2,758,187	275,055
1866–67	6,387,088	340,572
1867–68	7,811,429	686,928
1868–69	11,480,213	951,376
1869–70	12,754,022	1,037,883
1870–71	13,232,232	1,120,517
1871–72	17,187,328	1,454,985
1872–73	17,789,911	1,577,691
1873–74	19,624,235	1,742,926
1874–75	21,137,087	1,937,429

This growth is very astonishing. The economic effects of the industry have not yet, however, been as fully examined as they should be. The trade has expanded year by year without interruption, and it will no doubt continue to develop. Tea now constitutes one of the most prosperous industries of India.*

This product is nearly all shipped from Calcutta, as the details of the last-named year's exports, 1874–5, will show:

	Lbs.
Bengal	21,023,941
British Burmah	5,905
Madras	87,372
Bombay	13,817
Sind	6,052
Total	21,137,087

The total crop of India tea for 1875-6 was expected to reach about 29,000,000 lbs. Tea companies which have never given a profit for years are now declaring an *ad-interim* dividend. Of the five tea districts, Darjeeling, Cachar, and Kumaon produce well.†

The successful results of tea cultivation in India must be regarded under two points of view—

1. The tea supply and tea demand in the world.
2. The tea supply in India, and the demand for Indian as opposed to China and other similar teas, such as those from Japan and Java.

First, then, of the tea supply and tea demand in the world. What is the present supply? China stands at the head of the list. The exports from that country (for we are not concerned here with what is consumed within the empire) may be put down roughly as considerably over two hundred and fifty millions of pounds. India comes next; the internal consumption is a mere bagatelle, and the export may be stated at twenty-five millions. Perhaps a similar amount, viz. twenty-five millions (on this point we are open to correction) will cover the exports from the other two places named. Assuming, then, China, at the outside, to export three hundred millions, we have a grand total of produce for the tea-drinking, but non tea-producing countries of three hundred and fifty millions of pounds.

Of the above, Great Britain alone takes, in round numbers, nearly two hundred millions—that is, over one hundred and seventy millions from China, and rather over twenty-five millions from India.

We have then only about one hundred and fifty millions left for all the other non-producing but tea-drinking countries.

It is true that some of these cannot fairly be included as consumers of this said balance, notably Russia and a portion of many parts of Asia, to which tea is imported direct overland from China. Including the tea that goes to those countries (the China produce, by-the-by, is probably far in excess of the three hundred million pounds we have assumed, but correct figures on this head are not obtainable, nor do they here concern us), the fact remains that to supply all the

* Statement of the Trade of British India.

† A paper on "Tea Cultivation in India," by Mr. C. H. Fielder, is published in the 'Journal of the Society of Arts,' 17, p. 291.

world with the exceptions above, to which Great Britain is added, only about two hundred millions of pounds are available.

When we consider, as already shown, that Great Britain alone consumes nearly one hundred and fifty millions, it is evident that two hundred millions is but a scant supply for all outside her—America and Australia, both vast tea-drinking countries, with rapidly increasing populations. Victoria alone took for consumption, in 1875, 5,915,316 lbs. for a population of 752,445. The duty there is only 3*d.* per pound. Tasmania consumed, in 1875, 614,529 lbs. of tea for a population of 103,663. The duty on tea there is 6*d.* per lb. California consumes about 4,000,000 lbs.

The continent of Europe will take more and more tea yearly, for the taste is fast being acquired. The same may be said of many parts of Asia, and if tea is ever drunk by the millions in India, then —but we need not speculate so far ahead.

It is evident that, supposing the China supply to be a fixed figure which will not increase, any extension in India that now appears possible (the labour sets a limit to it) will not only not exceed the demand, but scarcely keep pace with it.

Some have started the theory that new tea-producing countries will spring up and compete with India, notably large tracts in tropical America, which have suitable climates, but I think the fear is groundless. Two conditions are necessary for a tea-producing country—a good tea climate, which is more or less rare, and good and cheap labour. These China and India have, the latter in perfection in many parts; but outside these two, to which add Java and Japan (the latter fails in cheap labour), what country possesses the said two requisites?

Tea Planting in Cachar.—The tea plants while young are liable to various mishaps, from the dryness of the weather, from insects, from wild animals, deer, pigs, buffaloes, which abound in the place, and from the want of efficient labour. A piece of tea land of 100 acres seems a small quantity, but in Cachar, except in very favourable situations, it extends to nearly a mile in length over small hills and valleys. The proper superintendence of 500 acres of such land is beyond the power of a single individual; consequently a great deal must be left to the care of native servants, and such, skilled in tea cultivation, cannot be found in the district, except a few who may stray from Assam, and even they find so great a difference in the aspect of the tea lands between these two parts of the country that their former experience is of little use to them. The Assam plantations, I am given to understand, are generally on level or gently inclining lands, whereas the Cachar ones are on *teelahs* and their slopes, not adapted to retain moisture. Under these circumstances there is no wonder that there should be failures and disappointments.

If the cultivation advanced by degrees, say 50 acres per annum in the beginning, the result would be more satisfactory and the planters would gain experience. If the plants could be carefully attended to for the first two years, they would acquire a firm hold of the ground, and need very little attention afterwards, except in keeping the ground clear of weeds and jungle. The expectation of making large plantations with quick returns will, I am afraid, terminate in disappointment.

The cultivation of tea in the beginning is not an easy affair. It must be attended with considerable expense, especially on land just reclaimed from a state of nature, which is very difficult of being kept free from rank vegetation, except under dense shade. Estimates may be made, but the actual expense of a certain portion of land cannot be ascertained beforehand, unless the seed sown produces a plant at every stake. I am given to understand that the Assam Tea Company spent twenty-four lakhs of rupees (240,000*l.*) before receiving any return, and that after a period of fifteen years.

The art of cultivating tea in Cachar is only in its infancy. Various methods are proposed, but the severe drought of the two last seasons has put it out of the power of the planters to judge of the best plan. Irrigating teelah lands is out of the question, as water is not always at hand. The former plan of clearing the land of all forest trees is now abandoned; only the underwood is cut, the ground hoed, staked, and the seed sown. This method will afford shade, and protect the young plants from the parching nature of the soil. In the third year the plants must be topped to make them grow into bushes, and the shade removed to allow the rays of the sun to act on the plants and make them produce leaves. This is to be done by ringing the timber trees shortly after the seed is sown, and removing the withered trees at leisure. This plan is to all appearance the best yet adopted.

The great demand for tea seed to carry on large and extended cultivations has already enhanced its price 400 per cent. There are now at this moment eleven companies engaged in tea cultivation in Cachar, and all cannot procure the seed they require, except perhaps those intimately connected with the Assam planters. It is to be observed that tea seed ought to be obtained fresh, and packed in moist earth at the place where it is procurable, and forwarded with as little delay as possible to ensure its germination.

The difficulty of procuring labour for a tea garden will be soon seriously felt, especially during the rains, from the extension of tea cultivation and raising recruits in the district for the army. In the cold weather the natives of the cultivated parts of Cachar, Sylhet, and Jynteeah, readily take service for a short time, but at other seasons, when they have their own cultivation to attend to, they are not easily procurable. Before a cooly enters a tea garden he receives an advance of a rupee (2*s.*), or wages for ten days; as soon as this period expires, he goes away or engages for another ten days, but seldom remains above a month or two. In order to procure this labour, there are men called Duffadars, whose business is to receive advances from the planters and bring in the men from the villages, for which service they receive a fee of one-twelfth of an anna, or half a farthing per day per man. Under this system the man is careless at his work, and under no responsibility for the efficient discharge of it, and takes no interest in learning the business of a tea-garden malee; for should he be reprehended for any negligence, he immediately quits the garden, and is sure to find employment in another, from the great demand there is for labour at present.

Some grants have an advantage over others in having a larger quantity of indigenous tea. These had the first choice and took in large tracts of land, retaining those portions of it where the indigenous plants were the most abundant, and these they cut down to form leaf-bearing bushes, thus depriving themselves of seed, which would be of great value from its freshness, to carry on future extensions. The success of a cultivation must depend on the plants raised from seed, for the indigenous trees are so scattered that the labour of picking the leaves and manufacturing tea will hardly be compensated by the value of it.

There are three or four species of tea plants, the China, the Kumaon, the hybrid, and the indigenous, all of which may grow in Cachar under proper treatment; but that which will be the most remunerative is still to be ascertained, for no plantation here has had sufficient experience. In Assam the indigenous is found to answer best in this respect, from its forming the largest bush, and yielding in consequence more leaves, but the quality of the tea is said to be coarse, not equal to the fine China. The indigenous, although it may grow spontaneously in the impenetrable jungles of Cachar, is the most difficult to be managed under the hand of man, from a want of the knowledge of its physiology. The year before last the planters removed several lakhs of plants from the jungles into their lands, all or most of which perished from the want of shade and moisture, and injury done to the roots by the carelessness of the labourers employed.

It is almost certain that tea will not grow in Cachar in exposed situations, especially the indigenous kind, with such dry weather as was experienced the last two years, without considerable expense of watering the young plants; therefore those who had the misfortune of having lands cleared either by themselves or the Kookies have allowed jungle trees to grow on them again for shade, after losing almost all their plants. This is indeed very discouraging, and it has induced some to throw up their former cultivation and select virgin forests, but such lands can only be procured in the interior, where labour is difficult to be had.

Lands near villages are not virgin forest, they have been cultivated by the Kookies in various parts, which renders the labour of cultivating tea on such lands very expensive, by their requiring continual weeding, shading, and watering the plants while young during the dry weather. It was thought in the beginning that lands so cleared would be an advantage, at least in saving the expense of cutting down large trees, but the dry weather experienced the last two years has shown this to be a mistake.

From the foregoing remarks an idea may be formed of the difficulties attending the cultivation of tea in Cachar, but the abundance of the indigenous tea found scattered in every piece of high land, which would be much more plentiful if the Kookies in their system of cultivation did not destroy a great part of it, shows that the plant can be profitably reared, and the failures hitherto are mainly owing to the want of attention to the nature of the plant, which requires shade and moisture in its infancy for two or three years, when it takes a firm hold of the ground, and nothing will destroy it.

A tea plantation conducted with caution and economy, and the ground gradually filled with plants, must become a valuable piece of property, highly remunerative to the proprietor, as there is very little expense afterwards, except in gathering leaves and manufacturing tea for six months in the year. The former operation, which is a light labour, can be performed by women and children at a small cost, and there is a disposition at present on the part of the natives to settle near tea gardens, to which they can be attracted with a little encouragement; thus the want of labour at present experienced will be removed in time.

Sikhim.—The first impression one gets on going through the Sikhim tea gardens is that the cultivation as a rule is carelessly and wastefully conducted, and that an attempt has been made rather to get a large area planted, than to have a small compact plantation with every bush yielding a maximum quantity of leaf. During the rains, there are on many of the estates more weeds than tea, and these weeds not only occupy ground which tea ought to occupy, but cost a heavy outlay to root out or cut down, and they look bad. We admit, however, that there are many gardens, in the Terai especially, below Punkabari, which could hardly be improved; and here, where the ground is level, a horse hoe, we believe, would be far cheaper and more effective in cleaning the ground than the regiments of coolies now employed. A hoe, such as is used for turnips at home, capable of being widened or narrowed by a hinge in front, and with three wheels, one in front and two behind, to allow of the depth to which its teeth penetrate being regulated, would, we believe, answer admirably. The distance between the plants varies on almost every estate, but the best and most recently planted grounds have the tea plants much closer together than on the old plantations. Tea hedges 3 feet apart, with 1 to 2 feet behind the plants in the row, is, we believe, about the best distance.

As the plucking of the leaf has to be done by coolies, these hedges are not cut into any regular shape, but are, as a rule, flat-topped. We think this is a mistake, for it exposes the smallest surface to air and light; and the centre of the flat upper surface of each bush being nearer the root than the sides, the plants, we should think, must "flush" irregularly. The hedges should be clipped into a semicircular form, or as two sides of an equilateral triangle. It would be interesting to know how much green leaf a tea plant of say six years and of a particular size can be made to yield without excessive plucking. It is said that nineteen maunds per acre have been got from a small area, and at 3 feet by $1\frac{1}{2}$. This gives only $2\frac{1}{2}$ ounces to each bush, which is not a very large amount of leaf, seeing that each plant has a surface of at least 3 square feet; but nine maunds of tea per acre is considered a very fair amount, which, allowing only half the number of bushes per acre, as at 3 by 3 feet apart, is about the same yield per bush, or $2\frac{1}{2}$ ounces. If a bush can be made to yield this amount, when growing at 3 by $1\frac{1}{2}$ feet, then the area of which a quarter is now covered with straggling bushes 4 or even 6 feet apart, might yield more than it does at present.

The greatest drawback to the improvement of the cultivation is, that it is in the hands of joint-stock companies, with but one object, to see their shares stand high in the market. A number of small estates managed by the proprietors would yield very much more tea from the same area; and the cultivation would improve more rapidly. On the present plantations, owing to their large area and the bushes being too scattered, much manuring or high cultivation is out of the question. It takes all the attention of the manager to keep down weeds. Taking the yield per plant at a very moderate estimate, ten maunds of tea ought to be got from each acre, allowing about two ounces per plant. A hundred acres of tea at this rate would give about 50,000 rupees (5000*l.*), allowing only 8 annas (1*s.*) per lb.; and the expenses of very high cultivation and the manufacture of the tea could not at the outside cost half this sum.

Experiments are much wanted to test the comparative values of different varieties of the plant. On walking through a large plantation, one cannot fail to be struck with the very great diversity of leaf, vigour, &c. Some plants have large soft leaves, others shoot small hard leaves; some seem to flush twice as well as others; and if a careful selection of plants were made from which to preserve seed, a very superior plant might be obtained. Such experiments would no doubt be made if the tea gardens were owned by the managers, and were in a state of very high cultivation. Hybridising has been tried, and plants are now grown which are said to be hybrids; but very much more might be done in this direction in crossing the Assam with the China plant, and in crossing superior varieties.

The object of the Indian Government in establishing tea plantations in Kumaon and Gurhwal was to demonstrate by practical experiment that the hills in those provinces were adapted by soil and climate for the cultivation of the plant, and that the manufacture of it would yield a very substantial mercantile return. The experiments succeeded, under the able management of Dr. Jamieson, beyond all expectation. The plantation of Paoree, which four years previous was a mere rhododendron jungle, in 1855 had 350,000 plants yielding tea, and 500,000 seedlings. The yield in 1854 was about 34,000 lbs. of tea, on a plantation of less than 200 acres; and the returns in 1855 was 5000 lbs. The Kaologir plantation (North-West Province) yielded 4112 lbs. in 1854, and 10,000 lbs. in 1855, the yield being at the rate of 70 lbs. per acre. There were 390 acres under culture, but not all bearing.

In the Dehra Doon the progress has been even more remarkable. As the tea lands in the Kangra valley yield from 200 to 300 lbs. of prepared tea per acre, while the expenses of culture are very small, the profit to be earned by judicious tea cultivation must be very great.

Nagrota, the first plantation started, is of insignificant dimensions, merely a small garden plot in fact, about eight miles north-east of Kangra. Bhawarna, situated about ten miles farther on, is not much larger. Holta lies about four miles farther, immediately at the foot of the Himalayas, about twenty miles south-east from the Sanitarium of Dhurmsala, and equidistant from Kangra. Holta has an elevation of between 4000 and 5000 feet above the sea. It has a truly delightful climate, which bears a strong resemblance to that of Kashmere. The Holta plain is several square miles in extent; and so much of it as is available is being rapidly brought under tea cultivation by Dr. Jamieson. The soil appears admirably adapted for tea, as well indeed as for almost any kind of crop; and both Dr. Jamieson and the Chinese consider that if any preference is to be given, it is the most eligible for tea purposes of any part of the sub-Himalayas.

Tea Cultivation in the Punjab.—About 1850 a lakh of rupees (10,000*l.*) was granted by the Government for the promotion of tea cultivation in the Dehra Doon, and in the course of five or six years the plantations were found extending in all directions, and the tea plant was thriving over four and a half degrees of latitude and eight of longitude, or an area of 30,000 square miles—about one-fifteenth of the whole area of British India. Of course this is not exclusively devoted to tea culture, but in districts throughout the whole space the plant has been grown with advantage. There are now about 40,000 acres under culture in the Punjab. In Kumaon some of the plantations have long been yielding twelve maunds of raw leaves per acre.

The tea industry in Chittagong is rapidly progressing, and some experiments on a limited scale have lately been made with coffee cultivation, which have proved successful. The total out-turn of tea from the division during the official year 1875–76 is estimated at 431,554 lbs. It is said that tea cultivation has already attracted the attention of the natives of the place, and that a few small gardens have already been opened by some of the neighbouring zemindars. In 1871–72 the value of tea exported from Chittagong was 25,214*l.*; in 1875–76 the value was 47,908*l.*

The following suggestions are from a communication received from Mr. James McPherson, as the result of his own observations in India:

"There are two very well-marked varieties of the tea plant, if indeed they are not sufficiently distinct to be ranked as species. These are *Thea Assamica* and *Thea Chinensis* (syn. *viride*). The first of these is the one with which western people became last acquainted, and it occupies a somewhat different position, naturally, to that in which the Chinese plant is usually found, if indeed the Chinese plant has even been seen in other than a state of cultivation. The varied conditions in which the two kinds, with their innumerable varieties, are found, may sufficiently account for the difference in their appearance. *Thea Assamica*, the Indian species, is usually found growing wild (and able to reproduce itself from seed) along the margins of the Assam forests, frequently manifesting a partiality for the banks of streams. The climate of Assam is tropical, and, in parts, very moist, and frost is almost unknown in its tea gardens, while the average temperature is about 70°, and the rainfall about 80 inches. The tea, like the wheat plant or the vine, has, however, a remarkable adaptation to a very great range of climate, and I have known tea grown with perfect success where the mean annual temperature was only 58° Fahr. and the rainfall from 30 to 50 inches. Perhaps it will reach its greatest perfection where the mean annual temperature ranges from 60° to 55° Fahr. and where the rainfall, or what is quite as important, the humidity of the atmosphere, is considerable during the growing season, which in northern latitudes usually begins in March. Considerable heat, and foggy, cloudy weather, constitute what is known as a 'fine growing time' for the tea plant. Moisture in the air, rather than moisture in the ground, seems to be requisite. Situations which are exposed to severe frost should be avoided, since it will entail too much labour to protect the *young* plants."

Ceylon.—On the higher mountain regions of Ceylon tea culture has advanced rapidly within the last few years, and the planters have begun to send supplies to the British market, for our imports of tea from the island were in

	Lbs.
1874	484,135
1875	159,592

In 1872 there were but 10 acres under culture with tea, in 1875 this acreage had increased to 108 acres.

An experienced planter thus touches upon the prospects of tea cultivation in Ceylon:

"In Eastern Bengal, in the North-Western Himalayas, and on the Neilgherries, the tea plant is successfully cultivated, but there is not the slightest similarity of climate between these three districts, and their soils are for the most part markedly different. It becomes apparent therefore to anyone possessed of the slightest knowledge of horticulture, that a system of culture which might be found admirable on the cold slopes of the Western Himalayas, would not be found to answer in the hot moist jungles of Assam or Cachar, and that the climate of the hill districts of Southern India and Ceylon, which are, as it were, a medium between the extremes of the other two, will require yet another change in the mode of treatment of the tea plant.

"When we come to think of the almost total similarity of the Neilgherries and Ceylon in all leading points, viz. latitude, climate, annual rainfall, and general character of the soils, we may reasonably conclude that the systems of culture which are the most successful in the Neilgherries will also be found those most efficacious in the sister district of Ceylon. We need only read one of the share lists of the Bengal companies to see how highly remunerative an investment tea may be made under proper management, and there are, besides these, many hundreds of private gardens whose returns are much greater, but of which the outside public receives no information. Tea cultivation is free from nearly all the dangers and risks attendant on coffee planting. It possesses, too, the advantages of growing at higher elevations, and consequently affording to the planter a better climate to live in, while it may be made to pay well on soils which are utterly unsuited to coffee cultivation. The demand for Indian tea is rapidly increasing in London, the colonies, and America; and I doubt not the time is fast approaching when China produce will be driven out of the market. The superior strength, flavour, and purity of the Indian growths are gaining ground every day, and from the ease and economy with which teas can be cultivated, even by very small capitalists, it is hard to find, under proper management, a safer or more remunerative investment for capital.

"The systems of cultivation and manufacture now practised are far in advance of those which prevailed some ten years ago. Higher cultivation, a thorough knowledge of the principles of manufacture and of the chemical changes through which the leaf passes during the various processes, and last, but not least, the invention of mechanical appliances to save labour, have lightened by a great deal the planter's toil, diminished his expenditure, and added to his profits.

"There must be some hundred thousands of acres of land in Ceylon which might be planted with tea to the profit alike of the planter and the country. That with high cultivation and judicious management this land might be made to yield with ease its 400 lbs. an acre, and that the tea, if well manufactured, will not fail to realise an advantage of upwards of 2*s.* per pound in London. As the cost of upkeep, &c., should not, under any circumstances, exceed 10*l.* per acre, a ready profit of 30*l.* sterling will accrue from every acre of land in full bearing.*

"A good selection as regards site, soil, and climate is all-important to any man who contemplates opening out an estate, and on this account stands at the head of the subjects to be treated of. To these, however, I shall add the supplementary and equally important questions of rainfall, labour, and communications.

"Absolute perfection in all points cannot be expected, but each of the qualifications pointed out must be developed to a certain extent before the site can be pronounced a suitable one for a tea estate. The headings therefore into which these chapters will be divided are: 1. Lay of land, climate, elevation, and aspect; 2. Rainfall; 3. Soil; 4. Labour; and 5. Communication."

Lay of Land, Climate, Elevation, and Aspect.—The first point that calls for notice is lay of land. Low undulating hill-sides form by far the best site for a tea estate; land, in fact, where the incline is just sufficient to carry off the water during heavy falls, without washing away the soil, and yet not so flat as to allow the water to collect and stagnate anywhere. Draining will, of course, be necessary, in a greater or less degree, on every estate, but a little forethought shown in the selection of site will reduce this item of expenditure to a minimum. At the same time, we would not reject a piece of land that was suitable in all other respects, on the score of a slightly excessive slope, as by additional drains in some places and by terracing in others, this fault may be easily overcome. Perfectly flat lands may often be made available for cultivation by such draining. The site of a tea estate should, if possible, be naturally sheltered from the effects of prevailing high winds. If natural shelter cannot be had, artificial means must be resorted to, such as laying out a belt of quick-growing trees all round, and in many cases here and there across the area of land intended for cultivation. Australian eucalypti and occasionally the larger kinds of cinchona are

* Making a large deduction from the figures here given, the profits are likely to be satisfactory. Ceylon tea, with but imperfect means of preparation available, has already been valued at 2*s.* 6*d.*

among the best trees that can be used for this purpose, and will soon afford sufficient shelter. The general question of the Australian and indigenous timber trees that may be grown with advantage on tea estates will be considered in a subsequent chapter. Tea suffers as much, if not more, from rough winds, than it does from extremes of heat and cold. Experience in the Neilgherries has taught me the great importance of shelter from strong winds, and I know of one or two gardens whose yield would be doubled if they only possessed belts of trees to shield them from the violence of the wind during the storm season. Valleys that take the form of a shallow cup or bason, offer the most favourable site for the formation of a tea estate; a plentiful supply of water, too, is no mean consideration. Every site should have a spring or stream of water rising high up, and capable of being diverted from thence to any other part of the estate; it may be utilised for household purposes, turning machinery, to supply the nurseries, and in time of severe drought for irrigation purposes. There should always be in some central situation a flat of a few acres, on which the manager's house and factory may be built. The further consideration, however, of these matters will be left for another chapter; I will now pass on to the question of climate.

Climate.—The climate in which tea grows best is that which is warm, moist, and equable throughout the year; where the weather presents, in fact, a succession of alternate showers and sunshine. Excessive downpours of rain, though doubtfully beneficial, are better than dry, hot seasons. The effects of either, however, will depend much on the elevation of the estate. Our first statement is proved by the luxuriant growth of the plant in Assam and the other districts of Eastern Bengal. These show a result far ahead of any that can be obtained in the tea districts of China. The plant, however, is one of the hardiest in cultivation, and capable of enduring great extremes of heat and cold, the effects of which are merely to temporarily check its growth, and diminish its yield, seldom killing it outright. The cultivation of tea is confined to the hilly districts of India. The reasons for this are chiefly—1. That the soils of the low country are not suited for tea cultivation; 2. That the sun's rays are tempered to a great extent on the hills; 3. That there is a more liberal and regular supply of rain. To sum up: the climate best adapted for tea cultivation is one like that of Assam, where the thermometer seldom ranges higher than 96° in the hottest season during the day, or goes down below 56° at night; where, too, there is a rainfall of from 100 to 120 inches, equally distributed throughout all the months of the year. Unfortunately, the climate which is most congenial to the tea plant is that which is the least so to the planter, and on this account many (more especially those who are working gardens on their own account) are content with smaller returns in a pleasant and healthy climate. I shall now take a brief notice of the several tea districts of India, noticing the growth, condition, and yield of the plants in the different climates and at different elevations. The climates of Assam, Cachar, and Chittagong are so similar in all respects, and so comparatively well known, as to render unnecessary a special notice of them; but I may make one observation, viz. that the hot season in Chittagong is occasionally accompanied by so little rain as to cause great mortality among the young plants, and to affect more or less the yield of older ones. In all these districts tea is cultivated from a very little above sea-level, up to an elevation of 2500 feet, or even more; and within this range there is not, I think, any appreciable variation of climate. At Darjeeling the tea plant is cultivated up to an elevation of 6000 feet. The rainfall here, though ample, is slightly less than that of the above-mentioned districts. The plant will grow, as I have said, at as high an elevation as 6000 feet, but, for anything like profitable cultivation, 3500 feet is, in my opinion, the outside safe limit. The higher up you go, the more highly you must cultivate; it follows, therefore, that the planter will get a better return for his money at the lower elevations.* The remaining hill districts in the north-west are the Kangra valley, Dehra Doon, Kumaon, Gurwhal, &c. What I have said about Darjeeling applies in a great measure to these also, i. e. success will very much depend upon the elevation, and the warmth and moisture of the climate. In Southern India, though practical tea planting is of very recent date, the plant is grown upon the Neilgherry, Anna Mulley, and Pulney hills; also, I believe, in Travancore; and at suitable elevations grows far better than in the hill districts of Bengal. In the Neilgherries, owing partly to latitude, and partly to the less liberal allowance of rain, tea is grown at higher elevations than would be advisable in Bengal. The rainfall varies between 60 and 80 inches, but it is most evenly distributed throughout the months of the year. The best elevation here is between 4800 and 5600 feet. Lower down than this the sun's rays take too powerful an effect during the dry season, while above 6000 feet, excepting a few well-sheltered localities, the wind is excessive. I have, however, seen tea cultivated at an elevation of over 7000 feet. The plants in this case were tolerably healthy, but, owing to cold, grew very slowly, and yielded but little leaf. On the Anna Mullay hills and Travancore, I think they might prove even better districts than the Neilgherries. The plants suffer from want of rain during the hot season—a very serious drawback in these low altitudes. From the foregoing remarks it will be seen that the yield is greatest in Eastern Bengal; but, at the same time, with high cultivation a very good return may be made at higher elevations, when the thermometer by day ranges between 62° and 75°; and the rainfall does not fall short of 60 inches. Under these circumstances, however, a higher system of cultivation must be adopted. It is for the planter himself to decide whether or no he will content himself with smaller returns, and live and work in a good climate; or make as much as he can in a short time at the risk of his health—nay, of his life also. To sum up: in Bengal I would not recommend the opening out of an estate at a higher elevation than 3500 feet above sea-level, while in Southern India I consider 5000 feet about the right elevation. If equally distributed throughout the

* The mountains of Ceylon, being only about 7° from the equator, I believe that tea, when fairly well sheltered from wind, will grow well there at 5000 feet, and even at a higher altitude.

year, 60 inches of rain may suffice, but the most favourable rainfall is from 80 up to 100 inches. With regard to Ceylon, what I have said regarding the Neilgherries will hold good there—excepting that owing to Ceylon being several degrees of latitude lower, tea might be found to grow well up to over 6000 feet.

Aspect.—Some planters think aspect an all-important consideration, and, in many cases, give apparently good reasons for doing so. Thus one side of a hill may be almost denuded of vegetation, and, consequently, get less rainfall than the other side which is more abundantly wooded. When the monsoon is very heavy, an aspect exposed to all its violence should be avoided; though in some cases the land may be sheltered by either leaving protecting belts of the forest or growing Australian or other quick-growing trees for this purpose. In Southern India, a northern aspect is considered by many a *sine quâ non*, on account of the sun's southerly declination during the dry months of the year; and Mr. McIvor, for one, lays great stress upon this point. In my own opinion, aspect is a question of slight importance in warm, sheltered, and moist situations, such as I would select for opening out a tea estate. I have now tea growing here on all aspects, and have noticed nothing that warrants my judging any one of these better than another. If the planter has a warm, moist, agreeable climate, a site well sheltered from rough winds, a good lay of land, and a fair soil, he need not care much about aspect, and it will be his own fault if he cannot get 400 lbs. of made tea per acre when his estate is in full bearing. As a rule, the suitability of a site for a plantation may very generally be determined from the nature and appearance of the vegetation growing on it. Heavy forest or luxuriant scrub land is generally well watered. Wherever ferns grow luxuriantly, one may feel certain there is good soil and abundance of moisture.

Soil.—On this point there have been diversities of opinion: some men say that tea will grow in any soil; others, that it will only grow in the soil of the richest virgin forests. Both parties are in error. The former are right as regards the growing; but the very highest cultivation will be needed to make tea pay, if grown in a poor soil. On the other hand, the richest soil may, if in too cold a climate, or in an unsheltered situation, turn out a failure. My own opinion is, that the soil should at any rate be of moderate excellence, the other above-mentioned qualifications of a site being present. The improvement of the soil lies very much in the planter's own hands; whereas he is powerless to remedy the defects of climate, rainfall, &c. The soil most suited for the cultivation of the tea plant is a light, rich, friable loam, extending to a depth of at least 1½ or 2 feet, with a good upper surface of decayed vegetable mould or humus. The latter contains in itself a sufficient supply of organic matter to last for the first five years of an estate's existence. In all cases, there must be a good supply of organic matter in the soil, and when this does not exist, the want must be supplied by manuring. The nature of the soils of the several districts varies considerably. In Eastern Bengal the soils contain a very large percentage of sand; so much so, in fact, that were it not for the abundant rainfall, the plants would be burnt up by the sun. The vegetable or organic matter contained in these soils is also subject to a good deal of variation. The soils of the Himalayas are much richer in organic matter, and contain stone or slate to a greater extent. These also, as they contain a certain amount of clay, form a more tenacious soil, less liable to wash away, but apt to cake in dry weather; and whenever this caking extends below the surface of the soil, the roots of the plant will suffer. Moderate cohesion at the surface is desirable, as by this means an abundant supply of moisture is preserved underneath. Perhaps, as far as soil is concerned, some of the Himalayan soils are the richest of all the tea districts of India. In Southern India the soils are, in suitable localities, richer than those of Eastern Bengal, but slightly less so than the best Himalayan soils. The surface soil is a fine rich loam, sometimes more than four feet deep, varying in colour from a yellowish ochre to a rich deep chocolate. In some cases a good deal of stone is mixed up with the soil, but on this point I shall have occasion to speak hereafter. In these remarks on the soils of the various districts, it is not intended to assert that the soils all over the districts mentioned are of this nature, but only those lands which are adapted for tea cultivation. Before entering upon the subject of soils to be avoided, a few remarks will be necessary regarding subsoils. I consider the latter entitled to quite as much consideration as the surface soils. The best subsoil for tea is a reddish and slightly ferruginous clayey gravel. The tap-roots are able to penetrate this to any depth, in search of moisture. The presence of stone in a subsoil is not injurious, unless it is present in the form of slabs or large boulders. In this latter case the tap-root is unable to clear the obstacle, and the plant dies. In Bengal a subsoil composed of sand with a slight admixture of clay is a very good one. The clay retains moisture, while the sand causes filtration, and does not allow any water to stagnate round the roots of the plants, in which case they would soon rot. Clay by itself is too stiff and retentive, while sand, on the other hand, is too porous, and renders it necessary for the roots to penetrate to a very great depth before they can reach moisture. The chief points therefore that are required in a subsoil are: 1. That it should retain a sufficient supply of flowing moisture for the support of the roots of the plant; 2. That the moisture so retained should never stagnate; 3. It should be so free that the tap-root can penetrate it easily; 4. That it should contain no injurious quantity of mineral oxides. It is a generally received opinion that all tea soils should be slightly *ferruginous*, that is, that they should possess to a certain extent that reddish appearance which always betrays the presence of iron in a soil. If this is not apparent on the surface, it should, I think, at any rate, be perceptible in the subsoil. There is one peculiarity common to the soils of all the tea districts, which is the very slight percentage of lime contained in them. The percentage of lime is by far highest in the Chittagong soils. This peculiarity does not exist in India only, but extends to the soil of the tea districts in China also. The existence of lime in a soil does not seem so necessary to the tea plant as it is to most other forms of vegetation. Now to consider the question of stony soils. Many are of opinion that the presence of stone in a soil is not desirable; but past experience, both of soils that were very stony, and of soils almost free from stone, has led me to think differently. Light soils, free from stone, are certainly more easy to work, but then they are more liable to wash. In clayey soils, stones assist filtration. Stone, unless present in large masses, is, in my opinion, no disadvantage to soil. Moreover, granitic gneiss, felspar, quartz, &c., when undergoing decomposition under the mechanical influence of sun and rain, supply a valuable inorganic manure. Under every stone there is a constant and never-failing supply of moisture; stones absorb heat during the day and give it out at night, thus rendering the temperature in their immediate neighbourhood more equable. They prevent wash, and retain large quantities of rich soil in their crevices, which latter would otherwise be lost. It is only when the tap-roots strike upon a large stone that any injury results. If a soil is too sandy, an admixture of clay and cattle manure will remedy the defect. This may frequently be effected by turning up a portion of the subsoil. If too clayey, burning and subsequently mixing wood ashes with the soil will be a good remedy. If deficient in humus, organic manures must be applied. There are certain soils especially to be avoided by the planter. These are—1. Peaty soils; 2. Strong heavy clays; 3. Soils composed almost entirely of sand; 4. Sour grass lands.

Labour.—There are two classes of labour generally employed on tea estates, viz. local and imported. If a sufficient supply of labour can be obtained, a great saving will be effected to the planter during the first five years; and whenever he can he should keep this point in view. Such labour is, as a rule, cheaper; there is no expense in procuring it, no necessity for bringing grain for the men, while the expense of hospitals and lines, medical attendance, &c., is saved. This labour is, however, apt to become very independent; and therefore it is always as well to have a certain staff of imported men to fall back upon in case of strikes, &c.

Communication.—Roadmaking is an expensive business, and ought to be kept within bounds; water communication is by far the best and cheapest, but not often procurable. When this cannot be obtained, you must select land within moderate distance of a Government road. If the tea has to be carried any distance by men or carts, carriage will form a very heavy item in your estate expenditure; as it will also in the case of tools, supplies, &c., that have to come from a distance. The value of a property, therefore, is much enhanced by its bordering on a navigable river, or having a good road near at hand.

On the Laying-out of a Tea Estate.—Considerable judgment is required in the selection of that part of a property which is to be opened out. The great point is to combine, as far as you possibly can, the essential qualifications of good soil and a good lay of land, bearing in mind at the same time that compactness of form, and free communication to all parts of the property, will in after-times greatly facilitate the working of the estate. The first thing to be done by the purchaser is to make himself thoroughly acquainted with the tract of land he has purchased, both as regards the lay of the land, the nature of the soil and subsoil, the number of springs, streams, &c. ; and what timber valuable for building, making houses, and for fuel, there is on it. He should also, previous to opening out, inspect any other estates that there may be in his neighbourhood ; and by carefully noticing the results on these, may save himself from falling into serious errors when he commences his own work. It is well worth his while to collect samples of soil from the various parts of his estate, and when dry to have them analysed, or else examine them carefully to ascertain, as far as he can, their general nature. He may compare these samples with the soils in the Neilgherry Gardens, and should note the general characteristics of those in which the tea plant thrives best. He will also be able, in these trips, to decide pretty accurately the future sites for his factory, buildings, and nurseries.

The best lands are found, as a rule, on the lower slopes of hill-sides, and in sheltered ravines. The higher up he goes, the poorer will he find his soil. The reason of this is, that every year large quantities of surface soil and disintegrated rock are annually washed down from the higher lands, and the lower slopes are thus covered with a thick and rich alluvial deposit. In Ceylon there are some striking exceptions to this rule: land close to the foot of mountains, and even in some cases on the tops of very high hills, being richer than that farther down the course of streams.

He will examine the springs and streams, and ascertain whether they can be rendered available for factory purposes, or in cases of extreme drought, for irrigation. A careful study of all the varieties of timber growing on an estate, and the means of detecting that which is of value, is very necessary. There may be abundance of wood suited for fuel and making charcoal, &c., but seldom is there any surplus of woods that are suited for building purposes, making houses, cabinet work, &c. When he has decided on the tract of land which he will open out, his next business will be to clear it—that is, to fell all the trees and low jungle, so as to allow them to dry all through the hot season, previous to being burnt. Felling, then, is the first consideration. Whenever I can, I prefer to do this work by contract. From past experience, I am convinced the manager, if he knows how to fix the rates, will get his work done cheaper and better on this system. Opinions differ as to how this work should be done. Some cut and burn the undergrowth, merely ringing the large trees; others cut all down together. A few trees of a comparatively harmless nature may be left here and there, as a relief to the eye : the injury resulting from their presence will be very slight. In addition to these, all those trees whose timber is valuable should be rung and left standing. The timber thus left will be less injured by the after-burning than it would be if felled. The operation of ringing consists of cutting away the bark, and a small slice of the alburnum all round the tree for a space of from one to two feet. When this has been done, the sap cannot ascend, and the tree dies rapidly. When the land is planted, the young tea plants will suffer very little from the falling of the trees. As soon as the trees that are to be left for ornament have been marked, and the timber trees rung, the remaining forest in jungle may be cut down immediately. The best time for doing this is just at the close of the north-east monsoon, as there are then four or five months in succession of fine weather to dry the wood previous to its being burnt. Many chips from trees are decidedly injurious to the tea plant, and in most cases shading the seedling, are unnecessary, if the transplanting has been effected at the proper season and with due care. The best method of felling is to begin from the bottom, cutting down clear all the scrub, and cutting the large trees three-quarters of the way through. This plan is continued to the very top of the piece to be felled. Here some ancient patriarch of the forest is selected and cut through, and as he totters and falls downward, he carries the rest of the forest with him at one sweep. To fell each tree separately would entail much greater expense. In clearing land, always, when practicable, leave a belt of forest from 25 to 50 yards wide, on all sides, so as to shelter the interior from severe winds. Never denude your hill-tops; by so doing you diminish your rainfall. Leave a belt of forest all along the course of springs and streams; otherwise they may dry up partially, if not wholly, during the dry season; also leave a fair proportion of trees of vigorous growth (especially when procurable, *Cinchona succirubra*), round your building sites, not only for the sake of shade, but also for the reason that though they absorb noxious gases, they exhale pure oxygen.

We now come to the question of burning the jungle so felled. As I have said before, on strong clayey retentive soils, burning is of unquestionable advantage; but as to burning under other circumstances opinions differ. On light rich soils, abounding in humus, a heavy burn does, in my opinion, more harm than good, both by drying up the surface and thus rendering it less retentive of moisture, and by setting free all the volatile gases contained in the organic portions of the soil. It is better, therefore, in these cases, to cut off, pile, and leave only the tops of the felled trees, together with all the small undergrowth. The ashes of these will supply no small amount of potash and other inorganic manures. The long trunks may be cut into convenient lengths, and rolled down into the nullahs, or, what is better still, where stone is scarce, ranged in lines horizontally along the hill-sides, to form terraces, and thus intercept excessive wash. This system is undoubtedly a more expensive one, but past experience convinces me that it will amply repay the cost in the end. The timber trees that have been left standing will have suffered little internal damage from this slight burning. The only advantage derived from a heavy burn is, that all forms of insect life in the soil will be destroyed, as also many germs of weeds.

For burning jungle, a fine day with a light favourable breeze should be selected, and the jungle should be set fire to from the very bottom of the block, a series of fires being kindled along the whole length. The remnants of the first burn may be collected, piled, and burned a second time. As soon as all the head branches have been burnt, the surface roots should be dug out and similarly treated. The larger stumps must be left to rot; their removal would entail too great expense. For some districts it may be thought advisable to destroy, as far as possible, all dead wood, as, during the process of decay, it furnishes food for myriads of white ants, which, in the opinion of some planters, attack the tree as soon as the supply of dead wood has failed them. In Southern India, at all events, I have never seen a healthy tea plant attacked by white ants, and I doubt much, if they do not, attacking a diseased and unhealthy plant, do the planter as much good as harm.

The planter's next care is to select the sites for his bungalow, factory, and office, in one group; the writer's house in a second; and cooly lines, as most convenient, elsewhere. For the factory group, I prefer a flat of two or three acres in extent, so situated that a water channel can run through it. The bungalow and factory should be built close to one another, and in as central a position as possible, so that the manager can, during the season of manufacture, be in and out of his tea-house at the shortest notice. The chances of tea being damaged is thereby much lessened. The writer's and servants' houses should also be near the main group of buildings. The cooly lines may be built at some little distance from the bungalow, and, if possible, out of sight of it. If, for these buildings, a natural flat cannot be obtained, artificial means must be resorted to, and a wide terrace cut out from the side of the hill, care being taken to cut a deep drain at the back, as damp is to the native one of the most fertile sources of disease. On some large estates a hospital will be required, and where needed no effort should be spared to render it as comfortable and effective as possible. It now remains to connect the factory group of buildings with the main source of communication, the various building sites with one another; and to make all parts of the estate accessible by roads of easy gradient.

It is often necessary to establish means of communication beyond the limits of the estate, that is, to the nearest Government road, or navigable river. If possessed of very strong powers of persuasion, the planter may induce our Indian Government to contribute to the expense of making these roads; but as a rule he may expect but little help from that quarter. At the same time I think unnecessary expenditure on roads a mistake; I believe that, both on the score of economy and the efficient working of the estate, there ought to be good communication throughout its whole extent. The first road to be considered is that from the factory to the easiest source of supplies. This road should be made at least 8 feet wide the first year, all revetments and bridges being made full 15 feet, and the gradient should not be less than 1 in 17. By adopting this course, the road can ultimately be made available for cart traffic at a trifling cost.

The general design of the estate is now complete. It only remains to get it ready for subsequent planting operations. The main drains are the next consideration. These are intended to carry off all the volume of water which cannot be absorbed by the soil. The existence of these on an estate are of the greatest importance, and I do not think that the majority of planters see sufficiently the necessity that there is for them. The heavier the volume of water that runs down the hill-side, and the steeper the gradient at which it flows, the more soil it will wash away in its course, and if an efficient system of drainage is not kept up, in two or three years the whole of the surface soil will be washed away, leaving nothing but the inorganic matters contained in the subsoil, from which the plants can obtain a subsistence. Many planters who are most careful in the selection of their soil, are equally careless with regard to its preservation. They forget that it is the capital from which all their profits are to be derived, and that if lost it can never be replaced. Manuring will be but of little avail, as the manure will be washed away precisely in the same manner as the soil has been. Heavy falls of rain may occur at any time, and by the want of a little forethought in laying out his estate, the planter may be subjected to heavy loss. These drains should be laid out horizontally, or rather at a slight gradient, say 1 in 50 or 1 in 60, at regular intervals from top to bottom of the estate. The distance between them must be regulated by the lay of the land, and the average amount of the annual rainfall; vertical escape channels may be constructed wherever the ground admits of its being done. The object in the easy gradient of the horizontal channels is that the flow of water in these drains may be very gentle, and that any soil which may wash from above will settle in the drain, and can afterwards be replaced round the roots of the plants hy manual labour. These drains should be traced by the quadrant, and pegged out, as is usually done in the case of roads. Water channels are required for the building sites and nurseries. The gradient of these may be a trifle sharper, say 1 in 30 to 1 in 40. They need not, except where water-power is required, exceed 18 inches in width, and the same in depth. The greater portion of these works should be done before the planting season commences; by this means all hands will be available for the preparation of the soil when the proper season arrives; all buildings required for the first year must also be completed before the end of the hot weather, let them be of whatever description they may.

Straits Settlements.—Experiments were made in 1871 by the proprietors of the Alma estate to introduce the tea plant. They have now some twenty-five acres in bearing, and the manager, who has had large experience in Assam and other tea-producing countries, considers that the trees have grown as well as could be desired, whilst the strength and flavour of the leaf are excellent; but he adds that its success as a profitable enterprise depends greatly on an abundant supply of Indian labour.

Java.—In 1826 some tea seeds sent from Decima, in Japan, by Dr. Von Seiboldt, were planted in the Botanic Gardens of Buitenzong. The plants having succeeded, the idea was entertained of commencing tea culture upon a large scale. The first plantation, of about 800 trees, was formed in 1827, and some specimens of tea from the first trees grown in the island were shown at an industrial exhibition held in 1828. A second plantation was formed at Caroet, in the regency of Preanger, the first being in the regency of Buitenzong. So successful was the progress made, that in 1833 the number of trees in the regency of Krawang was returned at more than 500,000. In Java, the best tea, with coffee, is grown at a height of 3000 to 4000 feet above the level of the sea. It is on the slopes of the mountains in the residencies of Preanger, Bagelin, and Banjoemans that the finest plantations of tea are found. The leaves are gathered after the second or third year. Up to 1842 tea was cultivated in Java exclusively on Government account, under the superintendence of its officials. There were then 13,500,000 tea trees.

The number of labourers required for the culture and preparation of the tea was so large, the supervision so difficult, and the result so unsatisfactory, that the Government resolved to relinquish some of its plantations to private individuals, undertaking to buy the tea of them at a fixed price. This resulted in an extension and improvement of the cultivation, but the purchasing price was found too onerous for the Government, and the contracts were annulled after seven years' trial. The consequence of this was that the cultivation of tea was abandoned in all but the regencies of Preanger and Bagelin, and the districts of Buitenzong and Krawang. It was found that private individuals were able, when left to themselves, to grow on more favourable terms than the Government, for while the former obtained 2 lbs. of tea from seven or eight trees, the latter only obtained 2 lbs. from thirty-three trees. In 1860, therefore, the Government gave up its last plantation in the regency of Bagelin. Now that it is left to its own energy without Government control or aid, it succeeds better.

In 1854 the island had 14,307,768 tea plants, from which 1,547,458 lbs. of tea were delivered to commerce. Nothing can be more attractive than these tea plantations, each containing from 70,000 to 100,000 trees, and giving occupation to from twenty-five to thirty families of native labourers. The seeds are sown in nurseries, from which the young plants are planted out in line at a distance of about four feet from each other. The tree is not allowed to exceed one and a half to two feet in height. The gathering of the leaves takes place in the rainy season at the age of two years. Both black and green tea are made. That known as Pekoe is made from the leaves gathered at the top of the plant and the extremities of the branches. It takes the leaves from eight trees to make two pounds of tea.

A tea planter in Java writes:

"I find tea pays better than coffee: in two years crops come in. My tea seed I get from Bengal, hybrid Assam. I commenced planting tea two years ago; all the land drained, lined, manured with ashes and buffalo manure, holes 3½ feet deep 3½ feet wide. The tea roots penetrate very deep into the soil. One man makes five to seven holes a day; each hole cost five cents, 5 by 5 feet; so all the land is worked at once, and no bother afterwards. I have about 70 acres planted; seed Bengal hybrid. I am now going to try the indigenous Bengal, which is hardier. Elevation, say 700 or 800 feet, but much moisture. Plenty of women to collect the crops; pluck leaves every thirty-five days, higher up in the hills forty-two days. I have now thirty chests each time; before June shall have fifty chests each crop. My neighbours plant 2½ by 2½; I don't approve of this. They make small holes, say 100 to 120 by a man in a day. I say, if you do a thing, if it is worth doing, do it well. I look after everything myself, so have plenty of work and no mistake. I avoid slopes; use level land.

The former one cannot cultivate properly; the latter is very doubtful."

Mr. Jacobson, a former inspector of tea culture in Java, published many years ago a work in three volumes, on the mode of cultivating tea, the choice of grounds, and the best processes for the preparation and manipulation of the leaf.

At first the culture of tea, like that of coffee, was not successful in Java. But by choosing suitable land, and calling in the aid of the Chinese for the cultivation and manufacture, it has prospered. And for the last nine years the cultivation has been free, and is no longer a State monopoly.

It is now cultivated in the thirteen residencies; but the principal establishment, where the final preparation is carried on, is in the neighbourhood of Batavia.

In 1863 the exports were 1,235,000 kilos. In 1870, 105,863 piculs (14,079,779 lbs.).

The cultivation of tea continues to increase, and about 3,104,000 Amsterdam pounds (or kilos.) were exported in 1872.

Java teas are attracting considerable attention in Europe and America, and the impetus thus given to the trade will no doubt before long lead to an increase in the present growing area.

There were in the Preanger Regency in 1874 twelve plantations, with 2991 buildings, and the produce was 1,134,366 kilos. The number of trees planted was 21,987,282.

The production in the residencies of Batavia (omitting Buitenzong), Cheribon, and Bagelin, was in

	Kilos.
1872	224,696
1873	792,000
1874	260,000

In *Japan* tea is cultivated from Kiusiou to Niphon, up to the 39° of N. lat., but the zone found most favourable is from the 30° to the 35°, especially in the regions on the coasts of the interior sea. The total annual production is only estimated at 20,000,000 lbs., but the shipments reach occasionally upwards of 17,000,000. The bulk of this goes to the United States, chiefly to California. In 1868 the quantity exported was 11,598,734 lbs. In 1869:

	Lbs.
To United States	8,287,907
„ England	1,111,392
	9,399,299

The following have been the exports in the last five years from Kanagawa, the export year dating from the 1st of May in one year to the end of March in the following year:

	Lbs.		Lbs.
1870	9,116,083	1873	11,958,583
1871	12,282,178	1874	11,900,161
1872	12,697,300	1875	15,919,665

In 1874 the exports from the port of Yokohama were 17,016,316 lbs., and from Hiogo 7,091,165 lbs. A considerable stimulus has within the last three years been given to the cultivation of the tea plant, with a most profitable result to the growers. The area of tea plantations is rapidly increasing, and the young shrubs planted are now coming into full bearing.

The production of teas for export is steadily increasing in Japan, and it is probable that the tea of that country, which is pure, delicate, and wholesome, will maintain its hold upon the tastes of those who have learned to like it.

Australia.—Baron Mueller considers that the extensive fern-tree gullies of Victoria would be exceedingly suitable for this culture.

"The tea shrub was raised in the Botanic Garden at Melbourne in some quantity as far back as 1859, and was since that time, with the sanction of successive Ministries, rather largely distributed to those of our colonists who wished to experiment on it; many plants were, amongst others, also sent to the Industrial School Depôt at Sunbury. In early age the plant is, however, somewhat tender, and apt to succumb to dryness, yet not only still at the Botanic Garden, but also in many other of our main public plantations as well as in private gardens, there must be now ample means to obtain seeds for further dissemination or test. The growth of the plant alone for seed would prove for some years remunerative. Already in 1862 I brought the first sample of Australian tea prepared from bushes grown by myself, before the London International Exhibition of that year. Subsequently other samples from a laboratory constructed by me for work of this kind, and until the last two years under my control, were exhibited at the various great international gatherings of industrial products, and one of these specimen lots may likewise be seen in the Melbourne Technologic Museum.

"A damp warm climate, with rains to the extent of 70 or even 100 inches, well spread over the year, and copious in the spring, is above all adapted for tea culture; with a view to the amplest return, tea bushes should never be shrivelled up by hot winds, or oppressed by lasting frosts. Rich forest land in its virgin state is preferable to any other. Wide valleys with gentle slopes or undulations, or slightly elevated level lands with natural drainage, are far more eligible than steep hill-sides, because the working of such lands is less expensive, while the risk of any denudation of the roots by washing away of earth on declivities is avoided. Light loams of a reddish or yellowish colour, crumbling throughout, of several feet depth, with a surface stratum of decomposed forest foliage, is insisted on as the most desirable for the largest and most lasting yields; nevertheless, in many other soils the tea bush will thrive."

Baron Mueller further observes:

"I believe that products would be obtained in our ranges, superior in flavour and strength, especially to the commoner sorts in general use; hence our competition with China and Japan (which countries have singularly long enjoyed the monopoly in this trade) should be particularly in the more precious sorts of tea. The presence of so large a number of the Chinese people in Australia seems to indicate much facility for turning their home experiences in this industry here to account. Probably neither in China nor in India can land for forming new tea gardens be obtained at such small cash outlay as in this and the other Australian colonies. The annual mean temperature of Melbourne (about 58° Fahr.) is slightly higher than that of the Darjeeling and Neilgherries tea districts (56° Fahr.), but at Assam it is 74°, and so at Cachar in the principal tea regions. Though we possess in Victoria warmer tracts of country (even so far south as Portland, the mean being 61° Fahr.) than that about the metropolis, yet we cannot expect to realise tea harvests equally heavy as those for which Assam is already so famed; but, like every other crop, this one cannot be grown in various parts of the world under conditions alike excellent, and we must content ourselves with lesser results. The rainfall at Melbourne averaged for some years 26 inches, but rose in 1872 to 32 inches. At the eastern boundary of Gippsland it was, however, recorded in 1871 at 54 inches. At Schnapper Point it was, in 1872, 43 inches; in 1874, 39 inches. At Daylesford, 1872, 42 inches; 1874, 40 inches. At Cape Otway, 1874, 42 inches. At Hastings, 1874, 45 inches. At Warrandyte, 1872, 48 inches; 1874, 41 inches. At Berwick, 1872, 51 inches; 1874, 42 inches. In our fern-tree gullies it would in all likelihood, as a rule, be much more. Want of moisture cannot militate therefore against the success of tea-growing in our forest glades, although in Assam the rainfall fluctuates between 70 and 95 inches. At Darjeeling it is still heavier—about 129 inches; but the enormous precipitation of moisture at the latter place is acknowledged to be adverse to the best development of tea there. It is quite possible that here in our colony every geologic formation and every climatic tract, though otherwise not unfavourable to this culture, will not yield products of equal value in flavour and taste, even if the most careful methods were adopted, to secure a proper curing of the leaves."

There can be no doubt that both tea and coffee can be cultivated with complete success in

Queensland.—Tea grows luxuriantly on the coast, but the plant, in order to develop the full flavour of the leaf, seems to require the hibernation, or rest for a period, that cannot be had in a climate where the warmth and stimulus to growth are constant. The cultivation and subsequent manufacture connected with the tea and coffee plants require, at certain seasons, a considerable supply of light labour.

Jamaica.—In 1868 a case of tea plants was sent out from Kew to Jamaica, and placed under the care of Mr. Thompson, the island botanist at St. Andrew. The idea has been formed on good scientific authority that the soil and climate are so well adapted that the tea plant will flourish there.

Brazil.—In 1810 a number of tea plants were introduced into Brazil, with a colony of Chinese to superintend their culture. The plantation was found near Rio Janeiro, and occupied several acres. It did not, however, answer the expectations formed of it; the shrubs became stunted, cankered, and moss-grown, and the Chinese finally abandoned them.

A report by M. Guillamin was presented about a quarter of a century ago to the French Minister of Agriculture and Commerce on the culture and preparation of tea in Brazil. It entered very minutely into the incidents of temperature and cultivation, and disclosed the important fact that the tea plant grows luxuriantly with the coffee and other valuable plants of the equatorial regions, and even on low-lying lands on a level with the sea, and exposed to the full rays of a burning sun.

In Brazil, the culture of tea has been extended in the provinces of San Paulo, Minas, Parana, and Rio Janeiro. Eight years ago Brazil produced about 300,000 lbs. of tea annually, and the quantity has since augmented; but it will never send much into commerce, as it has not labour to spare from coffee culture, and Yerba maté tea is preferred for local consumption. The Brazilian tea resembles, it is said, in flavour, the tea of Japan, and possesses a fine aroma.

North America. — The American Commissioners of Agriculture reported some four years ago that tea culture was just becoming a feature of importance in the Western and Southern States, and that in a few years enough tea would be grown in those sections to meet the home consumption. The Department had sent out to various parts of the country over 50,000 plants, nearly all of which have lived, and is now distributing seeds from plants raised in South Carolina.

The following instructions have been issued for guidance in North America: — The adaptation of various sections to the growth of the plant has been abundantly demonstrated, and plants from seed grown in the Southern States have, from time to time, been raised by the Department of Agriculture for distribution. So far back as 1848 the late Dr. Junius Smith abundantly proved that the mountains of South Carolina would produce and mature tea, although it was there subjected to severe freezing, and heavy falls of snow. It was grown in Florida and Georgia, and even farther north. Even in the grounds of the Department at Washington the plant has passed through a very severe winter without having been absolutely killed.

In the present state of the labour market the Americans cannot be expected to proceed on the plan of the British in the East Indies and establish large plantations. It would not pay to do so; but the intelligence of the farmers of the country, and the improved agricultural machinery in use, will render completely easy there what proved an insuperable difficulty in India, viz. the growing of tea for family use. The apathy of the Hindoo races, their dislike of anything new, and the fact that tea is not their popular beverage, militated against the production of tea for their own wants in anything like a general system. Isolated points occur where they acquire a taste for tea, and then they grow and manufacture it very well, but they cannot accustom themselves to cultivate it with any care.

Experiments in raising the tea plant have been tried with more or less success in Tennessee and South Carolina, but it has been reserved for California to attempt the culture on a large scale. A German gentleman, Herr Schnell, recently brought a small colony of Japanese to the State. Schnell had been a resident in Japan for ten years, was formerly connected with the Prussian Embassy, and was later in the Japanese service. On arrival, he purchased a " ranch " (farm) of 600 acres, near Placerville, El Dorado county. He brought with him 6,000,000 tea seeds, and immediately planted out a number of them; only a moderate quantity have thriven.

The tea shrub in California is an evergreen, from 4 to 6 feet high, with a straight stem and irregular branches, the former of a bright grey colour, while the latter is chestnut, the wood being hard with a peculiar odour. The leaves closely resemble those of the wild rose, the colour being bright green, but deepening with the advance of the season. The blossoms, at first of a rose colour, assume, when full blown, the colour of a tea rose; when the flowers fade away, they leave a small fruit which contains the seeds, which are planted in rows from 4 to 6 inches deep. The proper time for planting is stated to be in November or December, the sprout appearing in about a month. Within six months the plant reaches a height of 14 inches, when the leaves are stripped off and placed under manipulation. The trees are annually trimmed down to a height of 3 feet, and it is believed they produce a good yield for upwards of thirty years. The only question as to the success of tea in California is that of labour.

The following instructions have been issued for guidance in North America.

Soils.—Almost any good, free soil, upon which water does not stagnate, will grow the plant. A good garden soil will produce tea in perfection, but it will be best to describe a tea soil as a sandy, chocolate-coloured loam, containing an abundance of humus or decaying vegetable matter in a fit state for absorption by the roots.

Propagation by Seeds and Cuttings.—The first thing for the experimental grower is to understand the best manner of raising his plants. This is simple, the only precaution necessary being to use fresh seed. If tea seed is kept for any length of time out of the ground it turns rancid, as the chestnut and many other oily seeds are apt to do. Ripe seed is known by its dark chestnut colour. As soon as procured it should be laid upon a hard surface and covered with 2 or 3 inches of rotten leaves, decayed hops, or almost any convenient vegetable material. In this position the seed will germinate, and when the sprouts are 2 or 3 inches high the young seedlings may be transferred to beds much in the same manner as market gardeners prick out celery plants. The plants can be set in nursery beds at 3 or 4 inches apart, according to the time they may possibly remain. If they are " pricked out " into beds in the spring, to be finally planted out in the fall, or in the fall to be planted in the spring, 3 inches will be ample ; much will depend upon the time when the seed is received; if, however, the plants are likely to remain in the nursery beds for more than six months, it will be best to allow 4 inches between plant and plant. An easier method is simply to plant the seed in the beds in drills from 1 to 2 inches deep and 4 inches apart, in a half shady position; but vacancies from bad seed cannot well be avoided by this plan. By germinating the seed a full nursery is obtained with very little extra labour. The seed may also be planted in hills, as gardeners plant melons, the hills being

5 feet apart. But here they must be weeded all the time, and, as an acre of ground would have to be gone over for some 1742 plants, much extra labour will be entailed by this method of planting the seed where it is to remain. Better to treat it as cabbage, nurse in beds, and afterward plant out. It may be useful to suggest here that it would be well for the nurserymen to turn their attention to the raising of tea plants for sale in the localities where they are known to thrive.

The only attention a bed of young tea plants requires is the routine work of weeding, occasional watering in dry weather, and possibly light shading with branches of trees in leaf, cut into lengths of about a foot, and stuck among the plants until they become established. If the pricking or transplanting out is done in cloudy, showery weather, this labour may be saved. The propagation of tea by cuttings is a tedious and often very unsatisfactory process. The writer has put down many hundreds of thousands of cuttings with the view of perpetuating superior varieties. The returns of rooted plants varied with the season from 10 to 75 per cent. This method of propagation is expensive, tiresome, and unsatisfactory. A much better plan will be to secure a good pure lot of plants, and keep them separate as much as possible. I would suggest the propriety of the Department of Agriculture, and others who have the distribution of plants in their hands, sending one "strain" of plants alone to given localities as much as possible: the Assam kinds to hot and moist localities, and the Chinese type to drier and more elevated situations. The system of selection which has been practised with such success in the case of corn, tomatoes, and other plants, should be carefully attended to in the propagation of tea.

The Preparation of the Soil for tea should be precisely the same as the preparation for any other farm crop. Secure the best possible tilth, manure well, preferably with vegetable manure. A crop of any cheap seeded legume ploughed in would be excellent; but any available manure in which straw is incorporated would answer. Plough deep and well; even subsoil, where the experiment is intended to be thorough, and the land will bear it. Harrow and cross harrow. Mark out the land 5 feet by 5 in straight lines, as for corn, and it is ready to receive the tea plants, which plant at the intersections of the scoring. Or, if it be determined to grow the tea with some other crop—for instance, onions, turnips, tomatoes, melons, cucumbers, pea-nuts, low-growing pease, celery, or almost any crop which will not shade the plants—then the latter may be planted either as subdividing hedges at any distance apart to suit the taste, or they may be planted within the fences. This plan is very extensively practiced by the Chinese, and is a great economy of labour, since then the tea needs scarcely any special cultivation other than that given to well-kept hedges generally. The plants may be almost any distance apart in the rows, between 1 foot and 4 feet. The hedges may be clipped, but a flat top is the most productive form as regards yield of leaf. I am supposing that from one hundred to five hundred or more plants are to be planted for family use. When fully started the plantation of tea merely requires to be kept moderately well weeded, and in no case must weeds be allowed to overtop and shade the tea; it is a crop requiring the full sun.

Planting.—No especial directions are necessary further than to say that the plants must, if possible, be planted in the spring, in showery weather, and not too deep; anyone who can plant a garden with success can manage a tea plant. A little shade may be useful if hot, dry, sunny weather ensues; a few small boughs, stuck around the plants, are all that is needed to prevent intense evaporation from the soil and plants. I may mention that in deep soils the tea plant has a tendency to form a long, bare tap-root, somewhat resembling a root of salsify or carrot. The directions given as to germinating the seed on a hard bottom were intended to obviate this tendency to form a long tap-root, and start the plant in the way it should go, forming fibrous roots; but if perchance a long tap-root is formed in spite of all precautions, then, in transplanting, it must be got out as entire as possible, and more care will be necessary until the plant has commenced to make new roots and growth in its new position. The kind of culture required while the tea plants are reaching utilisable condition may be almost entirely performed by horse labour, if the tea is grown in with other crops.

I am not urging the formation of extensive plantations as yet, and, consequently, I cannot pretend to regard the setting out and tending of an ornamental hedge as anything but very pleasant pastime for the intelligent farmer in his leisure hours. The base of the plants should be kept free of weeds, and when 6 inches of growth is made, the extremities of the shoots and the terminal bud and three leaves below should be pinched out; if this pinching is done in the growing season the operator will not only be bringing his tea bush into a spreading shape by the process, but will also be taking off the very article which goes to make the bulk of the teas of commerce. This pinching of the 6-inch shoots should continue until the plants reach their third year, when a sufficient quantity of leaves will be obtained for manufacturing purposes.

Picking of the Crop.—When the shrubs are about three years old there will be a sufficient quantity of leaves obtainable to warrant a muster of the women and children of the farm, each of whom should be instructed to nip off the young and tender growth with the finger and thumb, at the point. The three leaves and terminal bud, together with the tender stalk, make the very finest class of Souchong teas, often ranking, if well made, as Pekoe Souchong, and worth at least 5 dollars per pound. If a coarser tea is desired, the young growth may be nipped out at the point. Some may question the propriety of picking the stalk, but it is as tender as the leaves, and is invariably used except in Caper and Gunpowder teas. The leaves may be gathered in the apron or anything else; there is no more mystery about the matter than there is about gathering pease, or any other crop, it being only necessary to select the young growth, for the coarse leaves are not worth gathering; they will not make good tea.

Having briefly treated of the picking process, I will give a variety of methods by which tea is made. It takes on an average 4 lbs. of raw leaf to make 1 lb. of tea.

Process No. 1.—1. Picking the leaf; 2. Spreading two inches thick on mats, &c.; 3. Tossing in the hands (as hay); 4. Tossing on flat trays; 5. Examine for bruised red spots; 6. Place thin on mats, &c.; 7. Cover with cloth until fragrant; 8. Roasting on pan; 9. Rolling under the hands; 10. Drying over charcoal.

Process No. 2.—1. Picking the leaf; 2. Spreading out thinly; 3. Tossing in the hands; 4. Roasting; 5. Rolling; 6. Roasting; 7. Rolling; 8. Roasting; 9. Rolling; 10. Partial drying over fire; 11. Exposure to the air; 12. Picking out coarse leaf; 13. Final drying; 14. Packing.

Process No. 3.—First day and night: 1. Picking the leaf; 2. Spreading out thinly. Second day and night: 3. Exposure to air and tossing; 4. Roasting at 180° to 200° Fahr.; 5. Rolling out juices; 6. Roasting on pan at 160°; 7. Rolling out more moisture; 8. Spreading out thinly. Third day and night: 9. Partial drying in sun or otherwise; 10. Picking out stalks, &c.; 11. Final drying. Fourth day, if convenient: 12. Sifting out dust, &c.; 13. Packing.

Process No. 4.—First day and night: 1. Picking the leaf; 2. Spreading out thinly. Second day and night: 3. Exposure to sun, turning over, tossing, and picking out of coarse leaves; 4. Panning, at 180° to 200°; 5. Rolling out juices; 6. Fermentation in heaps; 7. Spreading thinly. Third day and night: 8. Partial drying; 9. Picking out stalks; 10. Final drying. Fourth day, if convenient: 11. Sifting; 12. Packing.

Process No. 5.—1. Picking the leaves; 2. Wither in sun two hours; 3. Cool in shade one half hour; 4. Toss and clap in hands ten minutes; 5. Cool one half hour; 6. Toss ten minutes; 7. Cool one half hour; 8. Toss ten minutes; 9. Roasting or panning; 10. Rolling; 11. Roasting; 12. Rolling; 13. Final drying; 14. Packing.

Process No. 6.—1. Picking the leaf; 2. Roasting; 3. Rolling; 4. Exposure to the air; 5. Final drying on the pan; 6. Picking out coarse leaf; 7. Sifting; 8. Packing.

The foregoing methods have all been practised by the writer, and they will all produce first-class tea in certain conditions of the weather. No two days' work can be precisely alike as to the *time* the various operations require, any more than the operations of the hay-field occupy precisely the same time from year to year, but this is not important. The great thing to understand at the outset is the principle of tea manipulation, and, this once mastered, the practice may be modified to suit everyone's circumstances.

The difference between black and green teas is entirely due to manufacture. Black tea is subjected to the oxidizing influence of the atmosphere, often for a considerable time; great chemical changes ensuing. The tannin, volatile oils, extractive matter, and sometimes the theine are very much toned down.

Green teas undergo great changes also from the raw state, but the preservative qualities of moderate degrees of heat are brought to bear upon the leaves before they have been acted upon by the atmosphere, and the above chemical constituents, together with the colouring matter, are better preserved than in black teas. Black teas are bruised, beaten, and tossed before drying; green teas are not. Black teas are like a well-bruised apple, laid over for a day or two and then dried in an oven. Green teas are like a sound one, dried in like manner. These are the chief differences; but to make the matter more plain it will, perhaps, be best to briefly state the method of procedure and the utensils required.

Tea for family use, either black or green, may be made if the farmer or other operator can muster a cooking stove, or even a fire on the floor, and a brick or two, over which to set an iron or a block-tin pan, measuring 2 feet 4 inches in diameter and 7 inches deep; this is, perhaps, the most convenient size, but a smaller will answer perfectly well as long as the hemispherical form is maintained. This is the roasting pan, and in it the raw leaves are heated so as to cause them to exude their moisture. The pores of the leaves open with a series of miniature explosions, causing a sharp crackling sound; this is a tolerable test of the heat; that is, the leaves should crackle, but unfortunately they will do so when the pan is red hot, and liable to burn out all the goodness from the leaf.

Whatever heating medium may be employed, whether sun, or fire, or their combinations, the leaves should be perfectly soft and pliable before they can be rolled without breakage. They should be moist enough to stick together. When in this state the leaves are thrown on a table on which a bamboo or rattan mat is nailed. The Indian matting used for covering floors will answer, or the table may be shallowly grooved. A board to be worked by the hands may be grooved in the opposite direction, the whole arrangement being somewhat like a pill-making machine on a large scale. Or a machine (of which there are several) may be used, where the operations are sufficiently extensive to warrant its use.

Rolling.—This process has probably attracted more attention than any other part of the manufacture. The object is really to extract and press out the bitter juices (probably tannic acid, &c.), and it accidentally happens that the leaf receives the various twists seen in commercial teas. The Chinese manage this rolling almost entirely with the hands and feet. A ball of leaves is taken in the hands and rolled backward and forward, on the table, the pressure used being considerable; the leaves should become quite saponaceous, and when a quantity of juice is pressed out, and the leaves twisted, they may be pronounced properly rolled. It is a good plan to shake them out thinly after rolling, that the action of the air may evaporate the juices; and, in the case of black tea, oxidize the leaf. Some operators allow the leaves to stand in balls for a time, others warm them on the pan again; some place them in the sun, others in the shade; some place them in heaps to ferment, both before and after rolling. In short, the various methods by which good tea may be made are simply innumerable, but the principles of desiccation and manipulation must not be violated. What those principles are must in nearly every case be determined by practice; for beyond the recapitulation of the process as given, little more is known. I have frequently proposed the analysis of the leaves of tea in their raw state to the Government chemists in India, but I believe it has not yet been undertaken; consequently the effect of exposure, heat, and pressure upon the leaves can only be conjectured. It would probably aid the inquiry very materially if a good manipulator could co-operate with a careful analytical chemist, who, for the sake of science, would be willing to investigate the various changes produced by manufacture.

The business of the farmer, after rolling and expressing his tea in various ways, suited to his fancy or convenience, will be finally to dry it over charcoal fires or on the iron pan. The latter will invariably produce a tea of stronger quality, partaking more or less of the characteristics of a green tea, even though black in colour. When the tea is thoroughly dry it may be packed in wooden or in tin boxes, always taking care they are perfectly dry and air-tight.

YERBA MATÉ, OR PARAGUAY TEA.

Yerba maté is a product which, although it does not enter into European commerce, deserves notice from its extensive consumption in many of the South American States. In the former edition of the work full details were given of the mode of collecting and preparing the leaves, &c., and it is therefore only necessary now to give a more abridged description. The yerba maté is obtained from some species of holly, which have been well described by Mr. J. Miers in a paper on the history of the maté plant, in the 'Transactions of the Linnean Society.'* He shows that besides the *Ilex Paraguariensis*, St. Hil., there are several other species and varieties employed. Dr. H. Demessey also published a good account of it in his 'History, Physical, Economic, and Political, of Paraguay,' two vols., Hachette, Paris, 1865. The portion relating to maté or Paraguay tea was also published as a separate treatise, with illustrations, during the Paris Exhibition, 1867, by Bouchard-Huzard. Robertson, in his 'Letters on Paraguay,' London, 1839, vol. ii. p. 134, gives some interesting details, but it is unnecessary to go back to former years, I prefer to give the present aspect of the trade.

In their wild state the trees are about the size of orange trees. The trunk is about 2 to 3 feet in circumference, and has a smooth whitish bark, and the boughs, which resemble those of the laurel, are leafy and tufted. The leaves are evergreen, and when full grown are about 4 inches long, thick, glossy, and crenate at the edges, of a dark-green colour above, and paler underneath. The flowers are small and white, growing in clusters. The berries are red, very smooth, and similar to the Christmas holly. The leaves of this *Ilex* yield the same bitter principle, theine, which is found in the Chinese tea plant. Although the former may not afford so much of the agreeable narcotic oil as the latter, in consequence of the careless and

* Also in 'Annals and Magazine of Natural History,' 1861, No. xlvii., p. 389.

primitive manner in which they are collected and prepared for use, yet they produce a most agreeable and refreshing beverage, which forms the staple drink of the South American republics.

As far back as the seventeenth century the yerba maté was commonly drunk throughout the state of Paraguay. There can be little doubt but that the aboriginal Indians taught the use of this tea to their Spanish conquerors, and the early Jesuit missionaries planted great numbers of the tree before their expulsion, since which time its cultivation has been neglected. The expeditions to collect and prepare it start from Assuncion, the capital, to the yerba groves, a distance of 200 miles, and are generally composed of forty to fifty persons mounted on mules, having with them other mules and bullocks. On reaching a locality where the trees are abundant, wigwams are erected and the *tatacua* constructed. This consists of clearing a small space of ground, the soil of which is then beaten down with heavy mallets until it becomes quite hard and level; at the four corners of this space sticks are driven into the ground, from which a sort of net made from strips of hide is stretched, a fire is kindled beneath, and the leaves on the boughs, as they are brought in from the surrounding forests, are scorched by being placed on the net, care being taken that no ignition takes place. The scorched leaves and small twigs are then pulverized into a coarse powder by means of a rude wooden mill, and frequently stamped with blocks into dust, after which process they are ready to be weighed and put up into packages for export. Half a bullock's hide in a green state is used to form a kind of sack to hold the tea, being first sewn up at the sides. The tea is then pressed down until it is quite full, the mouth is sewn up, and the package, which usually weighs from 200 lbs. to 250 lbs., is left to dry and tighten in the sun for a few days, until it becomes as hard and impervious as a stone. Such a mode of collection and preparation is indeed primitive, and the twigs impart a woody flavour to the tea, otherwise very agreeable.

In Paraguay this tree combines, as it were, the properties of cultivated and wild plants. Indigenous to the country, the tree forms entire forests called "Yerbales," in the central, eastern, and northern regions of the republic. The Jesuits having formed vast plantations of it round their residencies, these have continued, and their produce forms in what are still called the Missiones, the principal article of commerce at the present day. The Government monopoly of the sale of yerba, and a heavy duty imposed upon its export, formed at one period the principal source of revenue in Paraguay.

There appears to be a considerable difference in the quality and estimation of the maté, according to the locality from which it is derived; whether this arises from the difference of the plant or mode of preparation does not appear.

That of Paraguay is the most bitter and aromatic of all, and the most esteemed; it yields four times the quantity of infusion that the maté of the Missiones or of Paranagua does. Hence, although dearer in price, it is the most economic. A coarse kind is made in

Parana, Brazil, from the leaves alone, and these being unpulverized, are used in the same way as Chinese tea.

At first Europeans do not like maté, it having a herby and somewhat bitter taste, but among the inhabitants of the South American States it is a much prized article of luxury and necessity, and is the first thing offered by them to their visitors; indeed their tables are rarely seen unoccupied by it; and the "gaucho" of the plains will travel on horseback for weeks, asking no better fare than dried beef washed down by copious draughts of maté. The demand being great and increasing, there is unfortunately continually going on a rapid destruction of the tree. The Jesuits foreseeing this, started large plantations in Paraguay, and at their branch missions in the provinces of Parana and St. Pedro do Rio Grande, some of which still exist and furnish the best tea made; and of late years some of the landowners, sensible of the short-sighted policy pursued, have established many plantations with the best results, as the quality of the tea improves with the cultivation of the tree.

It is difficult to get at any consecutive or reliable returns for the entire traffic in this commodity, the production of which is carried on in such a desultory and rude manner, and extends over so vast an area of wild country. A careful consultation of the official returns of the several republics and of Brazil, as well as British consular reports, enables me, however, to make an approximate estimate of the trade and consumption.

Forty thousand arrobas (or 10,000 cwts.) were imported into the Argentine Republic in 1870. In the next two years the consumption was as follows in the Argentine Confederation:

Description.	1871.	1872.
	lbs.	lbs.
Paraguay Yerba	260,000	3,356,000
Brazilian "	17,688,000	23,506,000
Total	17,948,000	26,862,000

The total consumption of yerba in the Argentine Republic in 1872 thus averaged 13 lbs. per head of the population, against 2 lbs. of coffee, and only $\frac{1}{4}$ lb. of tea. Altogether, nearly 27,000,000 lbs. appear to have been consumed in the republic during that one year. Surprising as this amount is at first sight, it is explained by the fact that yerba constitutes the only vegetable nourishment of many classes of the community. In the rural districts, as well as the smaller towns, this herb is considered a regular form of diet, and not, like tea in England, a mere accompaniment of the breakfast table. The method of manufacture is to mix ordinary sugar with the decoction of yerba until a thick syrup is produced, when it is ready for drinking. Probably the nourishing qualities attributed to the herb by the natives are derived from this mixture of saccharine matter. As might have been expected from the prevalence of this practice, the annual consumption of sugar in the Argentine Republic is enormous. In 1872 no less than 20,000,000 lbs. of coarse sugar were imported. Refined descriptions amounted to more than 22,000,000 lbs., although a duty of 25 per cent. *ad valorem* had to be paid. Viewing the extreme popularity of yerba in South America, it seems strange that it has not yet been introduced into Europe, as an addition to the food supply.

In 1854 the exports from Paraguay were 85,676 arrobas; in 1860, 174,238 arrobas. In time of peace there is annually exported yerba maté to the value of about 200,000*l.*, chiefly to Buenos Ayres. The exports in the three years ending 1863 averaged 4,500,000 lbs. per annum.

In 1856 it was estimated that 6000 persons were employed in preparing maté in the Brazilian missions. It is for the most part sent by carts to Itaguy, a small town on the banks of the Uruguay, and from there goes by water to the River Plate. In the year ending June 1858, 2,650,000 lbs. were shipped from that port. At Montevideo the Brazilian maté is preferred to that from Paraguay.

About 400,000 arrobas (100,000 cwts.) are produced annually in Parana, where it is indigenous; the finer kind is exported to La Plata, the coarser goes to Chili. In 1854 there was imported into Chili 144,792 arrobas.

The official value in Brazil was 13*s.* 10*d.* per cwt. in 1853, and 29*s.* 7*d.* per cwt. in 1856; in 1858 it fetched 32*s.* 4*d.*, in 1863 it fell to 21*s.* 10*d.* per cwt. The exports of yerba maté to foreign countries from Brazil have gone on increasing from 181,365 arrobas in 1841 to 605,179 arrobas in 1863.

From Porto Alegre 83,840 arrobas were shipped in 1862–63, and from Uruguay 27,445 arrobas; there used to be as much shipped from that port as 97,000 arrobas. From Paranagua 404,829 arrobas were exported in 1862–63. Thus the shipments from these three ports in the year ending 1863 amounted to 129,028 cwts. In 1865 the total shipments from Brazil to the neighbouring States exceeded 250,000 cwts. In 1872 the quantity was somewhat less, 200,000 cwts., valued at 251,000*l.*

The following show the exports and value from Brazil:

Year	Quantity.	Value.
	lbs.	£
1864	19,553,329	137,306
1865	15,402,899	89,575
1866	22,781,625	147,844
1867	23,370,334	172,104
1868	28,852,460	221,105

Chili is said to take now about 40,000 arrobas, and Peru 100,000 yearly.

It might be worth while to attempt the introduction and acclimatization of so useful and ornamental a tree in some of our British colonies, such as Queensland and Natal, where the climate is somewhat similar to Paraguay. Looking at the use of its leaves, we see no reason why it should not be cultivated with remunerative profits.

Such a valuable plant, doubtless, is worth the attention of some colonial planters, and with a careful collection of leaves only, and a better method of drying them, the tea would be rendered both grateful and palatable. But we have been so much accustomed to tea leaves being curled up and not powdered to dust, that possibly some prejudice might exist against using it in the form of powder, although the infusion is thereby very readily made.

SUGAR.

The luxuries of man soon become his necessities, and he works with intense thought and labour for things of which he once was wholly ignorant. This is the case with sugar. No longer than five hundred years ago our European race did not know sugar at all. A hundred years ago it was a great luxury. Now it is sold at 3*d.* or 4*d.* per pound, and used in abundance as an every-day article, by the poorest people. The sugar of commerce is an artificial article, like our distilled liquors, yet the saccharine principle, a distinctive element of food, is found in almost all the plants we use, especially the most valuable. It is met with in the stalk of the maize, and molasses has been repeatedly made from Indian corn. The beetroot contains it in large quantity, and most of the sugar now used in France is made from the beet, its culture having been forced by the Emperor Napoleon by means of high import duties. Several other vegetables contain the saccharine principle, which is thus diffused through the vegetable world as an essential element of human food. When we treat it, therefore, as a *necessity* of life, we are not far wrong; for, in one form or another, we must consume it. The fruits contain it, and the very trees, as the maple, the hickory, and the palms. We are thus invited to use this saccharine element with all our food, and as the concentrated form is the most convenient and manageable, we make it artificially.

Though the manufacture of sugar was commenced in the West Indies early in the sixteenth century, yet its use in domestic economy did not become general in Europe or America before the beginning of the last century. In the year 1700 only 10,000 tons were used in Great Britain, though the English were at that time the leading manufacturers of sugar. The consumption of sugar in the British islands in the year 1875 was 900,000 tons. In almost every country the consumption of sugar is steadily increasing.

Production.—The following may be taken as a rough estimate of the production of sugar over the globe at the close of 1876:

	Tons.
Cane sugar	2,140,000
Beetroot sugar	1,320,000
Date ,, ...	150,000
Maple ,, ...	20,000
Sorghum ,, ...	20,000

The appended table gives the official value of the sugar exported from the principal British possessions in decennial periods:

	1854.	1864.	1874.
	£	£	£
India	948,582	716,857	281,743
Mauritius	1,178,979	2,126,511	2,318,158
Natal	2	94,208	159,078
Queensland	..	..	108,373
Bahamas	..	28,064	12,641
Honduras	..	..	25,471
Jamaica	624,327	503,470	482,779
Virgin Isles	836	388	..
St. Kitts	96,065	95,201	110,564
Nevis	26,538	13,577	54,079
Antigua	..	55,155	71,753
Montserrat	11,614	9,542	23,508
Dominica	52,288	34,670	56,727
St. Lucia	41,468	95,700	127,712
St. Vincent	116,500	114,327	123,752
Barbados	728,586	554,488	711,676
Grenada	90,516	100,633	58,921
Tobago	..	55,645	37,104
Trinidad	289,319	741,881	673,973
British Guiana	726,768	1,329,713	1,980,552
Total	5,092,390	6,670,029	10,518,364

The West Indian production (omitting Cuba) may be thus divided:

	Tons.
British Guiana	75,000
Trinidad	50,000
Barbados	40,000
Jamaica	25,000
St. Vincent	8,000
St. Kitts	8,000
Antigua	8,000
St. Lucia	6,000
Tobago	5,000
Grenada	5,000
Dominica	3,500
Nevis	2,000
Montserrat	1,500
Surinam	11,000
St. Croix	5,000
Total	250,000

The Sugar Refiners' Committee recently prepared some approximate statistics for the Board of Trade as to the Sugar Production of the world, which we reproduce; but as shipments are in most cases the only data to be obtained, it must be recollected that the figures given are far from representing the total production. This is especially the case with such countries as China, India, Central America, Brazil, Peru, and Egypt.

CANE-SUGAR PRODUCTION in 1876, in round numbers:

	Tons.
Cuba	700,000
Porto Rico	80,000
British, Dutch, and Danish West Indies ..	250,000
Java	200,000
Brazil	170,000
Manila	130,000
China	120,000
Mauritius	100,000
Martinique and Guadaloupe	100,000
Louisiana (none exported)	75,000
Peru	50,000
Egypt	40,000
Central America and Mexico	40,000
Reunion	30,000
British India and Straits	30,000
Honolulu	10,000
Australia	5,000
Total	2,140,000

Of this the classification may be assumed to be as follows:

	Tons.
Muscovado	900,000
Centrifugal (1st products)	600,000
" 2nd "	110,000
Clayed	500,000
Concrete	30,000
Total	2,140,000

The following is given as the BEETROOT SUGAR PRODUCTION of 1875–76, by the Sugar Refiners' Committee:

	Tons.
German Empire	346,646
France	462,259
Russia and Poland	245,000
Austria and Hungary	153,922
Belgium	79,796
Holland and other countries	30,000
Total	1,317,623

The various kinds made are:

	Tons.
Refined	70,000
White crystallized	200,000
First product brown	700,000
After products	350,000
Total	1,320,000

Besides the quantity imported into the markets of the civilized world, as much more, it is estimated, is probably consumed locally in the producing countries. In India the local consumption was roughly estimated at over 1,000,000 tons.

Consumption.—The following are the latest statistics of consumption in the various countries, deduced for the most part from official documents, and the balance of imports over exports. In the European beetroot sugar-producing States it is not always possible to arrive at correct data of the actual consumption, and those countries with a star (*) affixed are mere rough estimates, being for the most part producing countries for which there are no reliable returns of consumption:

	Year.	Aggregate Consumption.	Lbs. per Head.
EUROPE:		cwts.	
United Kingdom	1875	18,374,543	62·8
Holland †	1874	800,000	25·03
Belgium	1874	1,000,000	23·19
Hamburg (imports)	1873	1,223,733	..
Germany	1874	6,120,000	16·6
Denmark	1873	533,831	33·3
Sweden	1873	630,741	16·9
Norway	1873	193,086	12·7
France ‡	1874	5,000,000	15·5
Austria and Hungary	1874	3,400,000	15·1
Switzerland	1873	381,295	15·9
Portugal	1874	300,000	8·4
Spain §	1873	81,817	·54
Russia and Poland ‖	1874	4,000,000	5·4
Turkey	1874	500,000	3·8
Greece	1871	86,800	6·6
Italy	1873	865,350	3·6
AMERICA:			
United States	1873	13,040,500	37·8
British America	1875	1,721,386	51·4
Brazil*	1874	642,857	8·0
Peru	1874	570,000	5·61
River Plate States	1874	1,000,000	43·9
Other South and Central American States*	1874	500,000	..
WEST INDIA ISLANDS (British and Foreign)*	1874	1,000,000	..
NORTHERN AND SOUTHERN AFRICA*	1874	1,000,000	..
AUSTRALIA	1874	1,713,142	85·9
INDIA, CHINA, and the EASTERN and PACIFIC ISLANDS*	..	25,000,000	..

† The balance of imports over exports of foreign sugar in 1873 was 44,510 cwts.
‡ The balance of imports over exports of foreign and colonial sugar in 1873 was 2,121,900 cwts.
§ Spain is also a sugar-producing country.
‖ The balance of imports over exports of foreign sugar was in 1873, 31,667 cwts.

The differences of consumption shown in this table are startling, but they are owing not only to variations in the wealth of the countries named, but to those of their climate. Countries in which wine is made and fruit ripens consume less sugar than those situate under more inclement skies. Thus, Austria and Switzerland, though richer than Sweden and Denmark, consume less sugar than the latter, where no wine is made.

The consumption of sugar has been greatly on the increase in the United Kingdom. In 1875 we imported 16,264,711 cwts. of raw sugar and 2,860,776 of refined, besides 768,410 cwts. of molasses and 237,997 cwts. of liquid glucose, or starch sugar; and of this quantity only 750,944 cwts. were re-exported. Of the total imports, however, only about one-third came from our own possessions, namely, from—

	Cwts.
South Africa	29,376
Mauritius	585,395
British India	430,772
Straits Settlements	116,664
British West India Islands	3,532,426
British Guiana	1,210,193
British Honduras	34,615
Total	5,939,641

The short table of proportions per cent. following shows the change that is taking place in the taste for raw sugar:

Home Consumption.	1869.	1870.	1871.
First class	·95	2·54	3·63
Second „	20·03	29·72	30·11
Third „	26·82	26·34	23·53
Fourth „	51·94	41·42	42·73

The proportion of refined used to raw has also risen.

The following figures, giving the official consumption per head of the population at decennial periods, show that we are the largest consumers of sugar of any nation on the globe:

Year.	Raw Sugar.	Refined.	Total.
	lbs.	lbs.	lbs.
1855	29·22	..	29·22
1865	37·05	2·73	39·78
1875	53·97	8·88	62·85

Of late years, owing to the bounty given by the French, we have been receiving large quantities of beetroot sugars yearly; thus, in 1874, 133,800 tons, and in 1875, 102,300 tons, principally refined beet sugar, were imported from France and Belgium. Good cane-sugar has been driven out of the market by inferior beetroot sugar, which for household purposes is 30 per cent. inferior, as every householder may know by filling two large cups of tea and putting in each precisely the same weight of cane and beet sugar, and testing the saccharine difference.

Until within a few years ago British Guiana was the only British colony besides Mauritius in which vacuum-pan sugar was manufactured, and Demerara alone made sugar suited to the wants of the British grocers. Now, Barbados, Jamaica, and some other of the British West India islands, have carried out this improvement.

Molasses.—Besides sugar we receive much syrup or molasses. The largest quantity now comes from the United States. The following were the countries which furnished us supplies in 1875:

	Cwts.
France	103,089
Egypt	36,762
United States of America	366,916
Spanish West India Islands	75,569
Australia	55,549
British West India Islands	113,187
British Guiana	2,897
Other countries	14,444
Total	768,410

It is a remarkable fact that the West Indians should export their molasses in such a state that it contains large quantities of extractable crystallizable sugar, and that a large and profitable trade should be carried on in its extraction both here and in the United States. Molasses proper ought to contain no extractable crystallizable sugar, and if it does contain any it ought to be called syrup, and not molasses. By cutting the canes at the wrong period, by keeping them till acids form, by boiling the juice in such a way as to ensure the acidity spreading as far as possible, the planter creates very much more than the unavoidable amount of molasses, worth from half to one-third the price of sugar; and he still further carelessly wastes his resources by letting large quantities of extractable sugar remain in the molasses. The colonial planter ought to study what is done on the Continent, in order to extract the last possible fraction of sugar from molasses. For instance, his attention should be directed to applying to the cane some modification of the supersaturation process of M. Marguerite, or of the osmogene process of M. Dubrunfaut, both of which processes are founded on strictly scientific principles.

Rum, another product from the sugar-cane, which we require largely for the supply of our navy, is furnished almost entirely from our own colonies. The imports from these in 1875 having been, from

	Galls.
Mauritius	583,365
British West India Islands	3,445,566
British Guiana	3,624,294
Total	7,653,225

Of this quantity, 5,386,843 gallons were taken for consumption.

A little over 1,000,000 gallons of rum from foreign colonies was also received, but re-exported.

Varieties of the Sugar-cane.—In most of the torrid parts of the New World, and in many of the islands of the West Indian group, species of the genus *Saccharum* have been found in an indigenous state. In the uncultivated parts of Trinidad three species were met with: *S. contractum*, Poit; *S. polystachyum*, Sw.; and *S. dubium*, H. B. The variety denominated the ribbon-cane, from its variegated coloured stripes, is also indigenous to the island, and to the neighbouring continent. This cane is remarkably hardy, but is less productive than the Otaheite cane now generally cultivated, and which was taken to the West Indies in 1769. The purple cane, a native of the American continent, has been grown in the islands, but is found inferior to the Otaheite cane.

The sugar-cane (*Saccharum officinarum*, Lin.) has a jointed stem from 6 to 12 feet high or more, solid, hard, dense, internally juicy, and hollow only in the flowering tops.

It succeeds in almost all tropical and sub-tropical countries, reaching in South America and Mexico an elevation above the level of the sea of about 5000 to 6000 feet. It is cultivated in most parts of India and China, up to 30° to 31° N. lat., the mountainous regions excepted.

In an account of the Society Islands and their principal vegetable products, by M. Cuzent, published at Rochefort in 1860, some interesting details are given of the varieties of sugar-cane cultivated there, which it appears to me desirable to diffuse.

Eight species are enumerated.

1. *Saccharum atrorubens*, called locally To Uti. The stalk is of a fine violet colour, large, and contains much juice, the pith is also of a violet hue. This variety is cut at about fourteen months. It is not indigenous, but was imported from Batavia in 1782 by Bougainville and Blight, who also introduced into the various colonies the varieties of canes with green and yellow stems known in the Antilles under the name of Tahiti canes.

2. *S. rubicundum.* Native name Rutu or Rurutu. The stem is of a clear violet, with white pith; the young leaves are violet coloured. This cane comes from Cook's Archipelago, and takes its native name from the island of Rurutu.

3. *S. fragile.* Native name Irimotu. This has a green stem, which is fragile and breaks with a straight fracture without splintering; the pith is white. It is rich in juice, but is little cultivated, because its stem is so pubescent, and the hairs enter the skin in cutting the cane, and also attack the respiratory organs.

4. *S. rubicundum* variety. Native name Oura. This is the ribbon-cane, having a violet stem with longitudinal bands of a bright yellow; the pith is white. This grows to a great size, especially in humid soils.

5. *S. obscurum*, Trin. Native name Piavere. This is the Creole cane; it has a light-red stem, and does not grow so large as the preceding varieties, the internodes are also less distant. The pith is white, and the juice not being so rich it is regarded as an inferior species.

6. *S. glaber.* Native name Vaihi-uouo, or simply Uouo, white, from the colour of its stalk. It does not contain so much juice as the other species, but its sap is more rich in crystallizable sugar. It was introduced from the Sandwich Islands, whence the name Vaihi, which is given to those islands by the Tahitians.

7. *S. fragile* variety. Native name Avae. This has a yellow stalk banded with clear green, having some resemblance to No. 6 Vaihi. The pith is white, tender, and very juicy, hence the natives

chew it in preference to the other kinds, but the sap is not very rich in crystallizable sugar.

8. *S. fatuum*, Bechey.

There are also two other indigenous varieties met with on the flanks of some of the mountains, which are not large, and designated by the natives under the generic name of To-Aeho. The first, called To-Patu, is red, and contains more juice than the second, the stalk of which is white. These varieties belong to the species known as *S. spontaneum*, Lin., or *S. floridulum*, Labill.

The Tahiti canes yield a fourth more juice and a sixth more crystallizable sugar than most of the other canes grown in the colonies. As those known as Tahiti canes grown in the West Indies have much degenerated, it is desirable that they should be renewed by fresh stock.

The botanical names given above are on the authority of M. Pancher, botanist at New Caledonia.

The Salangore cane, an eastern variety, has been introduced into Brazil and the French West Indian colonies; in the former it has become diseased, but in the latter it is well spoken of.

An acre of each of eighteen selected varieties of new sugar-canes was planted by Mr. R. Thomson, the colonial botanist, in Jamaica, in 1875; and about the same number of other varieties was also experimentalized on, so as to ascertain which would be the best to grow.

The Salangore cane is spoken favourably of there; it grows with great vigour under irrigation, and the number of shoots springing from each cane is remarkable. This variety should be planted wider apart than the space allotted to other kinds of cane.

The time has come when the yield of the cane must be increased, and it is well known that certain species are more susceptible of improvement than others. This law runs throughout the vegetable kingdom; and people who cultivate vegetables for manufacturing purposes always therefore not only seek for what grows best, but for what will yield most readily to cultivation. The beetroot growers, by acting according to good judgment on this point, have devoted so much attention to the selection of the richest varieties of their plant, that they have raised its saccharine strength from barely 4 per cent. to 8 and even 12 and 15 per cent., and this within less than fifty years. On the other hand, it is undeniable that the cane growers have remained content with the gifts of nature, and have done very little towards raising the quality and productiveness of their plant. The humble root which rivals the cane has been doubled and trebled in richness, whilst the sugar-cane has remained comparatively stationary. It is asserted by many able to decide the question, that beetroot has now reached its maximum of sugar-producing quality, and we ought to be encouraged in our efforts to improve the cane by the knowledge that this plant has not yet reached its maximum of production.

The results obtained from the trial of the Salangore cane at a plantation called Grand Parc, situated near Basseterre, are specially noteworthy. Planted at the full distance apart (two yards by two yards), which is an essential condition, and manured at the right times, the Salangore cane grows with such vigour, and in such thick tufts, that in five or six months it forms so thick a green covering that weeds cease to grow about it. The weedings are thus notably reduced. The cane goes through the period of flowering without injury. The tufts yield from twenty-five to forty canes. In consequence of the enormous quantity of canes produced by each tuft, the weight to the acre is much above that of an ordinary acre of canes. In one case sixteen tufts of canes, which were far from being the finest in the field, were cut in a square space of 38·45 mètres, and they weighed 367 kilogrammes net, from which, in proportion, we should find, in round numbers, 100,600 kilogrammes to the hectare. To ascertain the weight produced from a hectare of ordinary canes, the minutes of a meeting of the Sugar Society of Point-à-Pitre, of December, 1869, were consulted, and an authoritative declaration was made as follows: In Guadaloupe, an average of 40,000 kilogrammes of cane to the hectare is obtained, whilst at Grande Parc 30,000 only are obtained. The average at Beauport has been only 27,000 kilogrammes to the hectare. The *bagasse* of the Salangore cane gives so much fuel that only a small addition of straw is required, and this quantity leaves as much upon the ground for the use of the plantation as other kinds of canes. The juice of the Salangore cane is abundant. The sugar is easily made, without any other ingredients than those used in the manufacture of sugar from other kinds of cane. The yield per acre is considerably superior to that of other canes.

Mr. H. Prestoe, the colonial botanist of Trinidad, has recently published an official report, describing the fourteen best varieties of sugar-cane, among thirty-two surviving kinds of a larger number sent from the Mauritius. Eighteen of the thirty-two seem to be distinct varieties, and deserving of care and cultivation, as possessing characters that give them, in one way or other, a superiority over the two or three sorts at present in cultivation, and among which the yellow Otaheite takes by far the largest place. Some of the new varieties are peculiar for length of joint (properly *internode*, or 'tween joints), and some for length of joint united with stoutness. One is remarkable for both, joined with a very soft tissue. This sort is of a fine dark-claret colour, and is numbered 10 in the list. In common with many of the others, it also bears drought well, and is prolific. Two (Nos. 13 and 14) being extremely hardy and prolific, are recommended as fodder canes, to plant on poor, dry soils, unsuited for the better canes. They are much hardier than Guinea grass, and will yield a manifold greater weight per acre of surpassingly nutritious fodder. They are purple-striped. No. 8 resembles the best yellow Otaheite. No. 11, a dark-purple cane, perhaps a less luxurious offshoot of same parent as No. 10, is also soft in tissue. All to No. 12 are described as stouter, more promising canes than the common Otaheite, planted in the same soil and under the same conditions, and which were rarely $1\frac{1}{2}$ inch in diameter. Only No. 4 was so small, Nos. 2, 6, 9, 11, and 12 being $1\frac{3}{4}$ inch, Nos. 1, 3, 5, and 7 being 2 inches, while the joints of the very handsome, clean cane, No. 10, averaged $2\frac{1}{2}$ inches in diameter by $6\frac{1}{2}$ inches long. No. 5 has 6-inch joints, No. 9, $5\frac{1}{2}$ inches, and Nos. 4, 6, 11, and 12 have 5-inch joints. Those of No. 1 are 4½ inches, of No. 3, 4 inches, and of Nos. 2 and 7, 3½ inches. No. 6 grows very straight canes. No. 7 retained a green foliage, and although short in joint, is stated to have a very fine habit. The botanist is careful to say that, having been grown on poor soil, the dimensions given indicate, not the ultimate standard these varieties will attain to under more favourable conditions, but only their relative value compared with the common Otaheite, in fields planted alongside of them. He anticipates that a richer and moister soil will improve all. Purple and purple-striped canes are generally admitted to be preferentially adapted, by the hardiness of their habit, to the poorer drier soils; but it must be remembered, they have a hardness of tissue that gives more trouble in crushing. Nos. 10 and 11, however, are remarkable exceptions, and he thinks that others of the list, when tried in really goodly soil, will improve and assume a freer habit, and gain a larger size than ever shown by our old friend the yellow Otaheite. The paper mentions incidentally a grand purple cane obtained from the islands of the South-Western Pacific, the "Queen" cane, whose joints are 4 or 5 inches in diameter. Experiments in shortness of time to ripen, gallons of liquor per acre, saccharine strength per polariscope, and other particulars are also required, before the planter can know the relative value of the different kinds. There is not the least reason to doubt that with selection and good nursing, very superior and fixed qualities can be obtained in sugar-cane, as freely as they have been in wheat, turnips, beet, fruit, garden flowers, and domestic stock. Tropical staples are ages behind Europe in this respect, and have hence grand possibilities *in ovo*, but they will not be realised without effort, judgment, and perseverance. According to the 'West Indian,' a Barbados paper, a foot in length of sugar-cane grown in that island weighs three-quarters of a pound, and a bunch of canes grown in one hole weighs 54 lbs. on an average, which yield 4 gallons of liquor or juice, from which 4 lbs. of muscovado sugar are got. Of the 54 lbs., the juice weighs 50 lbs. An acre of ripe canes, planted 6 by 5 feet, gives 1452 bunches, or 5808 gallons of juice, or 5808 lbs. of sugar. At 50 lbs. of cane to the hole (or hill), an acre of canes, planted as above, would weigh, when cut, 72,600 lbs., or 36 tons, 90 per cent. being juice. It takes these 36 tons of cane to give 2½ tons of raw sugar, or 360 tons from a 10-acre field to yield 25 tons of sugar. For the first six months the plant requires but little rain to keep it in vigour; but afterwards it needs a constant supply, and an increase of growth in the last three months of the year.

The multiplication of all sorts of sugar-cane is usually effected from top cuttings, but this cannot be carried on for an indefinite period from the same original shoots without deterioration; and as seeds hardly ever ripen on the canes, new plants must from time to time be brought from a distance. Thus New Caledonia has latterly supplied its wild-growing splendid varieties for replanting many sugar fields in Mauritius.

The Bourbon variety is praised as one of the richest in sugar; the Batavian species (*S. violaceum*) is content with less fertile soil.

The Chinese variety (*S. sinense*, Roxb.) is hardier, and bears drought better than the ordinary cane. This species needs renewal only every second or third year, and ripens in seven months if planted early in spring, but if planted in autumn and left standing for fully a year the return of sugar is larger.

Many other varieties are known. Excessive rains produce a rank luxuriance of the canes at the expense of the saccharine principle. Rich manuring is necessary to attain good crops, unless in the best of virgin soil. The lower leaves of the stem must be successively removed (a process called "trashing"), also superabundant suckers, to promote the growth upwards and to provide ventilation and light. Moderate vicinity to the sea is favourable to the growth of the cane. The average yield of sugar varies from $1\frac{1}{4}$ ton to 3 tons per acre.

British Guiana.—This is essentially a sugar-growing colony. The value of its staple exports, the produce of the sugar-cane, in 1871 was as follows:

	£
Sugar	2,190,510
Rum	311,880
Molasses	65,313
Total	2,567,703

Of the sugar, about half goes to the United States, and the remainder to Great Britain and her colonies; the rum is nearly all sent to the United Kingdom.

The sugar exported in 1871 consisted of 104,310 hogsheads, being the largest crop this colony has ever produced. The rum consisted of 29,703 puncheons.

The following will show the progress of sugar production, as evidenced by the exports:

Year.	Sugar.	Rum.	Molasses.
	lbs.	imp. galls.	imp. galls.
1851	66,667,776	1,458,016	905,016
1861	115,755,200	2,728,913	319,884

There are in the colony 124 sugar estates, and the average annual produce of these in the two years ending 1874 was 90,888 hogsheads of sugar, 27,660 puncheons of rum, and 17,962 puncheons of molasses. Looking at the comparative value of the exports, the produce of the sugar-cane, they were as follows at three decennial periods:

Year.	Sugar.	Molasses.	Rum.
	£	£	£
1854	762,778	11,988	447,280
1864	1,319,625	56,870	247,508
1874	1,980,494	115,186	486,849

A sugar estate is divided into fields, of from 5 to 10 acres in extent, by a series of cross canals, and the method of planting the cane is simple and easy when labour is at command. The brushwood and grass having been cut down and weeded, are piled into rows, 6 to 8 feet apart, across the intended beds into which the field is to be divided. These beds are formed by digging open small drains, 2 feet wide and 2 feet deep, at intervals of every 30 or 36 feet, across the entire field, beginning within a few yards of the canal, in the centre of the estate, and running to the side draining trenches, into which they empty themselves. The soil from these small drains having been carefully thrown upon the beds, so as to raise and round them off in the middle, narrow banks or ridges of earth are made across them, from drain to drain, parallel to and equidistant between the rows of grass and brushwood; and in these spaces, between the banks of earth and grass, the canes are planted in line, each line being 3 or 4 feet apart, and each cane plant 9 or 10 inches from the next. The plants are procured by cutting off the tops or upper joints of growing canes into lengths of 10 or 12 inches, which are thrust in a slanting direction into the well-stirred ground, and in ten days or so the long grass-like leaves begin to spring from the eyes at every joint. These young canes require to be kept well weeded, and moulded about the roots from the ridges of earth or decaying grass on either side of them, which had been previously prepared for that purpose; and this must be repeated as long as there is room for the labourers to pass between the rows, which, according to the season, will be until the plants have attained the age of six or eight months, after which time the spreading of numerous leaves from each stock will have covered the surface of the field with so dense a jungle as in a great measure to prevent any further growth of weeds. When about nine months old, the cane throws out its "arrow," a long reed-like stem, surmounted with a tuft of waving downy blossom. At this period the plant is poor and weak, and little more than a mass of water; it soon, however, recovers, and in twelve or thirteen months from the time of planting is considered at maturity, having then sometimes attained a length of 20 to 25 feet, but more frequently of 10 or 12 feet, about as thick as the wrist, and divided into joints like a bamboo. When ripe, the canes are cut down to the very ground, in lengths of 3 or 4 feet, and thrown into punts, which are towed along the canal by mules or oxen to the wet dock at the door of the sugar mill. Immediately after cutting, the large quantity of thrash or dry leaves is rolled clear of the cane stumps, and heaped in rows, there to decay and form a rich manure for the succeeding crop. In a few days the stumps throw out their shoots, and the same routine of cultivation is repeated for twelve months more, any vacant spaces where plants may have missed being carefully supplied. The canes of the first year are called "plant canes," those of the second and subsequent years being distinguished as "ratoons"; and these ratoons have been known to be produced from the first plant for twenty years and upwards, the canes having been annually cut down and the stumps allowed to shoot again. But this continued reproduction from the same stocks, which is now compulsory on the planter from the scarcity of labour, of course causes the canes to degenerate, and to yield less abundantly. An acre of newly planted land will give two tons of sugar for the first year, gradually falling off to not more than one-fourth of that quantity as the stocks become old; and were there sufficient labour in the colony to admit of the land being replanted every third or fourth year, there can be little doubt that the present crops would be nearly doubled. The productive power of the greater part of the soil of British Guiana, indeed, appears to be unlimited. As an instance, it may be mentioned that, on an estate in Essequebo, the return obtained in 1851 from certain lands, which had been properly worked and perfectly drained, amounted to a fraction within 4 tons of sugar per acre.

The plan on which a sugar estate in this colony is laid out is described in the first 'Report on Thorough Drainage,' by the late Dr. Shier, agricultural chemist to the colony, page 15:

"The plantations, laid out for the most part by the Dutch, are on a uniform plan. They are generally narrow rectangular strips of land, with a façade or water frontage on the coast, the rivers, or canals. The façade varies from 100 to 300 Rhynland rods (12·32 feet).

"Exceptional cases occur where, from an estate being prevented from extending far back, extra façade has been allowed, giving to the estate more of a square form. Every estate is bounded by four dams; the front dam, excluding the sea, river, or canal; the back dam, parallel to the former, and excluding the bush water, which, in heavy weather, is very considerable, and would inundate the cultivation. The clay thrown out in forming the adjacent canals or trenches affords the material of which the dams are formed. Along each of the remaining sides there runs a dam from front to back. These are usually termed side lines. They are common to two contiguous estates, and prevent the influx of water from the sides. Thus the very long rectangular strip of land is surrounded with dams, which, when kept free from bush, answer the purpose of a road round the estate; but the produce is brought to the buildings (often situated in front) by canals. In fact, water transport of produce is universal. The arrangement of the navigation system is very simple. From front to back, and right in the centre of the estate, there runs a dam called the middle walk, with a canal on each side of it. These are termed centre canals, and are wide enough to admit of two punts passing each other. The dam forms a path for the cattle that draw the punts. At regular and comparatively short intervals branch canals strike off at right angles from the centre canals, and proceed to within a rod of the draining or side-line trenches, which are parallel to the side dams before described, and adjacent to them. These branch canals constitute the transverse boundaries of the fields, and navigation canals thus lie on three sides of every field, and admit of canes being carried by a short path to the punts. On some estates there is only a single centre navigation canal. These canals are principally supplied by the rain, but in protracted droughts, and especially when they are shallow, they are liable to run short of water: hence whenever access can be got to creek, lake, or bush water, it is brought from behind to supply the navigation system. In other instances salt water has to be taken in from the front when a cane crop cannot otherwise be got off the ground. The drainage of an estate is equally simple. From back to front, and immediately adjacent to the side-line dams, run the two main draining trenches, generally dug considerably deeper than the navigation canals. The small drains, again, cut at distances two to three rods apart, commence within a bed of the middle-walk side of the field, and terminate in the side-line draining trenches, being dug with a fall in that direction. The small drains are thus at right angles with the main draining trenches. In the front dam the sluices or kokers are placed. Sometimes there is only one on an estate, but generally two, one at the end of each draining trench. The main draining trenches are generally connected together by a trench running along behind the front dam."

The processes employed in the manufacture of sugar are as follow:

The cane-juice is received from the mill into cisterns or boxes, where such a proportion of lime is added as is considered necessary for its proper defecation. It is thence run into a series of cast-iron vessels called "coppers," which are built into brickwork, and heated by the direct action of a single fire in the ordinary manner. In these the juice is, as far as possible, cleansed by means of skimming, and evaporated down until it has reached that degree of concentration technically known as the "striking point," when it is transferred into shallow wooden vessels and allowed to crystallize.

Bisulphite of Lime.—This agent has been used in the manufacture for the last eight years, but at the present time much more extensively than ever. It is in some cases used even when the ordinary process is followed. There are three establishments in or near Georgetown for the manufacture of bisulphite of lime, so great is the demand. The apparatus for the manufacture of sugar is now wonderfully compact and perfect. The improvements likely to be made will, no doubt, be in the substitution of shallow evaporating vessels for the taches or teaches at present in use.

As an improvement upon this rude process, separate defecating vessels or clarifiers, heated either by steam or by the open fire, have been introduced on the majority of estates, and in some instances vessels in which the defecating liquor is allowed to subside previous to being run into the coppers, have also been used with advantage.

For upwards of thirty years vacuum pans have been in use on some plantations in this colony. Of late years their use has been greatly extended, and, from present appearances, it is likely that at no distant date no important estate in the colony will be without one. The advantages attending the use of the vacuum pan are chiefly these:

(1) A much more speedy manufacture of sugar than by the ordinary process.

(2) The production of a sugar (grocery quality) which goes directly into consumption, without passing through the hands of the refiner.

(3) The avoidance of all loss from drainage on the homeward voyage.

The loss from drainage of molasses of common process sugars is estimated at 10 per cent. of the original weight.

On plantations where the vacuum pan is used the process may be thus stated: As the cane-juice falls from the mill rollers it is mixed with a certain proportion (half per cent.) of bisulphite of lime. It is then thrown up to the clarifiers, and boiled by means of steam. A due amount of milk of lime is added, and the contents of the clarifier allowed to remain at rest (half an hour) till the impurities have settled, when the clear juice is run down to the copper wall. In some cases filtration through bag filters is practised as the juice leaves the clarifier. On some estates the contents of the clarifiers, at a boiling temperature, are run into subsiding vessels, in which the sediment takes place, from which the juice passes either through bag filters or at once to the copper wall. On the copper wall the cane juice is evaporated to a density of from 25° to 30° of Beaumé's saccharometer, when it is either taken directly into the vacuum pan or is first passed through bag filters. When the syrup is sufficiently concentrated in the vacuum pan, i. e. when crystals are formed to the satisfaction of the pan boiler, the contents are run into shallow wooden coolers, and after a short time transferred in portions to the centrifugal machines, in which it is freed from molasses. In some cases, while in the centrifugal machines, syrup is used to brighten the colour, and in other cases a small quantity of water. The sugar is then removed from the centrifugal machines, and at once packed into hogsheads. The sugar thus manufactured in this colony is of a pale straw colour, uniform crystal (not too large) of great brilliancy, and dry. A sugar perfectly white and brilliant could as easily be produced.

From the various improvements introduced, the manufacture of sugar is now a very speedy process; for instances are known where from canes in the field in the morning, the sugar has been on shipboard before night.

Sir R. Schomburgk, in his very interesting pamphlet on British Guiana, observes that 8 hogsheads of sugar per acre is an ordinary crop, 5000 to 6000 lbs. (53 cwts.) per acre not extraordinary; and that on an estate called "Mary's Hope," on the Courantine coast, 8000 lbs. = $73\frac{1}{4}$ cwts. have been produced. In British India the produce is only from 12 to 15 and 20 cwts. per acre, on the very best land. In Trinidad the produce cannot be estimated at less than 20 cwts. per acre.

The quantity of rum manufactured in British Guiana is very considerable. Formerly it was estimated that for every hogshead of sugar produced by an estate, there should also be produced a puncheon of rum. This estimate still holds good on estates where the ordinary process of the manufacture of sugar is practised; but on estates where improved methods with the use of the vacuum pan are followed, the quantity of rum does not exceed one-half of the old estimate. The great object of proprietors is to extract the largest amount of sugar from the cane juice, and diminish as much as possible the production of rum and molasses.

The rum produced does not bring so high a price in the market as that of Jamaica, not that less skill is employed in its manufacture, for no expense has been spared to obtain the best machinery and make use of the best methods. The reason of the inferiority arises chiefly from two causes:

(1) From the very impure cane juice obtained from the sugar-cane grown in this colony. So much salt still remains in the soil that on many estates the presence of salt in the cane juice can readily be perceived by the taste.

(2) From being unable to employ water for condensing the spirit at a lower temperature than 84° Fahr.

In Jamaica the spring water brought from the mountains is of a much lower temperature.

On the best estates till recently the whole of the molasses was manufactured into rum, but now a good many estates reboil the molasses in order to extract all the crystallizable sugar. This, however, can only be practised where the vacuum pan is used.

Formerly the molasses was exported to Great Britain and purchased by refiners, but lately a great deal has been sent to the United States, where a higher price has been obtained. It may also be stated that a considerable proportion of the sugar of the colony has gone to the same market.

Rum when rectified is colourless and possessed of a peculiar odour, arising, it is said, from an essential oil contained in the rind of the cane, and which finds its way, in the skimmings of the cane juice, during its evaporation, in the sweets used in setting up liquor for fermentation. Rum is coloured in this colony by caramel prepared from good muscovado sugar.

The proper manufacture of good colouring matter for rum is very important. For this purpose the best sugar should be selected, and placed in sufficient quantity in a pan on an independent fire. The sugar must be constantly stirred with a wooden paddle during the action of the fire on the pan, in order to prevent its getting a singed taste or flavour; and when it comes to a consistency, making it difficult to keep it in motion with the paddle, the fire must be withdrawn, and high wines gradually added to it, under the agitation of the paddle, until it comes to a consistency of thick cream, so that the whole will be perfectly dissolved. After this, it should be put into a cask placed on end, with two cocks, one about 6 inches from the bottom of the cask, the other about 2 inches from the bottom, and allowed to remain undisturbed, in order to its depositing the sediment left in it, until it runs off from the upper cock entirely free from sediment. It may then be used for colouring the rum, and about three pints of good colouring matter well concentrated ought to be sufficient for 100 gallons of spirit; but different markets require different shades of colour, and to regulate the shade of colour must be left to the judgment of the person entrusted therewith. Great care should always be taken that the colouring matter does not impart any cloudiness to the rum, because when rum is cloudy the value of it is very greatly deteriorated.

I would recommend colouring matter to be made in large quantity, because the longer it is kept the purer it becomes.* The strength of the rum generally exported from this colony is about 35 per cent. overproof.

French Guiana.—There were in 1874 about 235 hectares cultivated

* MacRae's 'Planters' Manual.'

with the sugar-cane, and 7 plantations, employing 655 labourers. The produce of sugar has fallen off of late years from 420,000 kilos. to 250,000 kilos., with a little molasses, and 75,000 litres of rum.

Surinam.—Sugar is the staple product of this Dutch colony, and the manufacture is now being actively carried on.

The following have been the exports for six years:

Year.	Sugar.	Molasses.	Rum.
	lbs.	galls.	galls.
1866	18,577,326	435,933	75,594
1867	21,164,179	523,738	78,128
1868	22,593,182	562,888	61,374
1869	19,600,220	484,266	58,542
1870	22,309,213	380,171	90,373
1871	23,709,797	317,223	167,412

Several of the wealthiest owners of estates have introduced the vacuum-pan process, making their sugar thereby, and thus rendering it more marketable and of higher value. They have also been erecting first-class distilleries on their estates, as, the price of molasses being low, they find it more profitable to distil than to sell the molasses.

Brazil.—Sugar is one of the great articles of export from Brazil, forming about one-sixth of the total value of the shipments. It has not made the same progress that coffee has done; its culture has indeed in some provinces been stationary, owing to the preference given to the growth of coffee and cotton, which are for many reasons supposed to be more advantageous to the planter, as requiring less capital and labour. The culture of the sugar-cane is in general carried on in the most primitive manner, and owing to the rudeness of the machinery and the want of knowledge of the latest and most improved processes of manufacture, the quality of Brazilian sugar is, with some few exceptions of note, greatly inferior to that of other American countries. However, in this as in most other matters the Brazilians are seeking to put themselves on an equality with other nations, and many enterprising planters are availing themselves of the latest improvements that machinists and scientific men have placed at their disposal. The sugar-cane can be grown in almost every part of Brazil, but is raised chiefly in the provinces of Rio Janeiro, San Paulo, Bahia, Pernambuco, Parahyba, Ceara, Alagoas, and Rio Grande do Norte. The exports of sugar were in

	Arrobas (32 lbs.).		Arrobas (32 lbs.).
1843	5,209,721	1863	10,121,719
1853	10,681,344	1872	9,762,135

The average annual value of the sugar exported is about 2,500,000*l.*

The larger planters manufacture their molasses into rum, but many of the small growers produce a superior quality of spirit, which is much prized. The average of the exports of rum in periods of six years was as follows:

	Canadas of about ⅘ of a gallon.		Canadas of about ⅘ of a gallon.
1841–46	2,526,200	1853–58	2,709,501
1847–52	2,503,373	1859–63 (five years)	2,569,308

The variety of cane grown by preference now in this country is the Salangore, as the Cayenne cane, so long in use, from the negligence exhibited in its culture, became a victim to the epidemic that attacked it, whereby it lost all its saccharine qualities. It is said that the Salangore cane gives an amount of saccharine almost fabulous; its vegetation is most luxuriant, requiring little care. But all recent introductions in Brazil present the same phenomena at the onset, as was the case with the Cayenne cane; and such new substitutes will be of little avail if the method and care in its cultivation be carried out in the old fashion.

About seventeen varieties of this plant have been acclimatized and cultivated in Brazil, and considerable quantities of plants are annually distributed to planters by the Imperial Institute of Agriculture here.

The Salangore cane is now more attacked by the disease than its predecessor, and to such a degree that very few districts are exempted from that plague.

The whole belt of soil from the Amazon to San Paulo is suitable to the cultivation of the sugar-cane, although it is more fully developed in the northern provinces of Pernambuco, Alagôas, Sergipe, Bahia, and Rio Janeiro.

Its cultivation is remunerative, especially the species called Salangore, which yields 11 to 14 per cent. of juice. In new lands a single hectare yields 100,000 kilos. during fifteen months. An active, intelligent labourer is supposed to take care of two hectares, which would produce 1000 kilos. of sugar, worth 150*l.* The cost of production in Rio, where wages are high, is about 14*l.* per hectare, leaving a net profit on two hectares of 60*l.* But the profit is greater when the condition of the land admits of the use of the plough and other improvements. In the manufacture of sugar great advantage has attended the use of steam as the boiling medium of liquids at a low temperature, and that of turbines for the forced clearing of the crystallized materials.

The exports of sugar from the port of Bahia in 1866 were about 48,000 tons, and the average of the preceding twenty-five years was only 41,000 tons. The cultivation of sugar in Bahia, incontestably at one time the most flourishing in the province, has of late years, from the invasion of a malady in the cane, given unsatisfactory results, probably through the exhaustion of the soil, upon which crop after crop was cultivated, without system or science. There were in 1871, 1010 registered sugar mills and 700 not registered in the province of Bahia. In the adjoining province of Sergipe there were 700 sugar mills. The production in the province of Bahia in 1870 was 70,000,000 lbs. of sugar, and over 2,000,000 litres of rum.

The old system of planting, as handed down from colonial days, is carried on, but there are indications of an awakening spirit to adopt superior methods. Ploughing and manuring, as understood by an Englishman, are almost entirely ignored. There are within this province 1345 "engenhos" for manufacturing sugar, besides a great number of small growers, who make a coarse sort of sugar (rapadura), in ordinary use among the population of the wild extent of this country, and not brought to market.

The progress of sugar production in Brazil is shown by the following comparative exports:

	Lbs.
1860–61	143,853,700
1871–72	312,389,000

The total quantity made, without considering the inferior products of molasses and rapadura, or coarse cake sugar, is estimated at 617,760,000 lbs. annually.

Year.	Quantity.	Value.
	cwts.	£
1864	2,264,794	2,164,700
1865	2,116,767	1,624,216
1866	2,585,730	1,876,816
1867	2,316,780	1,664,615
1868	2,439,404	2,280,631
1869	2,601,300	2,804,651
1870	2,665,278	2,822,674
1871	2,706,305	2,330,881
1872	2,839,892	2,657,735

The export of sugar from the port of Pernambuco, in bags of 160 lbs. weight, was as follows:

1860–61	730,476	1866–67	537,780
1861–62	861,728	1867–68	649,742
1862–63	724,784	1868–69	899,424
1863–64	712,035	1869–70	796,234
1864–65	564,223	1870–71	690,259
1865–66	721,955		

besides 90,045 barrels in the latter year.

British Honduras.—There are now 9636 acres under crop here. The cultivation of the sugar-cane has been steadily progressing, and there is little doubt but that it will be the great staple of this colony, notwithstanding its many other valuable and important products. In 1862, 177½ tons were shipped; in 1871, over 2300 tons.

Year.	Sugar.	Rum.
	tons.	galls.
1867	868	53,714
1868	1,025	39,268
1869	1,031	45,996
1870	1,478½	49,442
1871	2,320¾	65,848
1872	2,203	..

Improved agriculture is wanting; for the land, if properly tilled, is capable of producing as much per acre as Demerara and at less cost; for the rivers drain the land, and thus save the vast expense of both machinery for pumping, and the labour for keeping open trenches for drainage absolutely necessary to keep the cultivated land above water in Demerara.

The sugar-cane succeeds very well in most of the countries of Mexico and Central America, south of 28°. The most productive plantations are on the declivities of the table-land, and in the lower plains to the elevation of 5400 feet above the sea; but in places well sheltered, the sugar-cane grows nearly as high as 7000 feet. These plantations are most numerous in the valley of the Rio Santiago, and on the plains towards the Pacific. Their produce is very considerable, but nearly the whole of the sugar is consumed in the country.

Colombia.—The sugar-cane has hitherto been cultivated in Carthagena only in small quantities, for making rum and a spirit called anisado; but an enterprising firm planted in 1873 about 300 acres of cane, &c., and imported large and powerful steam machinery, at an outlay altogether of 20,000*l.*, and they anticipated from their first year's crop 10,000 cwts. of sugar. The climate and rich soil are peculiarly adapted to the growth of the sugar-cane. The chief difficulty is labour, and they have imported Indian coolies from Jamaica.

Venezuela.—This State has never been a sugar-exporting country, and the export which has been carried on may be said to have been almost exclusively confined to brown or muscovado sugar, and only to have attained any importance for about five-and-twenty years, between 1830 and 1855.

The following shows the total exports in periods of five years:

Year.	Quantity.	Average Price per lb.
	lbs.	cents.
1832–36	3,573,222	5
1837–41	2,107,708	$13\frac{3}{4}$
1842–46	2,894,284	$11\frac{3}{4}$
1847–51	5,398,267	$5\frac{7}{8}$
1852–56	465,099	28
1857–61	16,205	..
1862–66	314,580	..

In 1870, owing to a falling off of nearly 30 per cent. in the production of sugar in Cuba in 1869, a remunerative demand suddenly sprang up for Venezuela sugar, and large shipments of both muscovado and clayed (papelon) were made to Philadelphia and New York at $4\frac{1}{2}$ cents. per pound. As the crops have produced much more than could be used locally, the planters are glad of a profitable outlet for shipment. In 1873 the export of sugar from Venezuela was close upon 5,000,000 lbs.

Peru.—The sugar-cane grows with the greatest luxuriance, and it is sufficient to plant it once to have constant yields from the roots (rattoons). It is very common to see roots of this grass with more than twenty vigorous cane stalks. It promptly develops itself, and ripens at the end of six or seven months' planting. In the mountainous parts it is not grown for sugar, but to obtain aguadiente (spirit), of which the natives are very fond.

The sugar manufactured in Peru may be estimated at 720,000 cwts. per annum, of which there is sent to Chili 100,000 cwts., to California 50,000; the remainder being used in the country.

It is produced in the following places, and in the quantities named:

	Cwts.
Pimental and San José	160,000
Pacasmayo	120,000
Malabrizo	120,000
Huanchaco and other small ports ..	60,000
Cerro Azul	200,000
Pisco and Lomas	60,000
Total	720,000

In the valley of Canete, interior to the port of Cerro Azul, which is not more than 80 miles south of Callao, are several sugar-cane plantations, with manufactories for sugar and rum; these are called "haciendos." This valley produces annually sugar and rum worth more than 400,000*l.* There is a sugar refinery in Callao.*

In 1871 the exports from San José de Lambayeque were 58,251 cwts., of white crushed, muscovado, and coarse brown sugar. This was about the same as the previous year. The crop would have been larger but for disastrous floods, which ruined all the small farmers.

The import of Peruvian sugar into Great Britain is increasing rapidly. The following figures give the receipts in each year from 1870 to 1875, inclusive: 1870, 502,000 lbs.; 1871, 8,700,000 lbs.; 1872, 13,100,000 lbs.; 1873, 31,900,000 lbs.; 1874, 47,400,000 lbs.; 1875, 100,000,000 lbs. (say = 50,000 hogsheads); total for the six years, 201,602,000 lbs.

Louisiana.—In 1759 the first sugar mill was erected in New Orleans. In 1834 the produce was 100,000 hogsheads, and in 1840, 119,947 hogsheads, of 1000 lbs. each; and 600,000 gallons of molasses.

In 1845 there were 762 sugar estates, of which a little more than half worked by steam-power, and the rest by horse-power. The crop of sugar was 204,913 hogsheads. Of the estates, 757 used the old process of open kettles for granulation, and 5 used the vacuo process, with its expensive appendages of filters, animal charcoal, &c.

In 1853 there were 1481 sugar-houses in operation, of which 943 worked by steam-power, and 538 by horse-power; 53 used the vacuo process. The crop of sugar was 321,934 hogsheads.

The sugar interest of Louisiana, which was almost annihilated during the war, is again rising to prominence. In 1861 the yield was 449,410 hogsheads; in 1864 it was but 6668 hogsheads, and from that time it gradually rose until, in 1869, it was 87,000, and in 1870, 144,881 hogsheads, which was more than a fair average yield.

* Mr. Hutchison's Consular Report, 1871.

In 1872–73 the crop was 108,520 hogsheads of sugar, and 8,890,640 gallons of molasses, made by 1181 sugar-houses.

The product of a hand on a sugar estate is put down at the cultivation of 5 acres, producing 5000 lbs. of sugar, and 125 gallons of molasses. Two crops are made in succession on the same land, one of plant cane and one of rattoons; it then lies fallow two years, or is planted with Indian corn or peas. An acre yields about 1200 lbs. of sugar. The home production of the United States in 1870 was:

	Lbs.
Sugar from cane, say	87,000,000
Sugar from maple	28,443,645
Total	115,443,645

	Galls.
Molasses from cane	6,593,323
„ sorghum	16,050,089
„ maple	921,057
Total	23,564,469

The foreign importation of like products in 1873 into the United States, as compared with the above, stands thus: Sugar, including Melado, 1,567,795,088 lbs.; molasses, 43,533,909 gallons.

In June 1872, Mr. Lapice, one of the oldest sugar planters of Louisiana, left New Orleans for the Pacific Ocean, for the purpose of procuring a fresh supply of sugar-canes for planting, as it had been found that the old Creole cane originally introduced by Columbus, and generally cultivated in the West India Islands, had degenerated. The ribbon cane was brought in by a vessel from Java, and had proved hardy. Mr. Lapice, on visiting Singapore, found that the ribbon cane had been entirely abandoned, and a new kind from Java was in general cultivation. It is of a purple colour, and very small light stripes. Another new kind of cane has been introduced into Borneo from New Caledonia. At Saigon he obtained some specimens of a variety called the elephant cane. The old ribbon cane is being cultivated in Madagascar. The result of Mr. Lapice's voyage on behalf of the Louisiana sugar planters, was the arrival of a steamship with 11,000 cuttings from various new kinds of canes.

The 'New Orleans Picayune,' writing on the sugar manufacture there, observes:

" It appears that while the sugar-cane contains nearly twice as much sugar as the beetroot, in the process of extraction more sugar is obtained from the latter than the former. Millions of pounds of sugar are thrown away in Louisiana every year. The sugar exists in the cane in a crystallized form, and cannot be pressed out. It must be dissolved out by water. The fact that the Louisiana sugar industry needs the aid of science fully to develop the wealth of the State need not be longer concealed. The agriculturists of Europe call in science to their aid, and are thus enabled to compete with their less enterprising competitors who are blessed with superior natural advantages.

" The following figures are well worthy of perusal. They are from parties well versed in the subject. The amount of beetroots contained in an acre weighs, on an average, 30,000 lbs. The cost of cultivating beetroot in Germany is 16·55 francs; the internal revenue, 19·95 francs—6·70 dollars per ton of 2200 lbs. Cultivation of beetroots in France, 18 francs; internal revenue, 32·35 francs—10·07 dollars for 2200 lbs. Percentage of sugar in roots in France, 5 to 12 per cent. Percentage of sugar in roots in Germany, 6 to 13 per cent. The internal revenue is in France fixed on the juice after it is extracted from the beets. In Germany it is levied on the weight of the beets. Quantity of sugar manufactured from 100 lbs. of beets in France, 7 lbs. = 14·28 per cent. Quantity of sugar manufactured from 100 lbs. of beets in Germany, 8 lbs. = 12·5 per cent. In both France and Germany the average per cent. of molasses is 3·33 per cent. An acre of sugar-cane (canes that are brought to the sugar-house to be manufactured into sugar) costs in culture in Louisiana 50 dollars. Last season 148,740 acres of canes were taken to the mill in Louisiana. The average quantity of canes per acre was, this last season, 44,058 lbs., and the cost per 2200 lbs. 2·50 dollars. That year 6,553,108,807 lbs. of canes were passed through the mill; the juice produced had a density of 8° Beaumé, equal to 14·4 per cent. of pure sugar per 100 lbs. juice; but only 12·96 lbs. of sugar for the 90 lbs. juice contained in 100 lbs. of canes. When the sugar is drawn from the batterie or strike-pan, it contains water of crystallization equal to 15 per cent., which, added to the 12·96 of sugar, are thus divided: 8·942 sugar, 5·962 molasses—14·904 per cent. The quantity of sugar produced last year (1872) in Louisiana, 146,906,125 lbs. The quantity of molasses produced last year, 110,219,538 lbs. The cost of manufacturing sugar, and the expenses in fuel, hogsheads, barrels, freights, commissions, &c., at least 4 cents per lb. of sugar. Quantity of sugar that should have been produced was 586,013,250 lbs.; of molasses, 390,675,500 lbs.

"The question now comes, Can machinery be made that will extract the whole of the sugar from the cane? Many of the machineries now in use in Europe for the manufacture of beet sugar would exhaust almost the whole of the saccharine contained in the sugar-cane. But those apparatus cost very high in money, and require a great many hands to work them; presses to operate on 500,000 lbs. cane in 24 hours would necessitate from 48 to 50 hands to attend to them; to the juice water must be added at the rate of 25 to 30 per cent. The quantity of sugar left in the pulp, from 1 to 1½ per cent. Diffusion to work the same quantity of cane would require, to attend the diffusion vessels, &c., 20 to 25 hands; some 20 per cent. of water is added, and the cosettes or slices return ½ per cent. of sugar. The use of centrifugals or turbines to displace the saccharine from the pulp would be very costly. A sugar-house to work 500,000 lbs. (nearly 230 tons) cane per day would require 115 hands to be all the time on duty. The cost of a beetroot manufactory is from 32,000*l.* to 40,000*l.*, and some run as high as 160,000*l.*, 200,000*l.*, and even a great deal more. One in the Grand Duchy of Baden, 'Waghausel,' manufactures nearly 60,000 tons of sugar yearly, and has cost over 1,000,000*l.* Many of the planters are of opinion that beetroots would be profitable in Louisiana as a sugar-rendering plant, and could be cultivated in lieu of the sugar-cane. Sugar could not be made from beetroots with the machinery we now possess. Had we the machinery wanted to make sugar from beetroots, we would then, from one acre of canes, manufacture more sugar than from five acres of beetroots. Supposing sugar could be made as cheap from beets, could our sugar makers learn how to make the sugars? In Europe almost every sugar manufactory is attended by one or two chemists, besides almost every railroad train running to Paris takes to Messrs. Dubrunfault and other chemists samples of either roots or juice or syrup to be analysed. At the manufactory the juice has a density indicating 10 or 12 per cent. of sugar, and the deficiencies are so great it is necessary to know wherefrom they come. In every factory the beetroots are weighed, all the juice is measured, the density recorded and proved at least eight or ten times per day, and the percentage called for must be found. It would be very amusing to see our planters frying beet-juice 'in our open kettles,' and therefrom trying to make sugar. The black stuff coming would rather frighten them. Give us sugar-canes yet (although it is said they are degenerated) with deep-drained lands, 'renewed with peas,' thorough deep-ploughed land that will produce cane 8 feet long when cut for the mill, and weighing 125,000 lbs. (nearly 60 tons) to the acre, if the juice be $8\frac{1}{2}°$ Beaumé = 12,000 lbs. sugar and 8000 molasses; others may cultivate beets. Peligot is right when he says: 'If in Europe we had the sugar-cane we would furnish sugar to the world, and so cheap as to defy competition.' The apparatus used in Cuba will do better than either presses or diffusion, the tanks being so constructed that a very dense juice is produced. If the mill would give juice at 8° Beaumé, the displacement apparatus with the same canes would furnish juice at 8°·5 to 9° Beaumé. If more fuel is required, it is simply because a larger quantity of sugar is produced. Two or three hands can work the apparatus. Only one-half of the power is required to slice canes that is now used to press the cane with rollers. The bagasse used in Cuba contains 13·5 lbs. of sugar to 100 lbs. bagasse (each 100 lbs. of canes giving 40 lbs. bagasse, 250 lbs. canes gave the 100 lbs. bagasse), and a little over 10 lbs. of the 13·5 lbs. of sugar were extracted. Had sliced canes been used instead of bagasse the exhaustion would have been much more complete. In evaporating sugar in Louisiana, fuel equal to 1 lb. of coal is used to evaporate 3 lbs. of water. In Europe 1 lb. of coal evaporates 6 lbs. of water in manufacturing beetroot sugar."

The following details of the sugar-cane, its contents, and the manufacture of sugar from it, are well worthy the attention of all interested in its culture:

1240 gallons of juice at 8°·5 Beaumé produced on a plantation 1048 lbs. of sugar and 480 lbs. of molasses.

One gallon of juice at 8°·5 Beaumé will weigh 8·96 lbs. avoirdupois. Therefore, 1240 gallons of juice will weigh 11,111 lbs.

100 lbs. of cane contain 90 lbs. of juice. Then 11,111 lbs. of juice are produced by 12,345 lbs. of cane.

At 8°·5 Beaumé the juice contains 15·3 per cent. of pure and dry sugar. If so, 11,111 lbs. of juice, having that density, will produce 1700 lbs. of sugar.

When the sugar is taken out of the boiler, it is combined with water of crystallization, which, being added to the 15·3 per cent. of pure and dry sugar = 17·595 per cent. of sugar and molasses; of this, three parts are sugar and two parts are molasses, and we have for the 11,111 lbs. of juice at 17·595 per cent. = 1655 lbs., of which 1173 are sugar and 482 molasses.

This plainly demonstrates that the loss in the manufacturing was 427 lbs. of sugar and molasses. Also, we can perceive that with 11·8 lbs. of cane 1 lb. of sugar and 0·48 of a pound of molasses were produced; that, had there been no loss in manufacturing, 10·5 lbs. of cane would have produced 1 lb. of sugar and 0·66 of a pound of molasses; and that, if no molasses had been produced, but the whole juice had been converted into sugar, 1 lb. of sugar would have been produced by 7·26 lbs. of cane.

The land, according to quality, can grow or produce in Louisiana from 13,000 to 45,000 of canes to the acre; the length of the cane will vary from 3 to 8 feet; their weight being on an average 10 ozs. avoirdupois to the running foot.

Canes 4·5 feet long, weighing each 3 lbs., and growing 350 per row, of 100 feet long, would give 61,125 lbs. to the acre. As an average, the acre can be set down at 60,000 lbs.

When canes are cut before they are injured by the cold, they can be kept for making sugar from three to four months. They lose some of their water of vegetation; the sugar does not change in the least, and stays in perfect preservation.

May 9th, 1873.—Seven months ago, that is, in October, 1872, canes were cut to plant; the sugar in those canes is yet in perfect preservation, and the juice has a density of 8° Beaumé.

The joints of a cane that has dropped its leaf contain only crystallizable sugar. The buds, or young suckers of the joints, produce the larger part of the colouring matter found in the juice. In Louisiana the density of the cane juice varies from 6° to 10° Beaumé; 8°·5 Beaumé being the average; 15·33 per cent. of pure, dry sugar.

With displacement of methodical washings, the sugar contained in the sugar-cane can be easily exhausted. When thoroughly defecated, the juice of the cane is very easily manufactured into sugar, and the whole of the sugar-cane can be made to crystallize.

The planters require from 35 to 55, and even more, pounds of cane to make 1 lb. of sugar, and 0·66 of a pound of molasses. The average for the State is 2·25 lbs. of sugar and 1·50 lb. of molasses to 100 lbs. of cane. Thus 100 acres, or 6,000,000 lbs. of cane, are equal to

	$	$
135,000 lbs. of sugar, at 8 c.	10,800	
90,000 lbs. molasses, at 4 c.	3,600	
		14,400
Expenses, culture	5,000	
Manufacture	5,400	
Taxes, overseer, engineer, &c.	2,000	
		12,400
Total		$2,000

We have demonstrated that 10·5 lbs. of cane can easily produce 1 lb. of sugar and 0·66 of a pound of molasses. Then 6,000,000 lbs. of cane will produce equal to

	$ c.	$ c.
571,428 lbs. of sugar, at 8 c.	45,713 24	
380,952 lbs. molasses at 4 c.	15,238 08	
		60,951 32
Expenses, culture	5,000 00	
Manufacture	11,951 32	
Taxes, overseer, engineer, &c. ..	2,000 00	
		18,951 32
Total		$42,000 00

6,000,000 lbs. of cane manufactured into sugar of firsts, seconds, &c., would produce (white sugar)

	$	$
750,000 lbs. of sugar, at 12 c.	91,200	
140,000 lbs. molasses, at 3 c.	4,200	
		95,400
Expenses		25,400
Total		$70,000

Concrete sugar contains 10 per cent. less water than ordinary sugars, which usually have sugar three and molasses two parts. Thus 6,000,000 lbs. of cane manufactured into concrete would produce 867,510 lbs. of sugar at the price of some 7 cents per pound, or $60,725; less expenses, $20,725 = $40,000.

India.—A few particulars regarding the earliest development of the sugar industry will not be found uninteresting. The sugar-cane is a native of India and Indo-China, where it was exclusively cultivated from remote ages down to the middle of the thirteenth century. At this period the trade extended itself into the countries beyond the Ganges, and the cultivation was speedily taken up in Arabia, Syria, and Egypt. Gradually the plant was introduced into Cyprus and Sicily, and thence into Madeira and the Canary Islands, ere long becoming in Spain and France a favourite object of culture. In the beginning of the sixteenth century, the sugar-cane was imported into St. Thomas and St. Domingo, where its culture was rapidly developed, and a systematic trade established in those colonies.

The sugar-cane was doubtless known in India from time immemorial, and grown for food, as it still is in the present day, chiefly in those regions which are unsuited for the manufacture of sugar. From the elaborate investigations of Ritter, it appears that it was originally a native of Bengal and of the Indo-Chinese countries, as well as of Borneo, Java, Bali, Celebes, and other islands of the Malay Archipelago. But there is no evidence that it is now found anywhere in a wild state.

The extraction of the juice from the cane—the first step toward the manufacture of raw sugar—was, in early times, effected by the rudest appliances. The stump of a tree, the upper part of which was carved into a rude resemblance of a human head, was regarded as a deity, which enabled the ancestor of the poor ryot of the present day to obtain the juice which would yield the much-prized sweet crystals. Into the hole representing the mouth of the figure, or into one made lower down, was inserted the end of a long pole, which served as a lever to crush the juice from a piece of cane placed between it and the stump.* The Buck Indians or Caribs of British Guiana, it is curious to remark, now employ an almost exactly similar contrivance for a like purpose.†

This ineffective method gave place to one by which the juice was crushed out in a mortar. The primitive mill still used in Dinajpur is an adaptation of this plan, and is constructed as follows. A sound tamarind tree being selected, it is cut down at about two feet from the ground, where it may be a foot and a half or more in diameter. The stump is then hollowed out in the form of a mortar, and from the bottom of the hollow a hole is bored a little way perpendicularly. The exterior of the stump is next pierced by a hole which meets the previous boring obliquely, and thus affords an outlet for the juice, which runs into a strainer fixed over an earthen pot sunk in the ground amongst the roots of the tree. The pestle, it is to be observed, does not pound the pieces of cane, but crushes or squeezes them. It consists of the trunk of a tree some 18 or 20 feet in length, and about a foot in diameter, rounded off at the larger end, which is placed in the hollow of the mortar in an inclined position. A pair of oxen are yoked to a horizontal pole, which is supported at the outer end by a bamboo hanging by a notch made in the root end from the upper and smaller end of the long pestle, while the other end is attached by a loop to a bamboo hoop which encircles the stump, and thus acts as a runner. The pestle, therefore, forms a double-armed lever, the fulcrum of which is situated at the edge of the mortar, the cane being crushed between the sides of the pestle and mortar respectively. The force with which the pestle acts is increased by the driver sitting upon the outer extremity of the horizontal pole, and sometimes by weights being added. Such a machine, however, is totally ineffectual to crush the cane until it has been first cut into small pieces. To this end a bamboo stake is driven firmly into the ground, and a deep notch made in the end projecting upwards. The attendant passes the canes through this notch, which slits them longitudinally, while he cuts off the slit canes, in lengths of about a foot each, with a rude chopper.

The sugar mill of Chinapatam is a slight improvement. Instead of the standing stump of a tree being used, which could only be done when a suitable tree grew on the desired spot, the mortar is carefully fashioned out of the trunk of a tree some 10 feet long, 8 feet of which is firmly embedded in the ground. The hollow, for two-thirds of the depth, is in the shape of an inverted truncated cone, the

* The sugar-cane appears to be referred to in the Rig-Veda, probably the most ancient work known in the world, and in the Mahâbhârata. The Agni-Purâna also contains a reference to the art of sugar-boiling.

† Rev. W. H. Brett's 'Indian Tribes of Guiana' contains a coloured plate representing Caribs crushing sugar-cane in this manner.

remaining third being cylindrical, with a hemispherical projection at the bottom, like the lower part of a common beer bottle. A forked branch of a tree is worked down, Robinson Crusoe-like, to a beam or plank some 4 or 6 inches in thickness, and varying from near 18 inches in breadth at the single end to less than a foot at the forked ends, when, by-the-way, it has much the appearance of a monster boot-jack. This beam is placed horizontally with the hollow against the mortar, and the bullock-driver sits on the undivided end to which the cattle are attached, while the beam turns round the mortar like a screw-key which if too large would slip round a nut. The pestle is a piece of hard wood of the usual form, which is pressed down by a beam, one end of which is attached either directly over or near above the undivided end of the lower beam. There is a hollow on the under side of this upper beam immediately over the mortar, in which rests the top of the pestle, the other extremity being pulled downwards by cords attached to the forked ends. By tightening or slackening these cords, the upper beam acts as a regulating lever to give the pestle more or less force. The whole arrangement, when at rest, has very much the appearance of a huge lime-squeezer.

The transition from the arrangement last described to the vertical wooden roller mill now in use at Chica Ballapura, and in other parts of India, was but natural. We find in this mill the same idea of a lever pressing upon the top of the pestle applied to another purpose, in the beam which is fixed to the top of the longer of the two rollers which projects above the framework in which they are placed. The other roller, which is only the height of the frame, is turned by the four spiral grooves and ridges at the upper end being jammed against corresponding grooves and ridges on the long roller. The transmission of motion by means of the cog-wheels of modern times is thus seen to have had its origin, probably many centuries before the Christian era, among the ancient inhabitants of India.*

To place two such cylinders of hard wood in a frame, horizontally instead of vertically, so that they could be turned by two men, one at each end, and could be easily moved from place to place, was the simplest way of meeting the requirements of those who had but little cane to squeeze. Its cheapness, however (it can be made for two rupees, 4*s.*), was probably the greatest inducement to its adoption. Such mills are in common use near Calcutta. They are almost universally employed by the Chinese, amongst whom they are conveyed from place to place, along the rivers and canals in the sugar districts, by migratory sugar boilers. Being temporarily erected in some central spot, where the produce of several farms can be conveniently brought,

* See Reports from the officers of the East India Company on the cultivation of sugar-cane in Hindostan. Dr. Roxburgh, Mr. Touchet, Mr. Cardin, Mr. Peddington, Dr. Tennant, Mr. Prinsep, Captain Sleeman, Dr. Wallich, Dr. Buchanan, Mr. Haines, Mr. G. H. Smith, and others, 'Asiatic Society's Journal,' 'Transactions of the Agri-Horticultural Society,' and Parliamentary Report from the select committee appointed to inquire into the matter contained in the petition of the East India Company, complaining of the imposition of duties on East India produce. A woodcut of each of these three kinds of mills may be found in Ure's 'Dictionary of Arts, Manufactures, and Mines,' sixth edition, vol. iii.; and of the two last in 'Chambers's Encyclopædia,' vol. viii.

the workmen are kept in constant employment until the canes near at hand are all cut, and another move becomes necessary.*

We thus find, in the records of the ancient arts of Hindostan, roller mills for crushing cane, both vertical and horizontal, which are barely improved amongst the same people at the present day, and are exact prototypes of the machinery now in use.

The first mills used in more modern times were known as edge-mills, and are now chiefly used for crushing oil-seeds, apples (in cider districts), and in tanneries. A large heavy wheel, generally of stone, was made to revolve vertically upon its edge in a small circular area some 8 or 10 feet in diameter, by cattle or wind power. The pieces of cane were strewed in the concave path of the wheel, and the juice flowed away by a channel formed for the purpose. Père Lafitau relates the donation to the Convent of St. Benoit by William II., King of Sicily, of such a mill for crushing sugar-canes, along with its privileges, workmen and dependencies, which remarkable gift bears the date 1166.†

In the next century we find mention of the use of vertical wooden rollers in Europe, the introduction of which is generally attributed to Gonzales de Velosa. In the fifteenth century their use crept to Madeira and the Brazils. Early in the century following roller mills were established in Hayti and in other places contemporaneously with the spread of cane cultivation. The old vertical wooden mill is still to be found in many places in the West Indies and elsewhere; and more than one may now be seen at no great distance from Port-of-Spain, Trinidad.

From wooden rollers to those of stone and then of iron the progression was unavoidable. Many examples of stone roller vertical mills are still in existence, while vertical mills with iron rollers are, even now, comparatively common. Ligon states that when he visited Barbados in 1647, the planters were ignorant of many things, and amongst others he mentions "the true way of covering their rollers with plates or bars of iron." ‡ This information, it appears, they obtained from Fernambuck (Pernambuco), in Brazil, whence they had "gotten plants."

Cattle gave place, subsequently, to wind and water power, both of which are still largely used in remote districts. As recently as 1848 a mechanical engineer found it necessary to call the attention of the planters of Trinidad to the superior advantages of steam-power, which at that time seemed not to be fully appreciated. § The use of steam has enabled boiling houses to be erected, and consequently estates to be established, in situations where it had been impossible to do so previously. Its employment as the motive power in estates' boiling houses may now be said to be general, although it offers a

* Sir George Staunton's 'Authentic Account of an Embassy from the King of Great Britain to the Emperor of China,' 1797.

† 'History des Découvertes et Conquêtes des Portugais.'

‡ 'History of Barbados,' 1650. See also Houghton's 'Husbandry and Trade,' in the papers issued from Friday, June 17 (No. cccviii), to Friday, September 2 (No. cccxix), 1698.

§ See advertisement and correspondence in the 'Port-of-Spain Gazette' for that year.

method of economizing labour in many operations to which it has been seldom or never applied as yet, the advantages of which, even at the present day, remain to be estimated at their true value.

Within the last thirty or forty years mechanical engineers have brought the old model horizontal roller mill to the highest state of perfection. The first letters patent ever issued in England, in connection with sugar manufacture, were granted to "Willoughby, Francis, Lord; Hyde, Laurence; and De Marcato, David," for the "makeinge and frameinge of sugar mills;" and are dated and numbered A.D. 1663, February 4—No. 141. Mills have since been made of three, four, and five rollers; but those consisting of three rollers have been found to give the best results with the least expenditure of power. Since the above date, upwards of 80 patents have been taken out relating to machinery for extracting the juice from the sugar-cane, all of which, with some dozen or so of exceptions, are merely adaptations of, or improvements in connection with, roller crushing mills.

The *inspissation of the juice* appears to have been carried on in India from the earliest times of which any account is discoverable. Although the mill was universally without shelter, the boiling apparatus on the other hand was invariably covered by a shed. The range consisted of a series of (generally) eleven earthen boiling pots, suspended between two parallel mud walls about 20 feet long, 2 feet high, and 18 inches apart, the interstices between the pots being filled in with clay. A flue was thus formed, at one end of which was a large circular iron pan, exactly like the present copper, under which was the fireplace—a hole dug in the ground. The iron pan served as the teache.

The arrangement just described has undergone no alteration or improvement up to the present day; neither has the process adopted, which is as follows: After the juice has been concentrated to the consistence of sling—goor or jaggery as it is termed—it is placed in pots and handed over by the ryot, or farmer, to the goldar, or sugar boiler. When it has to bear carriage a long distance it is further concentrated by the ryot, until it resembles an inferior description of concrete. By the goldar the pot extract is put into bags of coarse gunny or sack-cloth, which are hung over a number of large earthen vessels, and on water being sprinkled on the tops of the bags the molasses drains away by displacement. The sugar from the bags is then mixed with water in a pan like a large copper, sunk in a cylindrical cavity in the ground which serves as a fireplace. After being allowed to boil for a short time, an alkaline solution prepared from the ashes of the plantain tree is added, and subsequently some milk. The liquor is next strained through cotton, and the former process is repeated until a sufficient concentration has been attained. It is then poured into earthen pots with curved sides, large at the top and pointed at the bottom where they are plugged with a plantain leaf, and placed in a curing shed on a wooden grating at some little distance from the ground. Here they are allowed to drain into vessels placed underneath. A layer of moist leaves of the *Valisneria spiralis* is placed on the top, which after some time is removed, and, the crust being broken, fresh leaves are added, and the process is repeated until complete crystallization has taken place.

There is one fact which must strike the most casual inquirer into the early history of sugar manufacture in its birthplace, and it is one to which the attention of the reader may here be directed. The raw produce, which goes by the name of goor or jaggery, is made chiefly by a number of farmers acting in concert. The process is carried out in common by the association, but is specially deputed to some of their number who confine themselves to this branch, the produce of each man's land being sent to the common factory. The goor is then handed over by the ryots to another distinct caste, the goldars, who make the solid sugar, some of whom again are sugar-boilers or refiners, and others confectioners, who make candy, &c. The vital principle of division of labour is thus most strictly carried out, the whole manufacture involving at least the employment of two sections of one caste, and, where it is largely followed, two distinct castes and no less than five or six sub-classes, which implies its division into as many different branches.

The following account is given by Baboo Joykishen Mookerjee, a zemindar of Hooghly: "Two species of sugar-canes, known in this country as the *kajlee* and the *pooree* canes, have from time immemorial been cultivated in this district (Burdwan). These canes always gave the cultivators very good returns, and their cultivation therefore, in former times, gradually increased with the increased demand of sugar for exportation.

"Whether these crops were native to the soil or merely acclimatized is not known; but no account of the total failure of these canes, such as was the case with what were called the Bombay canes, can be gathered from the accounts of the oldest inhabitants. More than forty years ago Mr. McDowal introduced the red canes from the district of Rungpore, and they were thence called the Shahiban Khooshir. The cultivation of this species of cane spread very rapidly, as the cultivators found that they yielded more juice and contained more saccharine matter than the country ones; and in about eight years it spread gradually over Hooghly in common with the other southern districts. About the same time, that is, nearly thirty-five years ago, the red or Bombay cane was introduced in the district from Nimgee Bungalow, a place a few miles from Calcutta. It was at first cultivated at Bally, Ooterparah, Rughoonathpore, and their neighbourhood, but in a few years the cultivation gradually extended to the banks of the Damoodah, close to Pergunnah Chunderkona. A very great impetus was given to the cultivation of sugarcane in this and the other districts by the large diminution in the supply of sugar from Mauritius and the West Indies, in consequence of the restrictions imposed about this time on the slave trade and slave labour. For more than fifty years the cultivators reaped luxuriant harvests of the Shahiban and Bombay sugar-canes, and improved their condition to no small extent. Brick-built houses sprang up in every direction, and the condition of a large portion of the tenantry was altogether very cheering. In 1854 and 1855, however, the first symptoms of the blight, which totally exterminated these valuable crops from the district, first made their appearance. A few cane bushes here and there appeared withered during the first year. This did not attract much attention, but the next year the cultivators were alarmed at the destruction of about two-thirds of the crop, and although every means that lay in their power were had recourse to to save the crops from the *Dhoosha* (sugar-cane blight), the attempt was entirely fruitless. After an inefficient struggle for more than three years, the cultivation of both these descriptions of sugar-cane was given up in despair and the ryots had to fall back on the cultivation of their own country canes, the *kajlee* and the *pooree*. After the extinction of the highly paying descriptions of canes, the ryots had not much heart to cultivate the inferior descriptions of cane; but they had not long to mourn for the extinction of their valuable crops, for in about the year 1860–61, the *shamshara* cane, which is nearly equal to the extinct descriptions, was introduced in this district. The cane is believed to have been imported from Otaheite. Its cultivation has steadily increased, and the quality of the cane has evidently improved by reason of the great care taken in its cultivation and of the large expense that is incurred in manuring the soil and irrigating the crops. A short account of the cultivation of sugar-cane in this district was published in the 'Agricultural and Horticultural Society's Journal,' vol. ix. part 3, of 1857, pages 353–358. It would be worth while to ascertain whether the importation of new seed or plants of the Bombay cane might not have the effect of restoring its cultivation."

Of all agricultural products sugar-cane requires the most care. Before filling a plantation the ground must be ploughed at least ten times; manured and left fallow for a whole year. In the second year, when the time of planting approaches, beds two yards square are prepared by kneading the soil till it acquires the consistency of mud. Ten heads of sugar-cane are then buried horizontally in each plot and well covered with the moist earth, which is allowed to dry for ten or twelve days or until cracks appear. Each cane-head planted has four or five joints, and from each of these a shoot springs twenty days after planting. From this time till the cane is ready for cutting, fresh water is admitted every four days. In three months the shoots attain the height of a yard, and at this stage it is usual for the outside leaves to be carefully wrapped and bound round the stalk as a support and protection. Later on, further support in the shape of a bamboo fifteen feet long to two canes, is added, and thenceforth the canes require to be tied afresh to the bamboo every six weeks as their height increases. The cutting commences a year from the time of planting. In some districts a large expenditure is incurred in fencing the gardens to keep out jackals, which are exceedingly partial to the sweet cane. For this purpose as many as 60,000 bamboos are required for a plantation of eight acres. The canes to be used for sugar and jaggery are taken direct from the field to a large open shed, where they are passed through a press composed of two circular pieces of hard wood made to revolve by rude machinery worked by bullocks. When about twenty chatties of juice have been obtained the boiling begins and lasts for an hour. To each boiler of juice a *viss* of lime is added. When boiled the mixture is poured into an iron vessel, and after being stirred for a while is poured out again on a mat, on which the sugar dries and becomes hard. It is then broken up and packed for market in baskets of five maunds each.

The goor of the Sahitru districts in Sinde varies in appearance and substance from that of other parts. It is remarkably hard, and requires some exertion to break it, and is at the same time of a very deep colour. This is doubtless owing to the nature of the sugar-cane, which is quite different from that of Southern India. It is a thin, cane-like plant, seldom much thicker than a small finger, very hard, and yielding little juice, so that to see the business of expressing the juice therefrom, one would imagine it scarcely worth the trouble. The flavour of the goor, however, is good. A superior kind of native spirit is made from this goor, which is very generally drunk by all classes without exception, although strictly forbidden in Mahomedan and Hindoo law. There are several kinds of it, which vary in price according to quality. The liquor is, however, intrinsically the same, the good or bad quality of it depending upon the quantity and variety of spices added to it.

Several varieties of sugar-cane are cultivated as the country cane, the original form of the species; the ribbon cane, with purple or yellow stripes along the stems; the Bourbon or Tahiti cane, a more elongated, stronger, more hairy, and very productive variety. *Saccharum violaceum*, Juss., the Batavian cane, is also considered to be a variety; but the larger *S. chinense*, Roxb., introduced from Canton in 1796 into the Botanic Gardens of Calcutta, may be a distinct species; it has a long, slender, erect panicle, while that of *S. officinarum* is hairy and spreading, with the ramifications alternate and more compound, not to mention other differences in the leaves and flowers.

In the Madras Presidency in 1870 there were 29,000 acres under sugar-cane; the largest quantity was grown in Bellary, the next in Ganjam and Cuddapah.

The following have been the quantities of sugar exported from British India:

	Cwts.		Cwts.
1865	477,099	1870	385,638
1866	428,341	1871	345,300
1867	221,006	1872	419,282
1868	93,187*	1873	671,659
1869	450,051	1874	337,465

* And 1345 bags.

Siam.—Next to rice, sugar is the largest article of export from Siam. Nachonyhaisi and Petno are the principal sugar districts; but it is also produced at Paklat, Bangpasoi, Chantibon, and Petchabure in considerable quantities. The owners of the mills seldom cultivate the canes themselves, but purchase them standing in the fields from the growers, who have usually money advanced to them by the mill-owners at the commencement of the season, to enable them to plant on their ground, they in return being bound to sell all their canes at a fixed price to the person lending the money, besides paying interest at the usual rate. The cultivation of the sugar-cane has greatly increased. It is mostly in the hands of the Chinese.

The extraction of the juice from the canes and its manufacture into sugar are carried on in a very primitive manner, without any of the modern improvements to obtain from the cane the largest possible quantity of a superior quality of sugar. The greatest quantity of sugar is made in the neighbourhood of Bangkok and the adjacent provinces, to where the tidal waters extend. Here irrigation in cases of drought may be carried on with the greatest convenience; and were there sufficient labouring hands to attend to its cultivation, ten times the quantity of sugar now produced might be raised in those localities to which the tidal waters extend, setting aside other places appropriate to its cultivation. With better machinery the manufacture might be greatly improved, and the culture is very careless.

White or clayed sugar, red unclayed, and yellow, are the three descriptions brought to market. The yellow is always deficient in grain. Most of it comes from up the country, and from Chantibon; it seems to be a peculiar description of sugar, and the Chinese manufacturers say they are unable to granulate it; it is usually pretty dry.

The best sugar is procurable in March and April, that which is made in the two following months is mostly from the second boiling and is much lower in quality. The quantity produced in each of the years 1857 and 1858 was about 100,000 piculs. In 1862 the shipments were 82,700 piculs, being 47,000 piculs less than a five years' average. The exports in 1867 amounted to 137,532 piculs; the greater part was sent to China; in 1870 the shipments were 101,307 piculs. Palm sugar is manufactured to a considerable amount at Pitchaburé, but it is all consumed in the country. This is not the same as the date sugar known in Europe.

A company called the Indo-Chinese Sugar Company was established here a few years ago, who received a large grant of 3000 acres from the Government at a yearly rental of 2*s.* 3*d.* per acre for the land under cultivation. The inland duty on sugar has been reduced to 9*d.* per picul on white and 4½*d.* on brown. Instead of the old hoe system of culture, steam ploughs and cultivators have been introduced, and large sugar mills on the newest principles erected.

China.—Although we have no data to guide us as to the sugar production of China and the local consumption, yet by going through the trade returns of the several ports, we glean some idea of the export trade as shown in the shipments for 1871, which were as follows:

	Piculs.
Swatow, brown	461,420
„ white	516,595
Canton	316,183
Shanghai	538,533
Amoy	194,406
Formosa, brown	560,510
„ white	26,544
Chefoo	7,930
Total	2,622,121

Equal to about 3,277,000 cwts.

The imports of native sugar at the other ports for the same year were as follows:

	Piculs.
Ningpo	87,000
Kiukiang, foreign	22,075
„ native	16,000
Chefoo	394,285
Tientsien	325,647
Newchang	80,042
Hankow	283,010
Chinkiang	285,149
Total	1,493,208

Or in round numbers about 1,866,500 cwts.

The following shows the coasting trade carried on. Sugar sent in foreign vessels from one port to another:

Year.	Outwards.	Inwards.
	piculs.	piculs.
1868	1,339,874	1,973,136
1869	1,198,522	1,574,554
1870	1,145,279	1,425,457
1871	1,762,390	2,099,836
1872	1,435,625	2,002,567
Total	6,881,690	9,075,550
Average	1,376,338	1,815,110
In cwts.	1,720,422	2,268,900

Mauritius.—This is now one of the principal British sugar-growing colonies. About 1750, the sugar-cane was first introduced into the Mauritius. In the commencement, it made but little progress, but as the cane began to be better appreciated, its cultivation increased with marvellous rapidity until it has now become the chief, almost exclusive, resource of the island. The white cane which is indigenous to the islands of the Pacific is said to have been first planted in the Mauritius, but the disease with which this variety had been attacked, considerably restricted in after years its cultivation. Of twenty varieties which have been introduced at different periods, the following six are said to be the most commonly cultivated in the island:

The white cane of Otaheite.
The bamboo, or cane of Batavia.
The Guinghan, or violet-striped cane.
The Bellouguet, or purple Java cane.
The Pinang cane.
The Diard cane, with which the white Bellouguet is generally confounded.

The last is a recent importation from Batavia. It is a hardy plant, thrives well with moderate care and attention, produces a greater quantity of stems than the white cane; but does not hold in the ground so well, which is a disadvantage in a climate subject to high winds and hurricanes. It yields well both in respect of the number of canes and the quantity of juice, which is superior in quality to that of most of the other species.

The Pinang cane is a very fine species, producing, after the Otaheite, the longest and thickest canes, but it does not, like the Diard and some other species, give so many stems. It is a tender plant, somewhat impatient of and requires a great deal of care.

There are two species of Bellouguet, the one white, the other red. Both species, like the Diard, give a great many stools and require a great deal of room to allow for spreading, without which the stems grow meagre; but planted wide apart and carefully tended this species will produce well. The white is preferred to the red, on account of the superior quality of the sugar made from it. The red gives a sap strongly coloured. It is very difficult to remove this colouring matter, which injures the quality of the sugar. Both species require sheltered situations to come to perfection. Their roots growing laterally and horizontally they have no hold in the ground. The great quantity of stems they produce offers a larger surface to the action of a high wind than the roots are calculated to bear; they are therefore easily uprooted, and considerable loss is the consequence.

The Bamboo cane is the hardiest of all the species; but it is not much admired, owing to its partaking partly of the nature of the reed from which it derives its name. The stem is hard and dry; but in exposed situations and in marshy ground it grows well and produces a fair return. It requires less attention and stands drought very well. The quality of the sugar made from the juice of this cane is inferior.

There are many other species cultivated; but none are of sufficient importance to require separate mention. In good soil, canes may, with attention and good manure, be cut for six or seven seasons running without its being requisite to replant. This is considered the longest time canes will yield a profitable return in the best soils, in the lower portion of the district. In the higher parts, the cane plant is never expected to last more than three seasons, and only two on poor soils, or where stones are common.

Mr. J. Horne, the sub-director of the Royal Botanical Gardens, Mauritius, in his valuable Report for 1875, states that the introduction and propagation of new varieties of the sugar-cane have been given up, for the present at least. It has been of good service to the colony, and, instead of the sugar crops depending upon the health of three or four varieties of the sugar-cane, the planters have now a choice of nearly one hundred. These are not all good canes, and some of them are better adapted to certain localities than others. At the propagating grounds, where they were well watered, manured, and attended to, nine or ten of the varieties proved to be positively bad. These were either very subject to disease of various forms, or deficient in saccharine, or they did not ratoon freely after being cut once or oftener, or they produced few (five or six) canes to the plant. Two of

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each variety have been planted in reserve ground in the gardens, in order that none of them should be lost to the colony. A great matter is the choice of healthy cane tops for planting. None but tops of the most vigorous and healthiest canes should be selected. Through neglect of this, the canes deteriorate, till at last whole fields come to be planted with cane tops which are unhealthy and positively diseased. The Sandwich Islands, and perhaps New Guinea, are the places to which the planters of Mauritius will have to look for new varieties, more prolific, hardy, and healthy than those they now possess. In the Sandwich Islands the sugar-cane is said to be indigenous, and there are thirty-five to forty varieties, of which only two are in Mauritius. One variety, called "Puolleæ," has been known to yield an average, per acre, of 12,000 lbs. = 6 hhds. of No. 16 sugar, on an extent of 30 acres of good land, which had been irrigated. It is reported to be hardy and to grow freely, in its native country, at an elevation of 2000 feet above the sea.

The principal improvements made in the manufacture are the vacuum pan, of which two are now at work, and the centrifugal drying machines, of which there are many at work, particularly in the higher parts of the district, where, from the nature of the climate, they are indispensable. The advantages of both are undeniably great. Samples of sugar made with the two improvements combined show that sugar can be made directly from the cane juice which will bear comparison with the best refined sugars: the crystals are larger, better defined, and when "clairced" are perfectly white, even without the aid of animal charcoal. The superiority of these methods over all others is incontestable. The sugar far exceeds in quality sugar made in any other way: it is made, dried, and is ready for shipment the day after the operation is commenced. All the inconveniences of the old system, which required at least fifteen days to perform what is now done in forty-eight hours, have vanished, Enormous purging houses with all the necessary encumbrances of casks, "caissons," &c., are no longer required. The syrup, which formerly remained in large tanks till it was fermented and unfit for any other purpose than to make rum, is now converted into sugar immediately, and almost all the crystallizable portion at once obtained.

The improvement next in importance is the process of making sugar called Wetzell's, from the name of the inventor. The operation is not so perfectly performed as in the vacuum pan. The quality of the sugar is consequently inferior; but still it is a great improvement on the old method,—the apparatus is less expensive, can be made in the colony, and with the aid of "turbines" sugar of fine quality is produced. The crystals are however smaller and not so clear and well defined as in vacuum-pan sugar. These machines are employed on many estates and the result obtained is satisfactory.

In a report by Sir Henry Barkly, he states: Some allege that Mauritius has seen its brightest days; that sugar cultivation reached its maximum limit several years ago; that the soil is in many districts exhausted, and the cane plant in consequence subject to the attacks of insects and other diseases, &c., &c. In my opinion there are no adequate grounds for any of these forebodings, though they are not surprising after the series of ordeals through which the island has had to pass. Granted that, although nearly a fifth of the surface is still either covered with forest or in a state of nature, it is generally too elevated, and consequently too cold and damp for the production of sugar, and that little virgin soil is available for the purpose beyond a few patches of woodland at the back of the estates of the more prudent proprietors. Granted that many estates have been most improvidently worked, yet there seems to be no reason why, with the improved system of agriculture now commencing, a greater variety of manures, more frequent fallowing, and a more careful rotation of green crops, the land now in cultivation should not go on producing more than it has ever hitherto done. As to the deterioration of the sugar-cane, which seems to me attributable in no small degree to the immoderate and uninterrupted use of guano, the steps which have been taken to introduce fresh varieties from Java, New Caledonia, and other countries, will, in the long run, permit the entire renewal of the plant; and the question is not, at any rate, so much beyond the pale of botany and agricultural chemistry as to justify any serious alarm. On the other hand, improvements of the highest importance, though, at the same time, singularly inexpensive, are now being carried out in the mode of manufacturing sugar, which are certain to lead to a considerable increase in quantity and a wonderful amelioration of quality, and consequently ought not to be lost sight of in any appreciation of the future prospects of this colony. I allude to what is called, from its inventor, the "Icery process," a mode of applying monosulphite of lime, by which the juice of the cane is so thoroughly defecated, that sugar but little inferior to refined is produced at a first process.

The great superiority of the Mauritius sugar arises from the manufacture by Dr. Icery's process of purification by monosulphite of lime without filtration by animal charcoal. The syrups remaining from the turbinage of sugar when treated with monosulphite of lime give most advantageous results. Under the influence of this agent, syrups become purified, decolorized, and crystallized with remarkable facility. Manufactured by this process, syrup sugars have a perfect grain and fine colour, not entirely due to the direct influence of the substance employed, but to the preparation to which the veson or juice has already been submitted, and the absence in the syrup of those foreign soluble matters which are the principal obstacles to the crystallization of the sugars of the second boiling.

In Mauritius by the processes used, all things being equal, the proportion of sugar from a barrel of cane juice (which weighs from 530 to 544 lbs.) will depend not only on the relative richness of the liquid, but also on the various circumstances in which the manufacture may be placed. The average yield may be taken at 95 lbs. of sugar per barrel of juice, and the average yield of sugar per acre ranges from 3500 lbs. to 5500 lbs.

Dr. Icery made numerous analyses upon the different species of mature canes cultivated in this island, but grown in localities differing in soil and temperature. The result of his observations was the following average percentage of the composition of the juice:*

* The full details of Dr. Icery's chemical researches are published in detail in the sixth volume of my 'Technologist,' 1866.

Water	81·00
Sugar	18·36
Mineral salts	0·29
Organic substances	0·35
Total	100·

The following are analyses made by Dr. Icery on different kinds of ripe canes:

Species of Cane.	Water.	Sugar.	Ligneous Substance.
Diard	0·698	0·200	0·102
„	0·703	0·197	0·100
Guinghan	0·682	0·209	0·109
„	0·703	0·186	0·111
„	0·697	0·196	0·107
Pinang	0·678	0·196	0·126
„	0·690	0·198	0·112
Bellouguet	0·716	0·197	0·087
„	0·703	0·203	0·094
„	0·729	0·187	0·084
Bamboo	0·695	0·190	0·115
„	0·669	0·214	0·117
Otaheite	0·703	0·210	0·107

Cane sugar ($C_{12}\,H_{11}\,O_{11}$) is distinguished from all other kinds by the property it has of crystallizing in large rhomboidal prisms, and the facility with which it is possible to obtain it in this state, when dissolved in water.

It will be seen from the following shipments of the seasons 1869–70 and 1874–5 that there is a large consumption of Mauritius sugar in Australia and India, where the coarser quality is principally sent:

	1869–70. lbs.	1874–5. lbs.
To United Kingdom	76,212,485 ..	61,586,770
„ France	22,310,088 ..	2,105
„ Australia	99,748,587 ..	54,499,693
„ Cape Colony	4,751,588 ..	5,725,722
„ India	59,209,368 ..	40,435,380

Quantities and value of the sugar exported, as given in the twelfth number of 'Statistical Abstract of Colonies': *

Year.	Tons.	Value.	Average Price per cwt.
		£	£ s. d.
1867	100,000	2,156,950	0 18 4
1868	99,000	2,143,166	1 1 10
1869	107,000	2,599,815	1 2 10
1870	102,000	2,549,881	1 4 11
1871	123,000	2,819,944	1 2 7
1872	128,350	2,844,593	1 2 2½
1873	116,582	2,897,909	1 4 11
1874	98,491	2,318,158	1 3 8

* These figures differ slightly from those given in the Governor's Reports and the Mauritius Almanac.

This amount may be compared with the quantity produced in the island twenty years ago, which was under 60,000 tons.

The following shows the sugar estates and their acreage in 1876:

District.	Sugar Estates.	Acres Cultivated.
Pamplemousses	29	11,414
Rivière du Rempart ..	22	12,250
Flacq	38	26,851
Grand Port	34	22,548
Black River	11	4,940
Plaines Wilhems	19	12,750
Mokha	17	11,133
Savanne	29	20,290

Reunion.—The extent of land under cultivation with sugar in this island in 1874 was 43,672 hectares, and there were 85 sugar estates, of which 79 had mills worked by steam. The produce of sugar ranges from 35,000,000 to 41,000,000 kilos. of molasses, 3,500,000 to 4,000,000 litres, and of rum 1,300,000 litres.

The sugar exported from Reunion to France in 1874 was:

	Kilos.
1st quality	4,443,534
2nd "	3,191,130
3rd "	1,241,634
Total	8,876,298

Straits Settlements.—In Province Wellesley considerable improvements have been made in agricultural operations of late years on the estates of European planters; while the Chinese are entering largely into the cultivation of sugar, and are obtaining steam machinery to replace the old cattle mills, which they have hitherto employed in grinding the canes. In 1871 there was an increase of 50,000 piculs over the exports of 1870.

Philippines.—The sugar-cane is cultivated in Negros, Panay, Cebu, Luzon, and in nearly every part of the Archipelago; the yellow variety being generally raised in the province of Pampanga (Luzon), and the purple in Negros and Panay. The shoots are planted in the month of February, and the crops are cut in January following. The yield of raw sugar from cane planted in an indifferent soil is about 12 piculs (15 cwts.) per acre, in the best soils about 40 piculs, the average therefore being about 20 piculs. The best quality is from Pampanga, and the worst from Taal or Batangas. The native apparatus for crushing the cane, which consists of two stone cylinders with wooden teeth, is now being superseded in many places by iron rollers from England. Steam sugar mills have also been erected on several estates. It is impossible to compute the total production, as there are no statistics on the subject, and we can only get at a few particulars of the shipments from different ports.

In 1863 there were 20 iron cattle mills in Panay, and 43 in the neighbouring province of Negros, but the demand for them was steadily increasing, the native planters finding their superiority to the primitive mills with wooden rollers to be very marked. Steam mills had also been erected for crushing cane, four being then at work at Negros on estates which produce collectively 1300 tons of sugar, and would double that quantity when further improvements in deeper ploughing and a less backward mode of general cultivation was adopted. There were in that year twenty-three Europeans engaged in planting at Negros. The united crops of Negros, Iloilo, and Antiqué were expected to yield about 21,000 tons, and in eight years more the British Consul estimated the shipments of the two islands of Panay and Negros would be about 62,000 tons.

The exports of sugar from Iloilo, island of Panay, were in

	Tons.		Tons.
1855	750	1860	7,048
1856	850	1861	4,598
1857	1800	1862	12,586
1858	1,290	1863	15,677
1859	5,427		

The progress made in sugar production in these two quarters since is shown by the subjoined statement of exports in piculs of $1\frac{1}{4}$ cwt.:

Year.	Iloilo.	Cebu.
1864	152,757	58,364
1865	117,445	93,835
1866	145,241	72,204
1867	153,123	133,384
1868	255,274	185,049
1870	312,359	149,106
1872	539,293	186,606
1873	545,001	169,260

From these figures it will be seen that the estimate of the British Consul is approaching realization, as the combined exports are already 45,000 tons.

Previously to the year 1867 the greater part of the sugar made in the Philippines was forwarded to England; but a large quantity is now taken by the United States.

Shipments of sugar from the whole of the Archipelago:

	Piculs.		Piculs.
1862	1,302,484	1869	1,101,500
1863	1,172,050	1870	1,256,582
1864	1,035,027	1871	
1865	896,832	1872	1,530,641
1866	855,280	1873	1,429,322
1867	1,015,887	1874	1,653,128
1868	1,180,567	1875	2,017,361

Java.—The sugar culture in Java is one of the chief supports of the Treasury. The principal points of the contracts which formerly existed were that the Government assisted the planter in making ready his fields, in planting and cutting of the canes, and sometimes in the bringing of the canes to the mill; while, in return for this assistance, he ceded to the Government a certain portion of his produce at a fixed price. It was found, however, that these conditions did not suit the present times, and in 1870 a measure was introduced and passed by the Chamber, in which several important modifications were made. The chief was that, instead of as hitherto paying Government in kind, planters could pay Government a certain sum of money in proportion to the product and extent of their estates. The consequence of this was that in 1872 a very much larger quantity of sugar than heretofore passed through the hands of the commercial community, and the yearly Government auctions, the aggregate of which in 1871 was 37,500 tons, will no longer be held. The number of plantations are over 200 in all, with about 70,000 acres under culture, and the total production of Java may be estimated roughly at about 160,000 tons. In 1863 the exports were 130,000 tons; in 1873 the production was estimated at 2,500,000 piculs.

Borneo.—The sugar-cane is grown by the natives sufficient for their own consumption.

In 1863 an English company was started, and 200 acres planted with cane, and sugar and rum are now articles of export to Singapore. Sugar to the value of about 10,000 dollars was shipped in 1865.

Sandwich Islands.—There were in 1868 thirty-three sugar plantations in operation, having 10,260 acres planted with cane, and the monthly expenses were about 9801*l.* The actual cost of producing sugar on an old plantation free from incumbrance does not exceed 2*d.* per pound for all grades manufactured. The produce is about 30,000,000 lbs. sugar, and 500,000 gallons of molasses. Three thousand one hundred and eighty-five persons were employed on the plantations. In 1874 the exports of sugar were 24,567,000 lbs.

Fiji Islands.—The natives grow canes for sugar for their own consumption. In 1863 there was one plantation, and the quality produced was good. Sugar is now also produced in the Society Islands.

At *Tahiti*, in 1847 there were about 250 acres of land under sugar-cane, and three small sugar mills in operation; fifteen tons of sugar were exported. In 1874 there were 290 acres, and the produce was 40,000 kilos. of raw sugar, and 71,400 kilos. of turbined.

Queensland.—Sugar is now a leading agricultural product here; it has started into existence within but a very few years, and as a large and increasing area of country has been taken up for its growth, it may be confidently expected that the industry will soon assume very large proportions. The planters have for the most part entered without experience on their work, and much has yet to be learned as to the best mode of cultivation and manufacture adapted to the conditions of soil and climate. Considerable quantities of sugar are shipped to the neighbouring colonies, where it commands a good price. A refinery has been established. Queensland, besides providing for its own consumption, will soon be able to supply Australasia with an article of a superior description. Sugar has succeeded in

Queensland, because it is suited to the soil and climate of the coast-land. In 1865 there were but 93 acres under culture with sugar; in 1869 the total had risen to 5165 acres.

The sugar plantations in Queensland continue to give promise of very satisfactory returns. There are now eleven distilleries in the colony in full work. The total yield of sugar, during the past crushing season, was 2854½ tons; the quantity of sugar imported during the same period, 2090 tons; thus showing that the production is not yet equal to the demand. There were 76,311 gallons of rum placed in bond during 1870, of which 35,379 gallons were exported. The total average yield per acre, for the cane crushed during 1870, was 1 ton 6 cwts. 0 qrs. 10 lbs. The average crop is now from 2 to 2½ tons per acre, although 4 tons are occasionally produced, as at Jeridah estate, Maryborough, from the old bamboo-cane of two years' growth. The sugar estates range between 18° and 28° lat. The Inspector of Distilleries states in his report that there is a prospect of a large increase in the area of land under cane, especially in the northern districts. The crop of the season ending March 1872 was 3750 tons of sugar.

The varieties of cane grown here are the black cheribon, the chigaco, a small yellow cane (name uncertain), a hairless variety, leaf with smooth edges; the violet cane, ribbon cane, and bamboo cane.

In *New South Wales* in 1872 there were 1994 acres under sugar-cane, which yielded 25,000 cwts., and 2399 acres unproductive. The yield of sugar in 1868 was 30,000 cwts.

Victoria.—The sugar-cane having been successfully grown in Spain and other countries on the Mediterranean Sea, Baron Mueller remarks that it is worthy of further trial whether in the warmest parts of Victoria under similar climatic conditions sugar from the cane can be produced with advantage. Though the plant will live unprotected in the vicinity of Melbourne, it does not thrive there sufficiently for remunerative culture. But it may be otherwise in East Gippsland, or along the Murray river and its lower tributaries. For fuller information, the valuable work of Mr. A. McKay, 'The Sugar-cane in Australia,' should be consulted.

Egypt.—The following account of sugar cultivation in Egypt, from the pen of the Right Hon. S. Cave, was contributed to the 'Barbados Agricultural Reporter' some years ago, and therefore requires considerable modification as compared with the present time:

"The sugar-cane was unknown to the ancient Egyptians: it does not appear in those painted and sculptured tombs which, like the Etruscan, have preserved the details of domestic life in remote ages. The date, and doum palms, still familiar to the Nile voyager, are portrayed there, as well as the lotus, and papyrus now almost extinct, but never the sugar-cane. Nor is it enumerated, as it surely would have been if known at the time, among the vegetables, 'the leeks, and melons, and cucumbers' for which the Hebrews longed, when wandering on the nitrous plateau of the great desert El Tih. And if identical, as supposed, with 'the sweet cane' or 'calamus' which formed part of the composition of the holy ointment for the Tabernacle, and is mentioned in Solomon's Song, and the Prophecy of Jeremiah, it was, even so late as the Jewish monarchy, brought 'from a far country.' Hence Dioscorides and Pliny have erred in calling it a native of Arabia, and it is correctly omitted from the list of indigenous products of that country by a most careful writer, Niebuhr the botanist. It was probably transplanted from India or China in early times, during one of the many migrations which brought the hordes of Eastern Asia to the shores of the Mediterranean. It is mentioned by Greek and Roman authors. The Crusaders found it in Egypt and Syria. Their antagonists, the Saracens, carried it with them into Spain, where it flourishes still in the semi-tropical climate from Malaga to Motril, having become the parent of a more important cultivation in North and South America.

"About the year 1500, Giovanni Lioni says that it abounded in the Thebaid and the north of Africa, and that a considerable trade in sugar was carried on with Nubia.

"Bruce, the traveller, saw it in Upper Egypt; and in our own day Dr. Lepsius, of the Prussian exploring expedition, found at Kemlin, in the province of Sennaar on the Blue Nile, under the 15th parallel of north latitude, a sugar factory, and manufacture of brandy from sugar-cane, conducted by a German, named Beauer, and worked by Arabs and slaves. The principal sugar-growing district in Egypt, at the present time, extends from Minieh, 28° 10′ N. lat., to Erment above Thebes, 25° 30′ N. lat., occupying both sides of the Nile valley, where broadest and richest, above the Delta. The sheet of canes is, however, interrupted, as in the West Indies, by Guinea corn, and vegetables, as well as by cotton and tobacco; and a considerable space is filled by groves of date palm, the fruit of which is an important staple in Egypt, and contributes largely to the revenue.

"When Mehemet Ali declared himself sole proprietor of the soil of Egypt, a measure justified according to M. Clot. Bey by the precedent of Joseph! he established large sugar estates and factories on the Nile, the first of which was founded at Reramoon, in 1818. These were originally managed by English, French, and Italians, though now almost entirely by native Egyptians. The first effect of this enterprise was the destruction of many an interesting monument of antiquity, spared by successive waves of invasion, but destined now to fall before the march of improvement. A Turk or Arab never dreams of quarrying for stone, so long as it can be more easily obtained by pulling down an old temple; so hieroglyphics and sculptured figures in every inverted position are plentifully scattered over the walls and floors of an Egyptian boiling house. The works thus built, the surrounding land was parcelled out among the Fellaheen, or peasantry, who were furnished with plants and rude instruments of culture, and compelled to bring in a certain amount of canes per acre, for which they received one-third of the produce in coarse black muscovado, the rest being refined, and sold by the viceroy in the towns at a price which in times of unusual abundance he kept up by exportation. Since his death the system has been much modified; the land has in most instances been resold to the former proprietors, and the factories have passed to the princes of the viceroy's family, or to companies. The forced labour system being also to a certain extent abolished, the Fellaheen prefer making as well as growing their own sugar, because, as they told me, the central factory, under the new system of sale, frequently omitted to pay them for their canes, but always exacted full price for the sugar made from them. This short-sighted and thoroughly oriental policy has generally reduced the factories to the manufacture of the sugar grown on their own estates.

"The nominal wages of a field labourer are three piastres, or sixpence a day, or two piastres with liberty to grow corn between the cane rows: except however on the prince's lands, where a quasi slavery is winked at, there is great scarcity of labour, owing to the large levies, and wasteful system of recruiting for the viceroy's army, and public works.

"The above causes have led to the abandonment of more than one once flourishing manufactory, such as those at Farshiout Bajoura and Gulf Sahau, though the actual breadth of cultivation is probably as extensive as ever.

"I visited several village factories; this is the description of one near the remarkable rock tombs of Tel Amarna.

"The mill was under a rude shed partially screened by date palms, and with a scanty palm thatch on the sunny side only, for there is little fear of rain in Upper Egypt. It consisted of two vertical wooden rollers about six inches in diameter turned by one ox. The canes were passed and repassed three or four times between the rollers, and very imperfectly ground after all. The small percentage of juice flowed into a vat beneath; when this was full the mill was stopped, and the juice, mingled with all kinds of extraneous matter, was carried in buckets to a deep iron pan under another shed, in which it was evaporated over a charcoal fire and then cooled in earthenware pots, like those under which seakale is grown in England. The result, very coarse sugar and molasses, is doled out to the Fellaheen in the proportions of their cultivation by the head man of the village.

"The factory which I inspected at Randa was a much more imposing affair, with its tall chimneys and spacious courtyard, its boiling house, curing house, and distillery, and cloud of aromatic steam which might be smelt a mile off on the other side of the river. It was on the usual West Indian plan. The motive power was steam. The canes were carried to the mill by camels instead of mules or oxen; and there was nothing very remarkable in the construction of tayches, or clarifiers. The yard and buildings were cleaner than they generally are in the West Indies, but the still-house cisterns had the usual number of dead rats floating in the fermenting liquid. The managers were Egyptian Arabs and very intelligent people. Here, as in the villages, the megass after passing the three rollers is carried back, and pressed a second time; it is then dry enough to be used almost immediately under the coppers. The juice is clarified with lime, white of eggs, and milk, and the greater part of the sugar is clayed in pots of the usual form, with fine potters' clay brought from Keneh and Girgeh. The loaves are not so white or fine as those imported from Europe, but native sugar commands the highest price, 'because,' say the Egyptians, 'it goes much farther;' which indicates that the imported is beetroot sugar. This explains the fact that though the produce does not suffice for the consumption of the country, it is nevertheless exported to the Hedjaz and other parts of Arabia. About nine hundred of these pots, equal to twelve tons raw sugar, are filled here daily when in full work; and the crop season lasts for three months. The manufacture goes on night and day by relays, and the labourers receive from one to four piastres for ten hours. The camel hire amounts to five piastres a day for each—tenpence. The usual proportion of rum and molasses is obtained.

"There are two kinds of cultivated land in Egypt, the Rei, which is watered by the natural rise of the Nile, and the Sharackee, which is artificially irrigated. The latter may be subdivided, as it is watered by the Shadoof worked by men; the Sakia worked by oxen, or the steam engine. It is plain that the cane, grown on the Rei lands, must be planted just before the inundation covers the field, or it would die of drought, and must be taken off before the next rise. Whereas, that which is grown in fields banked round and artificially irrigated, may be planted at other times, and the planter is free from the great uncertainty as to the height of the inundation, which is a constant source of anxiety to the proprietor of the Rei lands, as a deficient inundation causes wholesale destruction to the products of the soil.

"The manufacture can only take place at low Nile, so that the growth of the cane in the Sharackee lands does not exceed twelve months, the planting season being about February and March, and the reaping commencing in January. At Randa there were three steam pumping engines which watered about four hundred acres each. On these fields the canes grow to the height of 10 feet, but on the Rei lands, where the planting is two months later, they are necessarily much shorter. Ratooning for any length of time does not answer, and at least one-fourth of the crop is planted annually. The canes are planted in holes banked up with the hoe, much as in old times in the West Indies; the moulding is done naturally by the deposit of the Nile, there is no trashing, and for reaping a short heavy knife is used which cuts the cane close to the ground. The Egyptian native cane, as it is called, is much like that known by the same name and now nearly extinct in Barbados; but the West Indian varieties have been successfully introduced. The juice is usually watery, as might be expected from the length of time the canes are covered by the inundation, and the yield is not more than four or five kantars a feddan, or about 500 lbs. refined sugar to an acre.

"The chief manures are a nitrous saline earth found on the borders of the desert, and pigeons' dung. Vast quantities of half-wild pigeons are encouraged to breed in the Egyptian villages for the sake of their manure, and the turreted pigeon-houses form a conspicuous feature in the Nile landscape.

"In a country like Egypt it is extremely difficult to arrive at any accurate statistics. M. Clot. Bey fixes the quantity of refined sugar made in 1833 at 382,449 kilogrammes, or about 370 tons, and the raw sugar made at the three factories of Reramoon, Sakiet Monee, and Randa, at 21,395 quintals, or about 2140 tons. This must be the sugar for sale, and exclusive of that returned to the Fellaheen and consumed on the spot. The value of the sugar imported at the same period amounted to 666,000 francs. I was assured by a Government employé at Cairo (an European), that, under a better system of government, and with only its present population, Egypt is fully capable of producing 50,000 tons of sugar."

This estimate of production, it will be seen by the figures of the exports, given in subsequent pages, has been already reached.

An important paper on "Sugar Manufacture in Egypt" was read before the Institute of Civil Engineers in 1872 by Mr. William Anderson, of the firm of Easton and Anderson, engineers, which contained a good deal of practical and useful information respecting a new process for the manufacture of white sugar without charcoal filtration by the use of sulphurous acid gas, and other reagents in defecation, and an extensively rapid method of concentration of cane juice to syrup. The Abael-Wakf sugar factory, constructed specially for the sulphurous acid process, is situated on the banks of the Ibrahimia canal, about six miles south of Mayaga—a station on the Nile Railway, and also the site of large sugar works—and about two miles west of the Nile. The distance from Cairo is about one hundred and twenty miles. Mr. Anderson's firm also erected and set to work, at the same time, a second sugar factory at Bene Mazar, a place about six miles farther south. This was about half as large again as that at Aba, and arranged on the French system of defecation, using animal charcoal, so that Mr. Anderson, who personally superintended the completion and starting of both factories, had special opportunities for comparing the two methods of manufacture. Cane juice contains saccharine matter in a free state of solution. The work to be done consists, first, in cleansing the raw juice from impurities, and neutralizing its acids; and next, in concentrating it to the crystallizing point. The main difficulty to be overcome is to prevent the crystallizable sugar existing in the juice from becoming uncrystallizable, and therefore the process which achieves the highest result in this respect most economically is the best. Clarification is generally effected by neutralizing the organic acids of the juice by means of lime, and by removing the scum by skimming, subsidence, or filtration. Sometimes clay or whiting is added to assist mechanically in carrying down the impurities, and the operation takes place either in steam clarifiers, supplemented or not by subsiding tanks, or in the concentrating coppers. The most advanced and satisfactory system, the one adopted at Bene Mazar, and generally in Egypt, is to heat the juice nearly to the boiling point, adding lime until its neutral point is attained. A thick scum collects on the surface, and cracks when the temperature reaches about 210°—that is to say, when incipient ebullition takes place in spots here and there. Steam is immediately shut off, and the juice is allowed to stand about forty minutes. During this time the cake of scum, which is about two inches thick, becomes very compact, so that when at last the clear juice is suffered to run out through a copper strainer at the bottom of the clarifier, the impurities remain behind, and are thoroughly separated. Bisulphite of lime is now commonly used with the same object as sulphurous acid gas. It is added in solution as soon as possible after the juice leaves the crushing rolls.

In making inferior kinds of sugar, the clarified juice is run into a battery of open pans, called "taiches," the whole apparatus being styled a "copper wall." These pans are heated by direct fire under them, and the juice, as it concentrates, is ladled from one pan to the other, being skimmed all the time, and finished at last in the pan farthest away from the furnace. The whole operation is "messy," and extravagant in fuel. An improvement on the copper wall is the "concretor," a shallow tray set over a furnace, down which the juice runs in a thin stream, and is rapidly concentrated; but in this apparatus, also, on account of the steam from the juice being wasted, the expenditure of fuel is very great. For the higher classes of sugar the clarified juice is run through bag filters, and afterwards through animal charcoal, or through the latter only, and concentrated in the manner above described, or by means of double-action or treble-action tubular concentrators. At Bene Mazar four sets of treble-action concentrators are used. Each set consists of three vessels. The first set is heated by the waste steam from the various steam engines. The steam evolved from the juice in these boils the syrup in the second set of vessels, and in like manner the steam produced in the second set boils the syrup in the last set of vessels. The first set works at about the pressure of the atmosphere, the second set at a partial vacuum of ten inches, and the third set, like vacuum pans, under a vacuum of about twenty-six inches. After concentration, and for the higher classes of sugar, the syrup, at about 22° Beaumé, is again passed through charcoal filters, and then boiled to grain in vacuum pans. Inferior sugars are struck either directly from the last "taiche" of the copper wall, or from some one of a numerous array of tubular and other granulators, working at the ordinary atmospheric pressure. The molasses is now almost universally separated from the crystallized sugar by means of centrifugal machines. There is great difficulty in getting the juice and syrups to pass through animal charcoal of sufficient fineness to produce much effect. The animal charcoal used by refiners, for example, is about as fine as No. 1 shot, while that used in Egypt is as coarse as hazel nuts, and even then it clogs very quickly. It appears that, until the molasses has been in a great measure separated from the crystallized sugar—which is only to be done in the curing room—the syrups cannot be made to filter efficiently, and that, for this reason alone, it is well to avoid charcoal filtration. It is certain that juice is degraded by passing over large surfaces, as it thereby has a tendency to get sour, and thus to increase the percentage of molasses. It is hardly necessary to remark that the first cost of the charcoal, the daily waste, and the charges for fuel and labour in reburning, are serious items in the account.

A valuable contribution to the 'Chemistry and Physics of Sugar Manufacture' was also given in the foregoing paper by Mr. George Ogston, analytical chemist, in the following terms:

"The property of sulphurous acid gas, or of salts containing that gas, such as the bisulphite of lime, in preventing or arresting fermentation, and in bleaching vegetable substances, is well known. It seems to have been applied to the manufacture of sugar from cane juice as early as 1838, when Mr. E. Stolle took out a patent for discolouring saccharine matter by sulphurous acid gas instead of animal charcoal; and subsequent patents have been taken out in 1849, 1850, 1857, and 1862, for similar purposes. But it does not appear that any marked success has attended the use of the gas, though it is incomparably cheaper than the bisulphite of lime, which at present is largely employed in the British West India colonies. It may be that the latter substance finds favour on account of its not requiring special apparatus for its application; but I am inclined to think that sulphurous acid gas has failed from two causes. In the first place, it has to be applied quite as carefully as the lime used in ordinary tempering. Being extremely soluble, juice will take it up to the extent of thirty-three times its own volume, and hence a great excess is easily and imperceptibly added, only to require neutralizing again by lime, which forms sulphite and bisulphite of lime; the latter being wholly soluble in the weak cane juice, but is in part changed, at the expense of the atmosphere, into the sulphate, which, although soluble in about four hundred and fifty volumes of hot water, is deposited rapidly on the surfaces of the concentrators and vacuum pans, rendering them inefficient, and extravagant in fuel. In the second place, the gas has always been tried at existing factories, most probably with very defective and slow concentration; hence the juice, which if quickly concentrated—not, however, in vessels heated by direct fire, as in 'taiches' and concretors—would have made white sugar, has been degraded till all the benefits of the gas are lost. The Aba factory, it is believed, is the only one ever built expressly for the use of sulphurous acid, and hence the success which was immediately attained.

"In the simple clarification with lime, great care should be taken to add the exact quantity necessary to neutralize the organic acids in the juice. The salts of lime then formed—chiefly acetate—are all soluble, and are not deposited if concentration follows rapidly; but if there is an excess of lime, or long exposure to the air, the carbonate is formed at the expense of the atmosphere, and becomes very troublesome. At Bene Mazar, last crop, the clarification was constantly under European supervision, and so carefully done that, at the end of the season, there was no deposit whatever, either in the triple-action tubular concentrators or the vacuum pans; and, as excellent white sugar was made, it is presumable that the correct quantity of milk of lime was used. This varied between $1\frac{1}{4}$ gallon to $2\frac{1}{2}$ gallons, at 10° Beaumé, corresponding to from $1\frac{1}{3}$ lb. to $2\frac{2}{3}$ lbs. of caustic lime, or say, an average of 2 lbs. of caustic lime per clarifier of 353 gallons. At Aba, during my experiments, $\frac{1}{2}$ lb. of sulphur was actually consumed for 450 gallons of juice; but this quantity, in consequence of the imperfect arrangements for 'gassing,' was greatly in excess of what was necessary for clarification. Laboratory experiments seem to indicate that about $\frac{1}{10}$ lb. per 450 gallons will be sufficient. The lime required to neutralize this will be nearly the same weight, and therefore will form but 4 per cent. of the lime necessary for tempering in the ordinary manner; that is to say, 4 per cent. more lime will be required by the sulphurous acid process than by the ordinary method of defecation; and this is probably little, if any, more than the syrup, as it leaves the concentrators, will be able to retain in solution. The lime required at Aba, if used in the same proportion to the juice as at Bene Mazar, would be $2\frac{5}{10}$ lbs. per clarifier, increased only to $2\frac{6}{10}$ lbs. in neutralizing the sulphurous acid gas; it is therefore expected that the deposit of sulphate of lime, which materially interfered with the working of the concentrators last season, will be very considerably reduced, if not completely removed, more especially because they are not in a condition analogous to steam boilers out of which only steam is taken; on the contrary, from them at least 40 per cent. of the entering fluid flows out again, and must carry a large proportion of slightly soluble and suspended matters with it. The rapidity of the process of getting the juice to the state of syrup, when it is safe from fermentation, is best illustrated by comparison with Bene Mazar. In that mill a particle of juice in travelling through the apparatus remains two hours in the juice tank and clarifiers, two hours in the charcoal filters, an hour and three-quarters in the triple-action concentrators—in all, five hours and three-quarters, while at Aba the same state is reached in less than two hours, or in about one-third the time.

"It is well known that sulphuric acid is a deadly enemy to crystallizable sugar, and sulphurous acid being very nearly allied, it was feared that its use might also be, to some extent, prejudicial. To settle this point, samples of juice obtained from Egyptian cane were carefully clarified in the ordinary manner with lime, and then filtered through charcoal, and also by the sulphurous acid gas process; the resulting specimens of clarified juice were then analysed, and it was found that the samples obtained from the latter process were to a slight extent richer in crystallizable sugar; the difference, however, was very small, so that practically it became safe to assume that there would be no loss of crystallized sugar through the use of sulphurous acid. Inasmuch as the third boiling of molasses has to stand from three months to six months before it can throw down all the crystallizable sugar, a complete investigation into the yield of any process is a very tedious business, and, in fact, can only be accurately done by exact observation throughout the season's working, extending, with the manufacture of all the produce, over at least seven months or eight months. Nor is it possible to make any satisfactory estimate of the yield of the third boiling, as it varies very much, depending greatly on the state of the canes and the goodness of the original clarification and concentration of the juice. I devoted one month to watching the successive transformations of 164,345 gallons of raw juice as far as the third boiling; and, considering the immense number of measurements taken, the corrections for temperature necessary, and the circumstance that a large number of observers had to be employed, the results of my investigations are surprisingly accurate.

"The yield of 164,345 gallons of raw juice, at $9\frac{3}{4}°$ Beaumé and 72° Fahrenheit, was:

	Tons.	cwts.	qrs.	lbs.
First white sugar	54	18	2	18
Second boiling brown	18	6	3	1
Third „ estimated	9	3	1	14
All sugar—total	82	8	3	5
Molasses after second sugars	24	12	2	25

or at the rate of 1·124 lb. per gallon, the white sugar alone being 0·75 lb. per gallon. At Bene Mazar the yield of first sugars was 0·71 lb. per gallon, the total yield being estimated at 1·21 lb. per gallon. At either factory the result must be looked upon as extremely good, considering that the canes were very small, their dimensions seldom exceeding 4 feet long by 1 inch to $1\frac{1}{2}$ inch diameter. A great number of the canes were also so short that they had to be carried up to the mills in baskets. And, besides this, they lay frequently for two weeks and even three weeks cut before they were ground. During the experiments a lot of cane sent from Bene Mazar, where it had been cut down to make room for the Agricultural Railway, lay a fortnight before it was crushed. Sugar makers can readily estimate the deterioration of the juice which resulted from this delay.

"I am indebted to the courtesy of the Colonial Company for the following statement:—On their estate in Demerara—famous for the richness of its sugar-cane—from cane juice, when at its best in the months of March, April, and May, and indicating 10° Beaumé at 70° temperature, they obtained, of first white sugars, 8·43 per cent. on the cane juice, and of second sugars, 4·56 per cent., or in all 12·99 per cent., or about 1·405 lb. per gallon. The company does not work the molasses a third time, but as the second boiling forms 54 per cent. of the first, it is probable that very little crystallizable sugar is lost. At Aba, the second boiling forms only 33 per cent. of the first, and it is not likely that the sugar derived from the third boiling would make the aggregate amount greater than 50 per cent. This result seems to show that, under like favourable circumstances, equally high results may be looked for in Egypt. Sir Daniel Cooper, Bart., late Speaker of the Legislative Assembly of New South Wales, who is extensively interested in the sugar industry of that colony, has kindly communicated the following information respecting the yield of two sugar factories on the Clarence river. Of first yellow sugars they made in 1871, 0·89 lb. and 1·01 lb. per gallon of juice respectively; of second sugars, 0·29 lb. and 0·14 lb. and of molasses, 0·57 lb. and 0·47 lb. In these mills concretors are employed for the concentration; and as no use whatever is made of the steam from the juice, more than two tons of coal have been consumed per ton of dry sugars, besides all the megass. The quantity of molasses, or uncrystallizable sugar, remaining after the first boiling, may be taken as the measure of the degradation the juice has suffered during its manufacture into sugar. Taking the percentages in each case on the first and second sugars together, it appears that the Aba factory makes but 33 per cent.; Bene Mazar, 55 per cent.; the Australian mills, 41 per cent. and 48 per cent. respectively; and the Colonial Company, 47 per cent. This seems to demonstrate that the sulphurous acid gas process, when combined with rapid concentration, realises a larger percentage of marketable sugar than any other system of manufacture; and this result will become still more apparent by an inspection of the following table of produce by different mills, from which it will be seen that the Aba factory also yields the highest percentage of first white sugar:

	Egypt.		W. Indies.	New South Wales.	
	Aba.	Bene Mazar.	Colonial Company.	Chatsworth.	Southgate.
First sugar, white	56·1	43·6	43·6	..	..
" " yellow	..	..	..	50·8	62·5
Second "	18·7	20·8	23·6	16·5	8·4
Molasses and third sugar ..	25·2	35·6	32·8	32·7	29·1
	100·	100·	100·	100·	100·
Percentage of molasses on first and second sugars	33·7	55·3	47·6	48·6	41·4

"The total yield of all sugars and molasses, in pounds per gallon, was 1·325 at Aba; 1·62 and 1·75 in the Australian factories; and 2·19 in Demerara, showing that my statement about the bad condition of the Egyptian canes is fully borne out. The specific gravity of cane juice is affected not only by the saccharine matter it contains, but also by the various impurities in solution, and even by solid matters in suspension. The density of juice is generally taken by Beaumé's hydrometer; and as an illustration of the manner in which suspended matter affects its indications, it may be mentioned that milk of lime at 70° temperature, as long as it is kept agitated, will indicate 10° Beaumé when mixed in the proportion of ten parts by weight of water to one part of lime, but, when suffered to subside, will register only 2° in the clear solution containing one part of lime in 700 parts of water. Throughout my experiments the density of the juice and syrups was carefully ascertained, and I found, on comparing the actual yield of sugar with the tabular quantities represented by the density of the juice, that there was a total loss of 5·91 per cent.; and between the quantity contained in the juice entering the concentrators, and that held by the syrups running out, a loss of 1·62 per cent. These results, though valuable as indicating that no great error had been committed in the numerous measurements, cannot be taken as strictly true, because the readings of the hydrometers were undoubtedly affected by the lime, and its sulphate was proved to have been held in solution by the deposits both in the concentrators and in the vacuum pans.

"The information obtainable as to the manner in which the densities of saccharine solutions are affected by temperature, and the changes of volume which take place in concentration being very scanty, experiments were instituted to determine these points accurately. It was found that at all densities a range of 4° Beaumé corresponded to a variation of 122° of temperature, and that the law of variation in density due to change of temperature is the same as in water. The alterations of volume caused by concentration also followed closely those calculated from the specific gravity. Crystals, separating from impure solutions, are always purer than the mother-liquors; hence the dark yellow mass sent down from the vacuum pans, when drained from the uncrystallizable sugar and water associated with it, leaves a crystalline mass more or less white behind. This separation, technically called 'curing,' may be performed by simple draining in vessels of suitable form, or, as in refineries, in moulds of the familiar sugar-loaf shape, aided by suction: but on sugar estates it is generally done in centrifugal machines. When the syrup is good, the white crystals may be separated without washing of any kind, but generally from a pint to a gallon of water or weak molasses is thrown into each charge, to assist in washing the surfaces of the crystals; or the same object may be attained by projecting a jet of high-pressure steam against the inside of the revolving ring of sugar; the steam, condensing, washes away the molasses, and at the same time heats the mass and makes it dry more quickly when spread out afterwards on the mixing floor. Yellow sugars are frequently the pure crystals coated with more or less molasses, and therefore when considering the relative yield of different factories, it is necessary to know the quality of first sugars produced, as the loss in washing yellow sugars white amounts to between 10 and 30 per cent. of their weight. Dry white sugar runs like sand, but yellow has a peculiar 'cling' in it, due to the stickiness of the molasses. The most difficult variety to produce is the bright canary-coloured sugar, which can only be obtained from very pure bright syrups. The mother-liquor, separated from the first sugar, contains a considerable quantity of crystallizable matter which separates again, as in all crystallizing operations, by second concentration, and yields the second sugars, which it is generally most profitable to leave in the yellow state. The same remarks apply to third and fourth boilings.

"I have been able, with the assistance of the data obtained at every step of the manufacture, to calculate the degree of concentration necessary in the trays to supply sufficient steam for the vacuum pans and steam engines, and then to calculate the probable consumption of fuel per ton of sugar. By means of the indicator diagrams, it has been ascertained that the vacuum and centrifugal engines work at 108 collective I.H.P., and as they do not work expansively, and there must be considerable loss from condensation in the large steam pipes, they probably consume 50 lbs. of steam at 3 lbs. pressure per I.H.P. per hour. To supply these engines, therefore, would involve the evaporation of 541 gallons of water per hour in the concentrators. Supposing the factory to be in full work, each mill producing 1500 gallons of juice, that is, 6000 gallons per hour at

10° Beaumé collectively, the yield of all sugars at the ascertained rate would be 6744 lbs. per hour. From my observations, it appears that the water to be evaporated in boiling down the second and third sugars—including one gallon of water added to each centrifugal charge—amounts to 60 per cent. of the weight of the totally-finished sugars, or to 405 gallons per hour, to which must be added 10 per cent., or forty gallons for loss by radiation, &c. 6000 gallons of raw juice at 72° temperature, when clear of its scum and reduced in volume by five minutes' boiling in the clarifiers, would become 5476 gallons of clarified juice sent down to the concentrators at 72° temperature, and would contain 11,700 lbs. absolute sugar, which, at the specific gravity of 1·6, would measure 731 gallons. It was ascertained that, in the first sugars sent down to the coolers, the saccharine matter was associated with water amounting to 30·4 per cent. on the yield of all sugars, or 205 gallons per hour. In this manner (541+405+40+731+205) 1922 gallons of the juice have been disposed of, leaving 3554 gallons to be evaporated, one part in the vacuum pan being at the expense of the steam raised from the other in the concentrators. Allowing 10 per cent. on the total amounts for loss and waste, the quantity should be divided in the proportion of 60 per cent. to 40 per cent., leaving thus 1422 gallons to be evaporated in the vacuum pans by 2132 gallons, converted into steam in the trays. There is then in the syrup ready for the trays:

	Galls.	Galls.
Saccharine matter	731	
Water associated with first boiling	205	
Water evaporated in vacuum pan	1422	
Total syrup	——	2358
Water evaporated in concentrators to produce power, and boil second and third sugars	986	
Water evaporated to boil first sugar	2132	
Total evaporated in trays	——	3118
Total clarified juice per hour		5476

"The syrup, therefore, will form 43 per cent. of the clarified juice, and if the latter gauges 10° Beaumé, the former would indicate 21° Beaumé. Comparing this with the observations, it appears that 153,341 gallons of clarified juice were converted into 72,049 gallons of syrup, both at 160°, the latter being 47 per cent. of the former; or if the juice stood at 10° Beaumé, the syrup would have indicated 19° Beaumé; that is, rather less steam was actually generated in the trays than the foregoing calculations indicate, which is accounted for by the third boilings not having been made during the experiments, and, therefore, that much less steam was required by the vacuum pans.

"These calculations agreeing so well with observations make it probable that the latter were very accurate, and point to the result that by utilizing the steam from the concentrators, the evaporation of 57 per cent. of the juice only is necessary to convert the whole into sugar and the residuary molasses. For the third boilings, quiet and uniformity of temperature are necessary. As they have to remain crystallizing from three months to six months, a large provision of tanks is required. These seem to answer best when built of masonry and plastered with native cement. The third boilings form about 1½ per cent. of the raw juice; hence, in a factory working ninety days, at the rate of 6000 gallons an hour, tanks to accommodate 194,400 gallons would be required. The total horsepower required to work the Aba factory, assuming that a cubic foot of water at 62° Fahrenheit evaporated at 212° represents a horsepower of boiler duty, is computed as follows:

	H.P.
The four cane-mill engines take 68 I.H.P. each. Allowing 25 lbs. of steam per H.P. per hour, which will cover loss by steam pipes, &c., they will require of boiler power	112·0
The clarifiers have to heat 6000 gallons of juice per hour, from 72° to 212°, and to boil for five minutes, and will absorb ..	163·5
The concentrators having to raise 5473 gallons of juice from 160° to 230°, and to evaporate 3118 gallons under 3 lbs. pressure, will take	519·0
Steam under 60 lbs. pressure used in steaming centrifugals, calculated	11·2
Sulphurous acid pumps, calculated	1·5
Donkey feed-pumps „	2·3
Total H.P. = cubic feet of water to evaporate from 62° Fahr. =	809·5

or nearly 11 H.P. per ton of sugar per 24 hours. If 8 lbs. of coal are necessary to evaporate a cubic foot of water from 62°, then 6476 lbs. of coal would be necessary to produce 6744 lbs. of sugar, or the weight of coal will be 96 per cent. of that of the produce in sugars. Supposing the cane mills to express 68 per cent. of juice, the 6000 gallons per hour would produce 30,325 lbs. of wet megass. From experiments made on a large scale by Mr. Black, the resident engineer of the Magaga sugar factory, it appears that dry megass, fit for burning, weighs 53 per cent. of the wet; and he found that 29,578 lbs. of dry megass did as much as 16,000 lbs. of ordinary north country coal, or that it required 1·85 lb. of megass to do the same work as 1 lb. of coal. The canes yielding 6000 gallons of juice, therefore, produced 16,072 lbs. of dry megass, which, consumed in the evaporation of 809·5 cubic feet of water, gives nearly 20 lbs. of megass to the cubic foot. According to Mr. Black, 14·8 lbs. should be enough; but an imperfect experiment, made on a small Cornish boiler at Magaga, gave only 3·06 lbs. of water per 1 lb. of megass, or 20·7 lbs. to the cubic foot. As an approximation, Mr. Black considers that 1 lb. of coal is equal to 2 lbs. of megass, or 16 lbs. of megass to the cubic foot of water, so that there seems to be margin enough to warrant the statement, that the refuse of the canes should give fuel enough to make the sugar; and this would especially be the case in Egypt, where the climate is favourable to drying the megass.

"In addition to the megass, most of the Egyptian mills are said to consume one ton of coal per ton of sugar, but the true statistics are difficult to arrive at. I believe that in some of the factories in the

West Indies the consumption of coal has been reduced to a quarter of a ton per ton of sugar; but this is in addition to the megass, and triple-action concentrators are in use. The quantity of extra fuel required in any case depends upon the percentage of juice pressed out. From Mr. Black's experiments at Magaga, dry megass appears to contain 10 per cent. of moisture. Payen gives the composition of Otaheite cane at maturity as, water 71 per cent., sugar 18 per cent., and ligneous and other matters 11 per cent.; consequently the composition of dry megass may be assumed for different degrees of pressing to be as follows:

Percentage of juice pressed out ..	60·0	70·0	80·0
Water dried out of megass	21·1	13·6	5·7
„ left in dry megass	1·9	1·6	1·5
Sugar „ „	6·0	3·8	1·8
Ligneous matter, &c., left in dry megass	11·0	11·0	11·0
	100·0	100·0	100·0
Percentage of sugar and ligneous matter on juice	28·3	21·1	17·3

"The last set of figures shows how rapidly the fuel available decreases with the increased yield of the cane mills. In such great factories as that at Aba, when worked only to about a quarter of their power, great loss arises from condensation in long and large steam pipes, as well as from frequent stoppages for want of cane, and from the nature of the case, a really trustworthy return could only be obtained from records kept during the whole crop. The megass being spread out to dry over many acres of land, it is difficult to bring it in with the necessary regularity, so that observations taken only from day to day would most likely be deceptive. The Aba mill, however, was run some days by burning megass only, but no record exists as to how the stock of megass which was in course of drying was affected.

"The cost of the machinery, iron buildings, and roofs of the Aba factory in England, including also the animal charcoal filters and reburning apparatus, which were supplied as a measure of precaution, but never erected, was 90,000*l.* The cost of the Bene Mazar factory for machinery and iron buildings was 130,000*l.* Correcting the cost of the Aba factory so as to bring it up to the same powers of production as Bene Mazar factory—but deducting the cost of the charcoal apparatus—the amount would be 100,000*l.*, thus showing an economy in favour of the sulphurous acid gas over the animal charcoal process, in producing white sugar, of 30,000*l.* on the capital account, in addition to a saving of 14,000*l.* for the first year, and 7500*l.* per annum afterwards, in animal charcoal, and labour and fuel in using it. The Aba factory was ordered in April, 1870, and the whole was made and shipped before the April following. The Bene

Mazar factory was ordered in December 1870, and was all shipped by the following November, and during the same time the Malatea factory, as large as Bene Mazar, but which was not to be erected till a season later, was constructed and completed, so that in the space of nineteen months, machinery to the value of nearly 400,000*l.* was designed, constructed, and shipped. The erections on the spot were completed with great rapidity, especially when the obstructions of climate and carriage are considered, and the difficulties about straw to burn bricks and lime. In conclusion, I think that the large yield of first sugar, the small percentage of molasses, the calculations as to fuel, and the economy of first cost and working, justify the opinion that the sulphurous acid process offers a reasonable prospect of success to those who may employ it. It has been widely stated, however, that the white sugar produced will lose colour materially if kept in bulk. No evidence has, as yet, reached me on this point, and I can therefore only state the opinion of many chemists, that there does not seem to be any ground for the apprehension."

The sugar industry of Egypt has made a great extension of late years, which can best be judged of by the following statistics. In 1833 the production was only about 2510 tons. The exports have since been as follows:

	Cwts.		Cwts.
1853	29,276	1865	1,544
1854	29,943	1866	1,090
1855	24,056	1867	54,982
1856	14,237	1868	145,212
1857	24,999	1869	293.279
1858	28,261	1870	283,828
1859	23,517	1871	356,468
1860	11,681	1872	456,851
1861	14,184	1873	711,327
1862	13,226	1874	886,914
1863	7,657	1875	901,535
1864	2,300		

The small exports of 1863 to 1866 were due to the extension given to cotton culture in preference to sugar, owing to the scarcity of that staple.

There is perhaps no other instance of a continuously rapid rise in the production of a staple article of commerce, and which with the annexed Soudan and other districts bids fair to go on advancing in an equally rapid rate. To the seventeen sugar works previously belonging to the Khedive five more have been added since 1872. The annual production of these twenty-two works is about 14,625 tons. The Khedive has 55,000 acres under sugar-cane, and private individuals 35,000. The production of canes is about 53,550 kilos. per hectare ($2\frac{1}{2}$ acres), and the yield of sugar is 8 or 9 per cent. About two-thirds of the sugar produced is white and one-third red sugar.

Zanzibar.—The soil of this island, our consul tells us, is eminently adapted for the growth of sugar; labour is cheap, ground rent very low, and every condition exists for securing an ample return for capital sunk in a sugar factory. Sugar to the value of 3000*l.* was shipped in 1864.

Natal.—The varieties of cane grown here are the Bourbon, black

Cheribon, yellow, and ribbon. On some of the estates the sugar is manufactured by the common process, viz. flat open battery and Wetzell pan. As an instance of the cheapness of the plant used, that on one estate, J. Johnston and Sons, Helmsfield, cost but 1300*l.* beyond their own labour, and consists of mill, two clarifiers, flat battery of four pans, with iron tache and dipper. The liquor is reduced to about 26° Beaumé. in the tache, from whence it is skipped into a reservoir; after subsiding a short time, it is run into a steam pan and finished. The pan is heated by steam coil, the temperature being kept down to about 180° by lathed revolving drums.

Besides the home consumption, the following figures show the progressive exports of sugar:

	Cwts.		Cwts.
1860	24,369	1870	106,572
1865	74,185	1874	136,656

Jamaica.—The exports of sugar from this island have varied in the last eight years from 29,000 hogsheads to 37,000 hogsheads; of rum, from 16,000 puncheons to 20,000 puncheons. There was in 1874 47,565 acres under cultivation with sugar-cane in the island. The attention of sugar planters here has been for some years past given rather to improvement of cultivation than to increase of acreage under canes.

This calculation gives only about three-quarters of a hogshead (or 12 cwts.) as the average produce in sugar for an acre of canes in the colony. The extreme smallness of this return is owing to the system of more or less permanent ratooning practised in small parishes, where on some estates a complete field of yearling plants is hardly ever to be seen; the plants that fail being replaced yearly, plant by plant. Of course the produce is very small, but so also are the expenses and the risk; and it is the opinion of some that the financial result of this cheap system (which avoids the chance of the loss of a field of young plants from a drought) is good. However that may be, the practice greatly reduces the average produce of an acre of cane throughout the colony.

The export of sugar in the crop years 1870–71 (37,000 hogsheads) was larger than it had been for nineteen years. The following shows the exports:

	Hhds.		Hhds.
1866	33,637	1871	37,010
1867	31,206	1872	35,553
1868	36,259	1873	28,428
1869	29,268	1874	28,398
1870	31,966		

Comparison of progress:

Year.	Sugar.	Rum.
1854	558,571 cwts.	1,665,932 galls.
1864	522,498 „	1,280,854 „
1874	29,378 hhds.	29,378 „ 19,351 puns.

The consumption of sugar in the island is estimated at about 6000 hogsheads.

In Jamaica, in the Government botanic gardens, eighteen selected varieties of new canes have been planted out, and as many more are under trial, to ascertain which are the best for general cultivation. Encouraging accounts have been received from different parts of the island of the Salangore cane, which grows with great vigour, and the number of shoots from each stool is remarkable. It requires to be planted wider apart than the space allotted to other canes.

Colonel Stewart's patent for desiccating cane juice by sulphurous acid gas injected into the liquor has been adopted on Bushy Park estate, St. Catherine. On Belmont estate, in the same parish, the double retort system of distillation has been introduced. The high price obtained for rum caused sugar to be sacrificed to a large extent, and the manufacture of rum increased from an average of two-thirds to almost a puncheon for a hogshead.

At Nightingale Grove and Wales estates, in Trelawney, centrifugal machines have been erected. In Westmoreland a few more centrifugal draining machines have been introduced, and Wetzell's pan and centrifugal machines have been set up at Holland estate, in St. Elizabeth.

An astonishing extent of sugar cultivation is now carried on among the peasantry, for a return presented to the Legislative Council, in 1871, showed no less than 5615 small sugar mills to be in use. The average make of these is about two hogsheads per annum. In some cases the sugar thus produced is sent down to the coast and exported, but by far the largest part of it is consumed in the island. Cultivation among the large proprietors has been considerably extended in many cases, and several abandoned properties have been reclaimed, and irrigation adopted on a large scale with gratifying results.

The enterprising proprietor of Albion estate, St. Thomas, has established a vacuum pan and centrifugal apparatus. The sugar produced by the machinery is of a very superior character, equalling the best Demerara crystallized sugar, which is sold so largely for consumption in the United States.

This is quite a new feature in the history of Jamaica sugar manufacture, which has long been notorious for servile adherence to ancient routine.

Barbados.—This small island usually produces a large quantity of sugar, but the crop is of course affected by seasons and other causes.

The years 1859 and 1860 were bad crops, the next two years good, followed by two bad. The four years, 1865 to 1868, were very good crops; 1869 was a poor one. There are about 35,000 acres under cane:

Year.	Sugar.	Rum.
1854	50,000 hhds.	1,402 hhds.
1864	37,038 „	37,156 galls.
1874	47,355 „	16,801 „

The new method of stirring the sugar, by the oscillating process, after it has been poured from the copper into the cooler until the granulation is complete, instead of allowing it to cool in a solid mass as by the old process, is now very general. The stirring is commonly effected by a disc revolving in the cooler, which takes up and scatters the fluid sugar. The result is that the sugar crystallizes in larger grains, and parts more quickly and entirely with the molasses, so that there is less drainage on the voyage. Sugar made in this way sells for nearly 2*s.* a cwt. more than the produce of the same land made by the old process.

Tortola cannot now, as in her palmy days, boast of wealthy estate proprietors; and the relation existing between the labourer and the estate owners here is very different from that in other and larger colonies. The principle upon which they work is this: Those small farmers who cultivate canes upon their own land allow to the owner of the sugar works one-third of their sugar as payment for its manufacture. Others who cultivate a plot belonging to the same owner as the sugar mill receive one-half of the sugar as their proportion, the other half being claimed by the proprietor of the land and sugar mill as an equivalent for rent and manufacturing expenses.

St. Kitts.—The average produce of sugar in this island is about 10,000 hhds., 300 tierces, and 6000 barrels of sugar, 4000 puncheons of molasses, and 600 puncheons of rum.

It may be well to publish here for reference by the planter the analyses of twelve different specimens of canes, by Dr. Stenhouse.

	Trinidad.				Berbice.			Demerara.	Grenada.	Jamaica.		
	1	2	3	4	5	6	7	8	9	10	11	12
Silica	45·97	42·90	46·46	41·37	46·48	50·00	45·13	17·64	26·38	52·20	48·73	54·59
Phosphoric acid	3·76	7·99	8·23	4·59	8·16	6·56	4·88	7·37	6·20	13·04	2·90	8·00
Sulphuric acid	6·66	10·94	4·65	10·93	7·52	6·40	7·74	7·97	6·08	3·31	5·35	1·9
Lime	9·16	13·20	8·91	9·11	5·78	5·09	4·49	2·34	5·87	10·64	11·62	14·36
Magnesia ..	3·66	9·88	4·50	6·92	15·61	13·01	11·90	3·93	5·48	5·63	5·61	5·30
Potash	25·50	12·01	10·63	15·99	11·93	13·69	16·97	32·93	31·21	10·09	7·46	11·14
Soda	..	1·39	..	..	0·57	1·33	1·64	..	..	0·80	..	..
Chloride of Potassium ..	3·27	..	7·41	8·96	..	..	..	10·70	11·14	..	16·06	0·84
Chloride of Sodium ..	2·02	1·62	9·21	2·13	3·95	3·92	7·25	17·20	7·64	4·29	2·27	3·83

The first seven were all fine canes with the leaves; the eighth had no leaves; No. 9, but few leaves; No. 10 was in full blossom, and had been manured with pen manure; No. 11 were old ratoons, manured in the same way; and No. 12 were young *Mont Blanc* canes, manured with pen manure, guano, and marl. This is a valuable analysis, from having been made from entire canes.

By comparing these elements together, we observe that the proportion of potash and silica is great in all of them; phosphorus, sulphur, and lime also exist in considerable quantities in all the specimens, while soda is variable in some and non-existent in others, and chloride of sodium, or common salt, is abundant in the Demerara specimen, and varies much in the different specimens. We may therefore conclude that the sugar-cane is a plant requiring:

1stly. A considerable supply of those two substances found generally coexistent with nitrogenized compounds in all animals and vegetables, viz. phosphorus and sulphur.

2ndly. A large supply of potash and silica, particularly the last.

3rdly. That lime and magnesia are also essential ingredients (the first in the larger quantity), while soda is not essential to its growth, and that common salt while appearing also to be an essential ingredient is not so in any large quantity, but if presented to the cane may be absorbed by it to a great extent, no doubt injuriously.

Dominica.—The following gives the exports for this island:

Year.	Sugar.	Molasses.	Rum.
	cwts.	galls.	galls.
1867	56,337	54,400	55,063
1868	68,942	95,520	49,740
1869	65,650	90,940	45,719
1870	73,203	88,732	36,021
1871	66,220	94,015	40,615

Montserrat.—The cultivation of the sugar-cane is carried on in the different stages of preparing the ground, planting, weeding, and reaping, generally on the task-work system. The work is hard enough while it lasts, but the labourers, male and female, who commence working at 6.30 A.M., finish their task about 11 A.M. A large proportion of the agricultural labourers and rural artisans, carpenters, masons, &c., are owners or renters of pieces of land ranging from half an acre to two or three acres in extent, and planted in canes or provisions. The lower slopes of the loftier and the summits of the lower hills of this mountainous little island are marked by the clearings of these small cultivators, and nothing can surpass the vigour and energy with which this peasantry of African descent labour on these holdings of their own. Here and there may be seen the creaking cattle mill and even windmill which, with a little boiling house, some labourer or mechanic, intelligent, frugal, and enterprising beyond his fellows, has contrived to erect, and to this little factory his neighbours carry their bundles of ripe canes to be converted into sugar, one-third of which is kept as remuneration for the manufacturer. The sugar lands of many proprietors of considerable importance are cultivated more or less on the half system, a system by which the peasant occupiers of small plots of land are bound to grow canes which are brought at crop time to the works of the proprietor, who retains half the sugar produced as rent for his land.

The following statement shows the shipment of sugar and molasses for seven years:

Year.	Sugar.	Molasses.
	hhds.	puns.
1865	1039	236
1866	1607	393
1867	915	176
1868	1662	534
1869	1794	503
1870	1879	418
1871	1891	466

St. Lucia.—The crop of 1871 was the largest ever produced in the island. The shipments have been:

Year.	Sugar.	Rum.	Molasses.
	lbs.	galls.	galls.
1868	11,118,829	191,400	2,058
1869	10,517,725	205,000	1,840
1870	12,444,153	153,000	2,461
1871	12,918,960	234,800	9,316

The increased production of sugar in St. Lucia is attributed rather to extended area of cultivation than to improvement in culture. That less energy is shown in the latter respect is considered to be owing—in a measure—to the extraordinary fertility of the soil, which, not uncommonly, produces a crop from the same cane plants for twenty years in succession; whereas, in most other countries, the fields require to be planted every two or three years. The system of agriculture, as in most of the West India Islands, is somewhat rude; but signs of efforts to improve it are not altogether wanting. Virgin soil is being broken for the purpose in all directions; and while no estates have latterly been abandoned, some have been reclaimed, and others, which a few years ago grew little else but weeds and trees, are now yielding abundant crops.

Besides extension of cultivation, there is a progress in manufacture which makes further improvement probable, and will certainly render it more easy. Steam power is gradually superseding all other for grinding purposes. Fourteen steam mills were imported in 1870, of which seven replaced others that had been moved by wind, water, or cattle, and seven were destined for newly-opened estates. To meet any reduction in prices, improvement in the quality of the sugar grown upon this island, which is almost exclusively of the low class, is without doubt of the first importance. The estates are, for the most part, too small to support singly expensive works, such as produce the crystallized sugar of Demerara; and on this account the co-operative system, which has achieved extraordinary results in the neighbouring colony of Martinique, would appear to offer by far the best prospect of success. Its chief distinctive feature is the entire separation of agriculture from manufacture. Though co-operation has proved useful for the introduction of the system, and has tended greatly to enhance its profits, it is not essential to it. Before this innovation every sugar planter in the West Indies was also a manufacturer. He not only grew canes, but ground them, and turned their juice into sugar.

Under the Martinique system, the division of labour is complete. The planter is merely a planter, and sugar making is an entirely separate occupation. A central "Usine" manufactures the canes of a number of neighbouring estates, and pays for them by weight, irrespective of the sugar produced; so that the planter, after delivering the raw produce, has no further concern with it, and he is enabled to devote his capital and energy exclusively to the improvement of his cultivation. The first factories were established under agreement as to full supplies of material with the neighbouring planters, who also furnished a considerable portion of the capital. But now others are in operation, which have dispensed with a part of this security, and which partially depend for supplies on the growers' self-interest. It was, in fact, taken for granted by their projectors that the planters would sell their canes rather than make sugar themselves. This calculation was more than justified by the event. Canes are now coming to these factories from most unexpected sources, and from distances of 8 and 10 miles. Further proof is scarcely needed to show that the planters are deriving benefit from the new system. Though the extent of that benefit cannot of course be known, a notion of it can be formed from the price given for the canes. The lowest price offered by the Usines is the market value of 5 lbs. of the best common process sugar for every 100 lbs. of canes; and this is only 1 per cent. less on the average than is obtained by those planters who incur the risk, anxiety, and expense of manufacture. There is, however, more definite knowledge as to the profits of the manufacturer, who so far deserves them that he produces the best sugar yet exported from the West Indies. "The Usine of François," established in 1866, in the subsequent four years declared dividends as follows: in 1867, 19 per cent.; in 1868, 37 per cent.; in 1869, 48 per cent.; and in 1870, 36 per cent.; the decrease in the latter year was merely the result of the disasters in France, which receives the bulk of the Martinique sugars.

Grenada.—The great difficulty with which planters here have to contend is the paucity of labour and the badness of the roads. Whereas in this island nature is so bountiful that a family with but little labour can raise their own fruit and vegetables on an acre or two of land, where also, from the habits of the negroes and the climate, their wants and requirements are but few, it cannot be expected that they will labour on estates more days than sufficient to supply such requirements. Moreover, on the abandoned estates, they can squat unmolested, and do so in large numbers.

The exports have been as follows:

Year.	Sugar.	Rum.
	tons.	galls.
1869	3,254	131,243
1870	3,880	70,775
1871	5,256	65,950

St. Vincent.—The following table gives a comparison of the exported produce of this colony:

Year.	Sugar.	Rum.	Molasses.
	hhds.	puns.	puns.
1862	8,503	1,827	305
1863	8,756	1,554	409
1864	8,163	1,284	1,418
1865	8,454	1,794	916
1866	10,984	1,796	1,063
1867	11,137	1,683	1,209
1868	11,248	1,634	1,359
1869	11,164	358	3,783
1870	12,948	2,155	1,638
1871	13,315	2,656	953

Although no additional land has been brought into cultivation, by more attention to clearing the canes and a greater use of manures, a rather larger yield per acre has been obtained.

Trinidad.—About 1,000,000*l.* a year is the value of the products of the sugar-cane in this island in good years.

The exports were in—

Year.	Sugar.	Molasses.	Rum.
	lbs.	galls.	galls.
1854	50,055,998	782,401	285,446
1864	79,109,650	1,576,105	60,075
1874	99,739,550	1,697,131	39,761

In 1796, one hundred and fifty-nine sugar plantations produced 7800 hhds. of sugar; in 1802, one hundred and ninety-two estates produced 15,461 hhds.

A large Usine has now been for some years at work for the Colonial Company, in the midst of their estates in Naparima, Trinidad.

The Governor of the colony, in one of his official reports, thus speaks of the position of the sugar industry:

" Steam ploughs, adapted to climate and locality, with alterations suggested by the experience of one of the ablest agriculturists, have succeeded the earlier machines. Along with this, subsoil drainage has been recommended. These two steps united will not only yield the usual increase of nearly 50 per cent. in the field, but render the planter who is in a position to adopt them, greatly independent of those climatic vicissitudes of flood or drought which interfere so ruinously with cane culture. The cane-carrier, that indispensable adjunct in lessening the most laborious branch of manufacture, may be seen now in every district, and tramways are being multiplied in connection with the mammoth mills which have here and there displaced the toy-like mechanism introduced some twenty years since. Road-steamers, too, of various build, may be met on the highways.

" But the manufacture of sugar has not quite kept pace with these improvements; little has been done to remedy its defects, or to arrest the waste due to the old method of frying the cane juice in iron vessels. A few steam taches for open-air concentration, but which rarely work at a low temperature, expedite somewhat the process without improving much the quality. These last may be taken as indicating the ultimate stage of progress rendered here in a boiling house. What that stage actually represents in the history of sugar manufacture may be gathered from Stammer's exhaustive work on this subject finished since the fall of Paris. Speaking of the present mode of extracting sugar from the beet, he says: 'In some antiquated establishments may still be seen a few open pans heated by steam, but these are being rapidly disused.'

" This, then, is the ground on which the great staple of the colony now rests. It is in vain, I apprehend, to reassert the fact that ripe canes contain double the quantity of sugar yielded by the beet, and that average soil produces twice the weight of canes that it does of beet, if the cane planter is unable to bring any more efficient mode of manufacture than his old iron kettles in competition with the economical and scientific arrangements of the *triple effet* by Cail and others. There is, however, the dawn of better things at hand, in the complete separation of manufacture from agriculture, by the Colonial Company Limited, at their great central Usine at St. Madelaine. This step was alone required in the British West Indies to place a portion at least of its crop abreast of the rival beet, and with corresponding advance in agriculture, the sugar-cane may hold its own. The Usine of St. Madelaine is a triumph of capital, skill, and energy, and will be the pioneer of other establishments in pouring forth a crystallized sugar for the million.

"Of its success there can be no more question than of that of kindred establishments in the French islands, which have wisely adopted the suitable points of their national beet factories. These colonial Usines are reported, on good authority, to have cleared, according to circumstances of position and management, from 25 to 45 per cent. on the capital invested.

"This refers to the manufacture alone. As regards the cultivators of the cane, all of whom were more or less deeply involved, they are now, as regards at least one Usine Centrale, unembarrassed and mostly in receipt of fair revenues. There is therefore every inducement to lead the capitalists of this colony to embark at once in the double but separate businesses of realising the profit of both agriculture and manufacture. Should they, however, leave this desirable ground to be occupied by capitalists unconnected with and apart altogether from the acreage supplying the canes, the error will be irremediable."

A Trinidad paper of September 26, 1876, thus speaks of the sugar crop of the island:

"The quantity of sugar produced in each county this year was as follows:

	Hhds.	Estates.
St. George, or north-west county	13,560	24
Caroni, or west centre, north	17,061	35
Victoria, or west centre, south	23,910	44
St. Patrick, or south-west county	4,544	11
Total	59,075	114

"No sugar appears to have been made in the four eastern counties; at least if a trifling quantity was granulated at Mayaro, as is sometimes done, it has not been ascertained. Probably the small quantity of canes grown on that side was pressed only for syrup and molasses. The list of active estates is under the actual number of plantations having separate mills and management, the return in many instances throwing the produce of two large adjoining estates, or three, into one figure. The real number is therefore nearer 124 than 114.

"Of the sugar of St. George, only 949 hhds. from five estates now come from the plain and valleys north and west of the town. The remainder all comes from the plain east of Port-of-Spain and north of the Caroni river. The Caroni waterslope yielded 12,881 hhds. north of the river and 3137 south of it, the latter a quantity and ratio that is pretty certain to show a steady advance for some years; total for 1876, 16,018 hhds. The Chaguane quarter or Ward gave 3751 hhds., and the Couva Union, 8944. This takes us to the watershed of the Montserrat hills. The Guaracara estates, North Naparima and Savana Grande, yielded 13,747 hhds.; South Naparima, 11,122 hhds.; Oropouche, 1494 hhds.; and Cedros, 3050 hhds. This sums up the yield of the whole present sugar-making area of the colony.

"Classed under the various drainage districts, the result is as follows:

	Hhds.
North and west of the Laventille spur of hills	949
The Caroni basin	16,018
The northern drainage from the Montserrat range ..	12,695
Drainage from the Montserrat ridge (northern slope of Guaracara basin) to Oropouche lagoon	24,869
From the lagoon to Cedros (the south-west peninsula)	4,544
Total	59,075

"In soil and vicinage, the Oropouche district and the strip of plain across the lagoon (in which the first cane-pieces are now being opened by the Messrs. Tennant), belong to Naparima, and may claim to be classed as part of that superlatively fine cane district.

"Summarizing this statement, it appears that the Colonial Company's estates this year made 9262 hhds.; those of the Messrs. Tennant, 8397 hhds.; those of Mr. Turnbull (with Jones's estates), 4891 hhds.; Mr. Burnley's, 4297 hhds.; and Mr. Cumming's, 3300 hhds. It will be perceived these figures account for more than half of the crop. The Usine is down for 3164 hhds. Eight persons or interests besides the above five, made over 1000 hhds., and two between 900 and 1000 hhds. Comparing with the previous year, 1875, the crop is about 11,500 hhds. short, the deficiency being spread over all the counties except St. George, which made 2200 hhds. more this year than last. Victoria alone is 8000 hhds. short, its soil and roads yielding most readily to heavy rain.

"Dividing the production of the year by 114, the average would be 518 hhds. (against 624 last year); but if by 124, which is about the number of separately milled and worked estates, it will be seen to be 476 hhds. per estate. Only five estates made less than 100 hhds. apiece. With a longer open season, the Naparima crop, in particular, would have been a much heavier one."

Exports of sugar from Trinidad:

	Cwts.		Cwts.
1860	540,678	1867	828,116
1861	549,464	1868	830,708
1862	738,117	1869	929,365
1863	668,255	1870	819,043
1864	706,246	1871	1,071,839
1865	560,166	1874	890,533
1866	813,339		

Martinique.—In this island the number of hectares under culture with the cane in 1874 was 19,314, and there were 564 sugar pieces and small plantations. The number of labourers employed was

33,643. There were 88 sugar estates possessing steam mills, and 14 central Usines or sugar works.

The production has been as follows :

Year.	Sugar.	Molasses.	Rum.
	kilos.	litres.	litres.
1865	32,691,550	7,909,700	6,220,500
1866	33,202,000	7,920,650	6,272,050
1867	35,068,600	7,682,500	6,086,000
1868	36,613,895	7,942,000	6,321,000
1869	36,664,000	6,488,000	5,268,000
1870	37,820,000	6,343,000	5,084,000
1871	38,084,000	6,437,000	5,239,000
1872	38,023,000	6,324,000	5,218,000
1873	37,835,400	6,160,000	5,200,000
1874	38,653,000	6,206,000	5,320,000

The sugar crop of Martinique is probably less than one-half of that of Trinidad; the superior quality, however, manufactured by the Usines, raises the value of the crop much more in proportion.

The finest soil lies to the north and north-east of the island, where the estates are on a much larger scale than on the south side; the soil is volcanic, and cartage of canes or produce practicable at all seasons.

The seasons also are not so marked to the north of the island, less rain falling in the dry season than elsewhere; so much so, that sugar making and cultivation may be carried on at almost any period of the year. The showers fall principally in the early morning.

There are no Usines to the north. The largest estate there makes nearly 1000 barriques, equal to about 450 hhds. of a ton weight. The average crop of an estate is, however, from 500 to 600 barriques.

There will be shortly two Usines near St. Pierre, one of which has been for some time in operation, and the other in course of construction to the south of the town of St. Pierre. The Usines are principally erected in the southern part of the island, in the direction of and beyond Fort de France (as it is now called), where the country is more level, and the facilities greater for bringing the canes by rail to the Usines. The estates by which these Usines are now fed were formerly small properties, with inferior machinery of little power, making each from 140 to 180 tons of sugar. These small estates now grow more than double their former crops, which are manufactured on the Usines into sugar of three qualities, i. e.:—1st class sugar, of large and strong crystals and to all intents and purposes white; the 2nd class article, made from the molasses boiled a first time, resembles the ordinary crushed sugar imported from England, but is not quite so white; the 3rd class is superior in colour to the best muscovado, though somewhat inferior in grain.

The Usines or central sugar factories having attracted considerable attention as to their working and alleged successful operations, several official visits were made to them in 1872, and reports submitted. The following is one by Mr. R. H. Burton, Commissioner from Porto Rico.

There are fifteen Usines or central sugar factories in the island of Martinique, the greater number are in the vicinity of the Bay of Fort de France, within easy water communication, or having tramways from the establishments to their wharves.

Name of Factories.	Name of Director.	Class of Company, &c.	Yield per Cwt. on Canes.	No. of Hhds. for Crop 1871.	Power of Usine in Hhds. of 500 Kilos.	Capital Employed.	Price paid for Canes.
						£	*d.*
1. Galion	Briere de l'Isle, Wallé and Clerc	Commandite	8·86	3,860	4,000	98,000	5½
2. La Renty.. ..	Quennesson and Co... ..	Privé	7·86	7,494	10,000	120,000	5
3. Soudon	M. Poursigney	Anonyme	..	..	6,000	80,000	5½
4. Dillon	M. Daniel Guillaud.. ..	Ditto	7·20	2,200	6,000	92,000	5½
5. Robert	M. Bougenot	Ditto	7·15	2,700	4,000	56,000	5
6. La Rivière Blanche ..	M. Rousellot	Commandite	..	1,300	4,000	48,000	5
7. Pointe Simon ..	Quennesson and Co... ..	Privé	7·26	3,657	6,000	48,000	5
8. Petit Bourg ..	Bougenot and Quennesson	Commandite	7·03	2,500	4,000	48,000	5
9. La Rivière Salée	M. Daniel Guillaud.. ..	Ditto	7·50	3,000	6,000	48,000	5
10. François	Quennesson and Bougenot	Ditto	7·57	2,900	5,000	48,000	5
11. St. Marie	M. Premorant la Bougery	Anonyme	7·26	1,700	4,000	48,000	5½
12. Trois Rivières	M. Seheult..	Commandite	..	1,450	2,000	32,000	5
13. Simon	M. Briere de l'Isle	Anonyme	5·83	1,900	2,000	30,000	5
14. Trinité	M. Bally	Ditto	..	1,700	2,000	30,000	5½
15. Marin	M. Charles Harouard ..	Commandite	7·92	2,100	2,500	34,000	6
				38,455	67,500	860,000	

The figures for the crops of *Dillon* and *La Rivière Blanche* Usines are those of the number of hogsheads made in 1872, this being the first crop.

Usines *Galion*, *Robert*, *François*, *Trinité*, and *Simon*, are on the east coast; on the north coast, where the large estates are located, there are none; neither do the planters of that district appear to desire them; the north has always been the most productive part of Martinique, the estates there being well cultivated, and having good machinery; those districts where the central factories are now established, except *La Renty*, situated in the level lands of the neighbourhood of the town of La Martin, never had the latter advantage.

As an example of the working expenses and net returns of the French Usines, I have copied from the books of several of these their last year's results. To abbreviate as much as possible, but at the same time to give a fair idea of what they do produce, I take those of the three Usines, under the direction of men such as Messrs. Quennesson and Bougenot, who are those who have brought the Usines to their present state of prosperity.

Pointe Simon, the first established, is situated close to the sea, at the western extremity of the City of Fort de France. For many years it was a complete failure, and ruined its projector, Mr. Thorp, an Englishman. At his death it was taken over by the house of Cail, to whom it was heavily indebted, and, under the judicious administration of Monsieur Quennesson, aided by the Messrs. Busine, not only liquidated itself in a very few years, but gives annually a large net revenue. Its unsuccess at first is to be attributed to the inferior machinery employed, and the want of practical experience on the part of its projector. This Usine in 1872 made 1,825,550 kilogrammes of sugar, 189,791 litres of rum, selling also 130,000 litres of molasses, and gave a net return, after paying all expenses, of 400,000 francs.

La Renty, situated in the fertile plain of La Martin, passed through the same ordeal. Its founder, the Baron de la Renty, proprietor of three sugar estates, established it with the view of concentrating the manufacture of the sugar of these properties, but being without practical experience, he sank a large fortune here, when, finally, indebted to the house of Cail, their Agent, Monsieur Quennesson, offered to lease it for nine years, giving 50,000 francs to the Baron yearly in cash, and two-thirds of the net proceeds, which was to be dedicated to the reduction of the debt with the Messrs. Busine, as sub-directors. This Usine has cleared itself. It made last year 3,747,043 kilogrammes of sugar, which, with its proportion of rum and molasses, gave net, after paying all working expenses and repairs, 807,000 francs, equal to 32,280*l.* sterling.

François was established by a company "en Commandite," formed by Messrs. Quennesson and Bougenot. Profiting by their long experience they placed in this Usine most effective machinery; it was supplied by the house of Cail; the mill, for its size, is excellent, and was the largest then imported to Martinique. The arrangement for supplying the cane-carrier with canes from the waggons on the railroad could scarcely be improved on. This Usine was the first built of iron, with the sides filled in with brickwork, on a fixed plan to receive the machinery. Everything was arranged to facilitate the work, and from the offset it has been the most successful Usine in Martinique. The shares emitted at 500 francs (twenty pounds sterling), are quoted now at 1250 francs (fifty pounds sterling).

A hogshead of sugar in the French Usine weighs 500 kilogrammes, equal to 1102 lbs. avoirdupois.

The yield per cent. on canes ground varies considerably in the different Usines. It depends on the density of the juice extracted from the cane, and also on the greater or less perfection of the machinery employed, and the carefulness of the operators. Taking Usine *La Renty* as a fair average, it will be seen they there obtain 7·86 per cent. of crystallizable sugar, and about 3 per cent. of molasses. The molasses is of an inferior quality, and is converted into rum.

In 1871 *La Renty* purchased 47,615,538 kilogrammes of canes, paying 5 per cent. on weight of cane according to the market value in St. Pierre, of "bonne quatrième" sugar, "No. 12 Dutch standard." These canes produced :

	Cane.	Sugar.
	kilos.	per cent.
In 1st jet	2,883,358	6·05
„ 2nd jet	653,685	1·37
„ 3rd jet	210,000	·44
Total	3,747,043	7·86

or 104,974,229 lbs. cane produced 8,260,810 lbs. sugar. This sugar, with rum and molasses, was sold for—

	Francs.	Francs.
		2,461,000
The canes cost	1,075,095	
The total working expenses were ..	578,905	
		1,654,000
Net benefit		807,000

The director of this Usine receives 24,000 francs per annum, and the two sub-directors each 10,000 francs, with a percentage on net proceeds. The cane weigher receives 6000 francs.

Most of the Usines make only first jet, i. e. sugar extracted from the cane juice, and second jet, that made from the first molasses. The difference in the two classes of sugar is trifling, but third and fourth jet are much inferior, and require a great extent of cooler-room, the *masse-cuite* of these jets having to remain at times six to eight weeks in the coolers to granulate, and most Usine directors prefer to convert their second molasses into rum. The rum made in these factories is of very superior quality, and they should, in my opinion, be so constructed that this might be optional, according to the relative value of each product in the market.

The following schedule shows the number of pounds of canes ground to make each hogshead of 1102 lbs. sugar; and canes ground for each 100 lbs. sugar, made in the year 1871, in the three Usines before mentioned, with the expenses in francs for the canes taken to make each hogshead, manufacturing or current expenses of the factory per hogshead during the twelve months, and net profit.

Name of Usine.	Number of lbs. of Canes ground per		Cost per Hogshead.			Net Profit to Usine per Hhd. of 1102 lbs.
	Hhd. 1102 lbs. Sugar.	100 lbs. Sugar.	Canes.	General Expenses.	Total.	
			frs. cts.	frs. cts.	frs. cts.	frs. cts.
La Renty	14,007	1,275	143 43	77 24	220 67	107 68
François	13,853	1,257	139 31	81 52	220 83	129 96
Pointe Simon	15,056	1,368	153 98	71 29	225 27	100 55
Average	14,305	1,300	145 57	76 68	222 26	115 73
			£ s. d.	£ s. d.	£ s. d.	£ s. d.
Equal in sterling to			5 16 5¼	3 1 4	8 17 9¼	4 12 7

Thirteen tons of canes for one ton of sugar. Or, in other words, for each hundred pounds of canes purchased by the Usine, the planter received 9¾*d.*; the general expenses of the Usine were, during the twelve months, 5⅓*d.* on every hundred pounds of canes ground, and the profit on each was 7¾*d.*

The question is, do these profits of the Usine bear an unjust proportion to those of the planter?

Could not the Usine afford to be more liberal?

Count Adhemar, of Guadaloupe, has entered very minutely into this argument, showing that all the profits are in favour of the factory, and the chance of loss for the planter; but he starts his arguments on a false basis, at least as far as would regard Porto Rico, his calculations being based on the supposition that a fair yield per acre would be 279 cwts. of canes. Such a poor crop of canes would not be tolerated here; we seldom get less than 500 cwts., more frequently 600 cwts., and very often as much as 800 cwts. per acre, so that what the Count makes appear as a loss to the planter would, in our case, be a very handsome profit.

My opinion is, it should be borne in mind that Usines, at the outset, were very unprofitable speculations; all their projectors ruined themselves—an evident sign they were paying the planters too heavy a price for their canes in proportion to the power of extraction of their machinery, though this machinery was admitted to be far superior to that on any sugar estate; therefore the planter, at 5 per cent., was receiving a greater value for his canes than that on the sugar, &c., he, with his own machinery, would have extracted from them, and minus the expense of manufacture.

Formerly few estates' mills, driven by steam or water power, extracted more than 50 per cent. weight of juice from canes ground: windmills and cattle mills seldom or never did this; and under the bad system of defecation and concentration generally practised on small estates, one pound of dry sugar per gallon of juice was considered the average yield. Under such circumstances, the planter who is relieved from the trouble and expense of manufacture, and receives for his canes the value of 5 per cent. of dry sugar,—good 4ths,—drives a profitable business, unless he can have at his disposal capital sufficient to erect a good plant.

Certainly, an old-established factory could afford to be more liberal, but in a country where central factories were being introduced for the first time, where, of course, incidental and unforeseen expenses are liable to occur, it would not be prudent for a company to start such an establishment on any other basis; neither would it tend to the advantage of the cane-planter that it should do so; for the failure to the company would be ruin to the man who might have spent more than his all in planting and cultivating his cane-fields, and the percentage might be increased after the second or third year, when there would no longer be fear of failure. That some Usines have extracted upwards of 8 per cent., there is no doubt; but that many have not obtained 6, is also a recognized fact. Moreover, with any percentage of extraction, a factory, to pay a good premium on capital employed, must be supplied with canes for at least one hundred and twenty days' full work. This can scarcely be expected in a new factory, established, as probably it would be, in a district not yet fully cultivated.

There were many causes which tended to the failure of the first factories established. The difficulty of transporting the canes to a distance, and the loss of time in the factories from their irregular supply: it is impossible to work satisfactorily a sugar manufactory, where the work is interrupted for want of material, imperfect defecation and concentration producing an excess of glucose, causing a small return of crystallizable sugar and a large quantity of inferior molasses. Neither were the mills of sufficient extracting power. This may be better appreciated by perusing the following schedule of extraction.

One hundred pounds of canes yielding juice of 10° B. will, at 50 per cent. extraction, give, in cane juice, 4·714 gallons.

	Gallons.
55 per cent. will give	5·185
60 " "	5·657
65 " "	6·128
70 " "	6·600
75 " "	7·071
80 " "	7·543

When the factories were first established, mills, such as they now use, or those used on the larger properties of Cuba and Porto Rico, were unknown. The inferior mills employed, and of which I saw some dismantled, could extract but a portion of the juice contained in the cane, but gradually, as these Usines fell under the sole direction of practical men, these evils were remedied. At *Pointe Simon* a powerful mill and engine was introduced, by the side of which the first one used was a mere plaything; the new one extracts from 68 to 72 per cent. of juice from the cane, whilst the former failed to extract 60 per cent. and during many days consecutively; and at intervals I saw the average quantity of cane juice extracted per hour was 2680 gallons. The rollers of this mill are 1 metre 50 centim. long (59 inches), by 80 centim. diameter ($31\frac{1}{2}$ inches), and make $2\frac{9}{10}$ revolutions per minute.

The coppers were discarded, and the "triple effet," as used in the beetroot factories, was introduced, and found to work successfully. The vacuum-pan and other machinery was enlarged, and this Usine, which at first could scarcely manufacture ten hogsheads of sugar a day, now produces twenty-five in ten working hours. Intelligent men have been employed in each department, and a most complete success is the result.

The projectors of new factories, profiting by experience acquired, adopted at once those portions of machinery which had proved most effective; and M. Bougenot, in his Usine at *François*, has fully demonstrated the advantages of a judicious combination of machinery, and a minute attention to results, by the enormous interest he has yearly divided among the shareholders of his Usine. No doubt this prosperity has served as an incentive to the formation of fresh Usines. Some have been more fortunate than others, but all have paid large dividends, although none of them have been fully worked, as may be seen by the schedule, which shows the work they are capable of doing, and what they have done. As their supply of canes increases, so no doubt will also their profits. I heard of no instance where this had been less than one hundred and thirty-five francs (5*l.* 8*s.* sterling).

La Renty has produced 27 per cent. per annum on estimated capital.

Pointe Simon has also paid $33\frac{1}{3}$ per cent. per annum, and *François* has varied between 36 and 48 per cent. since it was established. These are facts not gathered by hearsay, but from personal inspection of the books of these factories, kindly placed at my disposal by the gentlemen who direct them; and I cannot omit this opportunity of warmly acknowledging the kindness and attention I received from the numerous directors I visited.

Of course the effects produced to the island generally have been very beneficial. Since the establishment of these factories the export of sugar has exactly doubled, and being of a superior quality, giving no loss by drainage to shippers or purchasers, its proportional market value is greater. The shipping towns have profited by this increase of commerce, and the vessels have brought prosperity to many with them. Merchants who first feared that the central factories becoming great depôts for sugar would interfere with their business, have found it has not been so; for when by chance they may have lost the consignments of sugar, or the agency of some petty estate, other currents of commerce have resulted, which more than indemnified them.

The following is a report made by the Commissioners appointed to inquire into the working of the central sugar factories system in Martinique and Guadaloupe, presented to Governor Baynes in 1872.

We arrived at Basseterre, Guadaloupe, upon the 18th June, and proceeded without delay to the town of Point-à-Pitre where the largest central factory or Usine, in the French islands, is situated, the "Compagnie Sucrière E. Souques et Cie," commonly called "L'Usine D'Arboussier." This factory stands in the suburbs of the fine seaport of Point-à-Pitre, is constructed upon the grandest scale, and is replete with all the improvements in machinery and the manufacture of sugar devised by modern science.

The cost was 216,000*l.*, and the Usine, when a third mill, now being put up, is available, will be equal to an out-turn, in the first six months of the year, of from 8000 to 10,000 tons of sugar.

It commenced operations on the 5th April, 1869, but did not get regularly to work until the 25th.

The first season was completed with part of the copper machinery not fitted up, and at no time was the Usine supplied with canes to keep its mills going. The supply of canes is derived from both divisions of Guadaloupe, the volcanic and calcareous. From the former they are conveyed in large lighters towed by steam-tugs; from the latter by the tramway, several miles in length. The canes are carted by the planter to his nearest point on the railway, or shore, and thence by the Usine to their destination, where they are weighed by a sworn agent, in the presence, if required, of a representative of the estate. The planter receives $5\frac{1}{2}$ per cent. of the weight of his canes of "bonne quatrième," equal to "No. 12 Dutch standard," the price being regulated by the market of Point-à-Pitre at the time the canes are delivered.

The process of sugar manufacture at this Usine is as follows:

The canes are brought by the planter to a siding of the main tramway on his estate. The waggon generally carries 2 tons of canes, and one mule on a good level ordinary tramway can draw easily two waggons. The waggon, when brought to the mill itself, conveys the canes to the rollers, the megass being elevated by power to a platform over the boilers. The juice on leaving the mill bed falls through three strainers into a tank which has a double bottom heated by steam. It is treated here with a little bisulphite of lime, and is then run into a monte-jus. This monte-jus by steam sends the juice up to the clarifiers, where it is heated in the ordinary way and tempered with lime properly. From this it is passed to the charcoal filters, through which it gravitates, and then passes by a gutter into a receiver. From this it is passed to a monte-jus and is thrown up by steam into a cistern over the "triple effet," passing from the first to the second, and from the second to the third boiler, as the attendant wishes. When it leaves the third boiler it is, generally speaking, 25° Beaumé, and is immediately passed over new reburned charcoal. It gravitates through this and falls into another receiver, from which the vacuum pan takes it up and boils it to sugar. The first quality sugar is generally crystallized in the pan, and is then dropped into sugar boxes which stand 7 feet from the ground; under these boxes a little charging vessel runs on a railway that is hung from the bottom of the said boxes, and this vessel conveys the sugar over the centrifugals, where it is cured; the molasses from this being boiled up, when found in good condition, with the syrup of the following day. When these molasses are thick and clammy they are boiled into mass by themselves and dropped into sugar boxes, where they are allowed to granulate for a number of days. This makes the second quality sugar, and the molasses from this, along with the skimmings and subsidings of the clarifiers, go to make rum. The juice that leaves the clarifiers does not pass over fresh charcoal, but follows the syrup from the "triple effet," this assisting to wash out the sweets which may have been left by the syrup.

The following figures show the weight of canes delivered to the factories in the three years commencing with 1869:

Year.	Tons.	Kilos.
1869	17,808	17,808,217
1870	42,808	42,808,079
1871	68,745	68,745,493

This year (1872), notwithstanding the severe drought, the receipt of canes was upwards of 75,000,000 kilos., or 75,000 tons.

Thus, in the first three years, the growth of canes upon plantations under contract to the Usine had quadrupled, and the management, accused at first of having established a factory in a district devoid of canes, have been compelled to erect a third large and powerful mill, with its accessories, to provide for the reception of the normal quantity of canes expected, viz. 100,000,000 kilos., or 100,000 tons per annum.

This factory pays $5\frac{1}{2}$ per cent. for its canes, and the figures following give the financial results for the three years ending 1871:

	Profits.	Loss.
	£	£
1869	4,385	
1870	..	440
1871	28,899	
	33,284	
Deduct	400 loss in 1870	
Leaving	£32,844 balance to credit.	

A profit of 7000*l.* was expected in 1870. Severe losses, owing to failures during the war in France, and other circumstances connected with that trying and exceptional year, are assigned as the reason for the failure of profits to the Usine in 1870.

In 1870, 6096 "boucauts" of sugar of 500 kilos. each, equal in round numbers to 3000 tons, were obtained from the 42,808 tons of canes received, or 7·12 per cent. of sugar.

Three per cent. of syrup was also obtained, which was converted into 470,486 litres, equal to 117,620 gallons of rum of an average Centigrade strength of 60°, equal to $39\frac{1}{3}$ gallons per ton of sugar.

In 1871, 10,651 "boucauts" of sugar, or 5325 tons, were obtained from the 68,745 tons of canes received, or 7·74 per cent., composed as follows:

1st quality sugar	6·24 per cent.
2nd and 3rd ditto	1·50 „

A minimum average return of 8 per cent. is confidently expected when not less than 25 per cent. of plant canes are regularly forwarded from the contributory estates to the factory.

The superintendent, in a report made to a general meeting of the shareholders on the 24th April, 1872, and unanimously adopted, remarks that this factory was compelled after its second campaign to refuse the offer of fresh contracts, and to increase its working power 50 per cent., to enable the Usine to keep pace with the rapid increase in the production of the estates engaged.

"But two years ago," says M. Souqués, "a lack of canes was dreaded; now an excess of supply is to be feared."

This Usine, in April, 1872, the third year of its existence, declared a first dividend of 24 per cent., exclusive of 4 per cent. carried to the credit of the "Sinking Fund Account." The general manufacturing and working expenses of the Usine in 1871 amounted to 117,732*l.* The sugar realised (3,543,867 francs, or) 141,754*l.*, the proceeds of rum were (306,894 francs, or) 12,275*l.*, equal together to 154,029*l.*, showing a profit upon a simple debit and credit account (without charging interest upon capital and tear of stock, &c.) of 36,297*l.* upon a manufacture of 68,745 tons of canes and of 731,193 litres, or 182,728 gallons, of rum.

We had not the advantage of seeing this great laboratory at work, the operations for the year being ended.

The Commissioners beg respectfully to observe here that the processes of the manufacture of both sugar and rum in all the Usines, both in Martinique and Guadaloupe, visited by them are more or less identical, the only perceptible difference being the adoption in the newer factories of the appliances of modern science and improved mechanical and other arrangements. The clarification of the juice, its reduction to syrup at a low temperature, the perfect crystallization and colour of the sugar, and a maximum return are obtained by repeated filtration through animal charcoal, the "triple effet" and vacuum-pan processes, and, last of all, the centrifugal machines. A great drawback at present to the Usine D'Arboussier is the want of fresh water. Salt water is obliged to be used, as also water derived from wells decidedly brackish. The injury to the boiler tubes and other machinery from using salt water has been so great, that arrangements are now being made, at a great cost, to bring fresh water to the Usine from the other division of the island.

We take leave of this "palace factory" with the remark that the proprietors of contributory estates, as well as several shareholders with whom we had the pleasure of conversing, expressed themselves perfectly satisfied with the present condition of affairs, and very confident as to the permanent success of the Usine. The shares, originally issued at 500 francs, are now quoted at 1500 francs, but none are to be had. We were informed upon good authority that estates which before the establishment of Usines were in debt, or constantly changing hands, were now in a flourishing condition, and that others which had almost fallen out of cultivation were now making excellent crops.

We had the pleasure and advantage of several interviews with M. Souqués, whose family possesses a small private Usine, called "Beauport," not far from Point-à-Pitre. We were unable to visit the factory, but we were informed by M. Souqués (and his statements were confirmed by independent testimony) that this Usine purchased canes from the neighbouring estates, paying 6 per cent. for them, and that upon a manufacture of 2000 tons of sugar per annum the clearances of the Usine were very handsome. The precise amount was not, however, communicated to us, but we observe that Mr. Russell, a gentleman who appears to have visited Guadaloupe from Demerara three or four years ago, in some notes of his visit, entitled 'Two Weeks in Guadaloupe,' speaking of the Beauport Usine, states:—"The books show that they cleared 19,400*l.* upon 59,963,371 lbs. purchased (1868). These figures show a profit of about 14*s.* 6*d.* per ton of canes purchased." Mr. Russell states the quantity of sugar made (in 1868) to have been 2600 tons, and 62,700 gallons of rum, or a return of about 210 lbs. of sugar and $1\frac{1}{4}$ gallon of rum per ton of canes manufactured. The Usine "Cluny" is, we were informed, in general respects a similar factory to that of Beauport, and canes are brought by water in punts from a distance of 20 miles, and afterwards conveyed some miles farther by tramway to the Usine. The island of Guadaloupe is divided into two parts by a narrow channel, called the Rivière Salée, running north and south. The western portion (Guadaloupe proper) is of volcanic origin: it is mountainous, well wooded, and abundantly supplied with water; its soil, resulting from the disintegration of conglomerate, is generally of a stiff argillaceous nature.

Notes on Usines, and the Manufacture of Sugar as carried on at Martinique.

1. *Contract between Planter and Mill-owner.*—The engagements between the Usines and the cane-growers are generally for periods of ten years.

2. *Proportion of Sugar allowed in Exchange or Payment for Canes.*—When first established, the Usines only allowed the planters 5 per cent. of sugar per 100 lbs. of canes, but some of those lately established give as high as 6 per cent.

3. *Mode of Paying the Cane-growers.*—Sugar is never actually given by the Usine to the cane-grower, but the value of so much per cent. per 100 lbs. of canes: this value is fixed in the following manner:—Every fortnight the average between the highest and lowest prices quoted at St. Pierre for muscovado is taken, and such average price fixes the value of the percentage allowed by the Usine to the cane-grower; thus—A. sends 500,000 lbs. of canes to the Usine from the 1st to the 15th March; the Usine allows 5½ per cent. = 27,500 lbs. of sugar for the 500,000 lbs. of canes. The average price of muscovado sugar at St. Pierre is, during the same period, say, \$3 per 100 lbs.; 27,500 lbs. sugar at \$3 per 100 lbs. = \$825. To this amount, therefore, A. will be entitled for his 500,000 lbs. of canes. The cane-grower is thus excluded from participation in the advantages of the manufacture of the superior quality of sugar made by the Usine, except to a moderate extent at those Usines where, after a certain percentage of the profits has been reserved for the shareholders and for a reserved fund, the balance is divided between the cultivators of the canes and the proprietors of the Usine.

4. *The Carts go by Usine Tramway from Estate to Usine: but carted from Cane-piece to Tramway.*—The Usine is fed by means of tramways which are laid down with regard to the configuration of the ground, rather than directly, to save cartage to the cane-growers, who generally, if possible, suit their cultivation to the direction of the tramways. On *Les Digues* estate the canes for a crop of 300 barriques (= about 150 42-inch hhds.) used to be carted by about forty-five oxen, to a small mill of about 5 horse-power, driven by water: now, by sixty oxen, they cart canes to the tramway sufficient to make 500 to 600 barriques; that is to say, with one-third more oxen, they are able to cart canes sufficient to make about double as much as formerly. The railway passes near the centre of the estate; the cane-pieces farthest from it are barely a mile off. On some estates, however, I am informed, the cartage is from 2 to 3 miles.

5. *Varying Price, and Participation in Profits.*—Where the Usine gives the value of 6 per cent. per 100 lbs. of canes (to the cultivators) there is no participation, on the part of the cultivators, in the profits of the Usine; but at the neighbouring Usine of *Petit Bourg*, where the canes of *Les Digues* estate are manufactured into sugar, the cane-

growers, I was informed, received the value of $5\frac{1}{2}$ per cent. (of manufactured sugar per 100 lbs. of canes), and after 11 per cent. interest had been handed over to the shareholders, the remainder of the profits was divided between the shareholders and the cane-growers. The arrangements between the Usine and the cane-growers are, in almost every instance, different; and, as far as I have been able to learn, those that have been lately established give more liberal terms to the cane-growers than those of some years' standing.

6. *Some Canes sea-borne to Usine.*—Some of the Usines on the seaboard bring the canes by water, when steamers are employed to tow iron barges in which the canes are transported, sometimes from 6 to 8 miles.

7. *The Petit-Bourg Usine.*—The canes are ground in a mill of 40 horse-power, made by Cail and Co., of Paris. The rollers are much thicker, in proportion to their length, than the general run of mills manufactured in England and Scotland. Although of 40 horse-power, the mill at the *Petit-Bourg* Usine has rollers only 5 feet in length. This mill extracts about 72 per cent. from plant canes, and from 60 to 70 from ratoons. The steam is supplied, both for the machinery and boiling, by five multitubular boilers of the shape of locomotive boilers. Were coal only used, these boilers would be equal to 100 horse-power each, but as the megass is consumed in the boiler furnaces immediately on its issuing from the mill by the aid of 2 tons of coal per diem for each boiler, their efficiency as generators of steam is diminished about one-half; that is to say, the five boilers barely supply 300 horse-power. The amount of sugar manufactured is about 15 tons per day of fifteen hours; and the waste of animal charcoal about 15 tons per annum. Sixteen centrifugals are used, driven by two 12-horse engines. This Usine, which is not on a large scale, is fed by means of about 6 miles of railway: the rails weigh about 25 lbs. to the yard; the gauge is about 4 feet. Sixty cane-waggons are employed, measuring $11 \times 8 \times 2\frac{1}{2}$ feet, each capable of carrying about 6500 lbs. of canes, and each drawn by one mule, of which there are twenty-five attached to the Usine, all small animals. The average cost of the tramway, per mile, in an undulating country, is about \$7000 per mile; on level land, the expense hardly exceeds \$5000 per mile. There are three lines of rail laid down before the mill, to facilitate the discharge of the waggons. The cane-waggons on the tramroad are loaded by the cane-growers, but they have nothing to do with the expense of traction on the tramway, or the cost of laying it down and repairing it. From the mill, the megass is carried by a web to a platform about 16 feet above the ground; this platform is about 40 feet square, close-boarded to a height of about 6 feet, except where the web discharges the megass at the end of the platform opposite the discharging web, on five shoots leading direct to the furnace mouths of the boilers, at an angle of about 50°. The megass is put into the furnace by the stoker, with sufficient coal to enable it to burn freely. The boilers contain from 120 to 130 tubes, 3 inches in diameter inside, and about 18 feet long. The grating surface is about $4\frac{1}{2}$ by 6 feet. The chimney is 70 feet high by 3 feet in diameter, and of sheet iron. Each boiler has a separate chimney.

The sides of the boilers are not coated with any non-conductor, as it has been found that the damage caused to the boiler by the contact of any insulator and any leakage that may take place, is not compensated for by the heat saved which would otherwise be lost by radiation.

8. *The Usine always more advantageous to the Cane-grower than an Estate Mill.*—Some planters are of opinion that if they had mills of from 25 to 30 horse-power, it would pay them better to manufacture their own sugar, than to send their canes to the Usine. I am inclined to think, however, that if the data they have given me are correct, the Usine, under any circumstances, pays them better. I conceive that the profits of the Usines are generally much greater in proportion than the profits of the cane-growers who supply them. The Usine should be established by planters, they being the shareholders. So great are the profits of the Usine, that almost every year a new one is started in Martinique, and not the slightest difficulty is experienced in raising the necessary funds.

9. *Cost of establishing an Usine.*—The plant of an Usine capable of making, say 2000 tons of sugar, costs, including about 8 miles of railway and $4000 for ten acres of land, about $240,000. The largest Usine at Martinique was established by Baron de La Renty; it is called the *Usine de La Renty*, and is capable of making 3750 tons. The plant cost $500,000.

10. *Salary of the Manager.*—The *gérant*, or administrator (manager ?), of the Usine gets, in addition to a salary of from $3000 to $4000, a percentage which often brings him more than his fixed salary. One of the most successful, and probably the most economical administrators in Martinique is M. E. Bougenot, of the *Usine François.* Such a man might probably be induced for $5000 or $6000 to order the machinery for, and superintend during the wet season (when the Usines at Martinique are not at work) the erection of an Usine in Trinidad. I consider that even $10,000 dollars would be well laid out in securing the services of one who has practically worked and established Usines at Martinique.

11. *Profits of Usines in Martinique.*—One of the Usines pays the shareholders from 40 to 48 per cent. per annum on the capital invested. I am informed that the average profit of Usines is from 25 to 30 per cent. per annum.

12. *Number of Hands employed.*—An Usine of 2000 tons employs on an average 150 hands.

13. *Distillation of Rum.*—Besides the apparatus for manufacturing the sugar, there is attached to every Usine a distillery where the refuse is utilised for the manufacture of rum. I was unable to ascertain what were the profits of the distillery as compared with those of the manufacture of sugar, but was assured they formed a material item in the general return to the shareholders.

In *Guadaloupe* there were in 1874, 20,686 hectares of land under culture with sugar-cane. The number of sugar works was 495, of which 59 had mills worked by steam, 80 by water-power, and 80 windmills, and 1 by cattle; 264 plantations without works are served either by the eleven central steam Usines, or other mills conveniently situated. The number of labourers employed was 44,856. The produce made was:

Year.	Sugar.	Molasses.	Rum.
	kilos.	litres.	litres.
1865	30,328,452	4,311,972	1,819,312
1866	27,475,290	3,385,190	1,985,483
1867	28,013,900	3,168,304	2,269,500
1868	35,731,600	3,555,199	4,060,001
1869	35,831,394	3,355,670	2,569,703
1870	40,202,550	3,665,295	3,665,295
1871	40,634,550	3,332,595	1,817,288
1872	39,993,950	12,139,441	1,314,048
1873	34,582,585	2,583,381	1,367,580
1874	40,775,732	3,400,438	1,849,385

St. Croix.—The aid of steam in breaking up the heavy soil of this island is much desired, but the total failure of a steam-traction plough, introduced in 1862, has hitherto discouraged the planters from again risking so heavy an outlay.

The exports in 1870 were 22,968,214 lbs. of sugar, 437,058 gallons of rum, and 730,677 gallons of molasses; in 1871 the quantity of sugar exported was 25,223,547 lbs.

In 1873 the exports were 9,852,803 lbs. of sugar, 144,041 gallons of rum, and 354,442 gallons of molasses.

Colonel Stewart's process for improving the quality of sugar has been introduced, and resulted in making a superior article, where proper chemical knowledge has regulated the proportions of lime and sulphur required in the manufacture, having also due regard to the character of the water, which is often mixed with mineral deposits, as it is raised from a great depth and frequently through a lime or marl substratum.

Porto Rico.—The production of sugar during 1870 was very remarkable, certainly not less than 125,000 tons, and it is expected to be progressive. The value of the sugar exported, 101,298 tons at $5 per cwt., was 2,025,966*l.*; of the molasses, 5,206,655 gallons at 20 cents the gallon, 291,202*l.*; the small quantity of rum at $25 the puncheon, 146*l.*; making a total of 2,317,314*l.*, for the produce shipped of the sugar-cane alone, besides 640,000*l.* for other agricultural products. The estates here are well mounted with first-class machinery for sugar making and distilling; ploughs and agricultural implements are in general use. Colonel Stewart, an American officer, has introduced into the island his system of purifying sugar by the fumes of sulphur, which is simple and inexpensive, and has long been in use in the United States.

Sugar and molasses exported from Porto Rico:

Year.	Sugar.	Molasses.
1857	80,982,188 lbs.	2,707,740 galls.
1858	121,319,374 „	3,730,511 „
1859	91,732,084 „	3,089,652 „
1860	127,244,749 „	4,231,772 „
1861	145,995,816 „	4,616,180 „

Year.	Sugar.	Molasses.
1862	150,584,628 lbs.	4,987,252 galls.
1863	146,467,263 „	4,972,645 „
1864	110,425,022 „	3,732,076 „
1865	157,332,185 „	5,554,037 „
1866	64,017 tons	5,206,655 „
1867	68,229 „	5,063,094 „
1868	73,929 „	5,660,316 „
1869	81,372 „	5,969,020 „
1870	101,298 „	7,293,011 „
1871	108,133 „	7,590,915 „
1872	94,262 „	6,087,550 „
1873	101,195 „	6,082,539 „

The finest qualities of sugar are produced in the divisions of St. Juan, Mayaguez, and Ponce, and the muscovado sugars in Vieques, Naguabo, and Arroyo. The Americans take the greater portion of the former. 32,282 gallons of rum were shipped in 1873.

Cuba.—This island has always been a large sugar-producing colony, and has steadily maintained its progressive increase and the quality of the sugar produced, notwithstanding many adverse circumstances. The sugar crop and export last for about four, or at most six months, of each year.

Two facts strike the spectator who is accustomed to the culture and manufacture in the British West Indies, namely:

1. The inferiority of the culture of the cane in Cuba compared to that in Demerara, Barbados, Trinidad, Jamaica, &c., and the smallness and poor quality of the different species of canes in the Cuban fields.

2. The vast superiority in Cuba of the manipulation of the cane juice, and the excellence and high quality of the sugar produced.

There are about 1400 sugar estates in the island. The value of the sugar exported ranges from 12,000,000*l.* to 13,500,000*l.* sterling.

In 1855 the exports from Cuba were 1,905,580 boxes of sugar, 256,100 casks (of 30 gallons) of molasses, and 31,214 pipes of rum.

In 1840 the sugar crop was 143,600 tons, in 1853 267,850 tons; since 1863 the crops have been as follows:

Year.	Sugar.	Molasses.
	tons.	tons.
1863	506,000	170,500
1864	575,000	170,900
1865	620,000	185,500
1866	545,636	208,800
1867	565,529	193,500
1868	710,609	259,000
1869	664,155	247,100
1870	684,032	213,400
1871	527,000	152,500
1872	667,850	200,000
1873	600,000	240,000

Beetroot sugar is now the fear and dread of all tropical countries producing sugar-cane, and if the Americans can ever cultivate the beet in large quantities in the States, Cuba will, notwithstanding her large labour population, 350,000 negroes and 100,000 Chinese, greatly suffer from this cause in her exports, for the United States still take 70 to 80 per cent. of her sugar produce.

In 1863, 40 per cent. of the sugar and 77 per cent. of the molasses went to America; 34 per cent. of the sugar to England. In 1873, 64 per cent. of the sugar and 91 per cent. of the molasses went to America, and 25 per cent. of the sugar to England.

The following semi-official statement of the yield of the cane for ten years, computed in tons, is given in the annual report for 1873 of the British Consul-General, Mr. Dunlop:

Year.	Sugar.	Molasses.	Total.
1864	515,090	203,450	718,540
1865	619,780	218,075	837,885
1866	612,180	241,150	853,330
1867	597,146	226,200	823,346
1868	749,389	286,151	1,035,550
1869	726,237	279,570	1,005,787
1870	725,505	245,870	974,375
1871	547,179	184,965	732,144
1872	708,234	235,441	943,675
1873	796,179	242,308	1,308,487

Synopsis of exports:

Year.	Boxes.	Hogsheads.
1867	1,134,620	287,246
1868	1,336,559	502,231
1869	1,307,676	431,719
1870	1,355,154	502,153
1871	817,675	376,901
1872	1,145,351	484,021
1873	959,736	557,378

Reducing this into tons, it shows as follows:

Year.	Sugar.	Molasses.
	tons.	tons.
1869	639,406	247,050
1870	659,886	213,388
1871	470,941	152,459
1872	630,862	201,995
1373	714,960	189,333

The local consumption of sugar is stated to be about 220,000 tons, but comparing the production with the exports, it would seem to be about double that amount.

The quality of the sugar exported from Cuba is excellent, and is superior to most of the sugar produced elsewhere, from the scientific way in which it is manufactured from the cane juice. The sugar works on most Cuban estates are as good as any of the large German beetroot sugar factories, where the newest and best appliances are ever in use.

The sugar crop of 1870–71 was about 25 per cent. short of the average of the previous four years. This arose from the disturbed state of some portions of the island, where the insurgents continued to burn sugar estates, and also in a slight degree from the effect of two severe hurricanes which swept over the centre of Cuba with great violence in Oct. 1870; but as the price of sugar kept high, the value of the crop amounted to nearly 12,000,000*l.* sterling.

Sugar is exported from Cuba chiefly in boxes or cases, of which about 3¼ are equivalent to one hogshead. The hogshead generally weighs net about 1500 lbs. English. They are smaller than the Jamaica hogshead.

The exports in 1873 were distributed as follows, in tons:

	Sugar.	Molasses.
	tons.	tons.
Europe	231,196	3,593
United States	479,373	177,519
Other parts	4,391	8,221
Total	714,960	189,333

The *molasses* produced in Cuba is not large, as will be seen by the appended statement, and much of it is now re-worked for sugar; a very small quantity of rum is exported, in casks of from 110 to 120 gallons. Exports of molasses from Cuba:

Year.	Hogsheads.	Tons.
1862	177,894	115,631
1863	180,367	117,239
1864	172,954	112,420
1865	184,483	119,824
1866	213,167	138,558
1867	192,528	125,143
1868	262,882	170,873
1869	258,669	168,134
1870	225,861	146,809
1871	154,356	100,331
1872	..	201,995
1873	..	189,333

Average of ten years, from 1862 to 1871, 202,316 hhds., or 131,496 tons.

MAPLE SUGAR.

The sugar maple (*Acer saccharinum*) flourishes throughout most of North America. Its height is often upwards of one hundred feet. It is a highly ornamental tree, loves a cold climate, and makes excellent fuel. In the production of sugar an orchard of maple trees is equal to a field of sugar-cane of the same area. An open winter, constantly freezing and thawing, is the forerunner of a bountiful crop of sugar.

In the older States of the Union the great demand for timber and fuel and the increased cutting tend yearly to lessen the amount of sugar produced. In the more recently settled States of the northwest, maple sugar is on the increase.

The maple sugar crop of the year 1855 was officially estimated at Washington at about 550,000*l*. Maple sugar being a product of the forest, is chiefly confined to those regions of the interior where it is a cheap and ready substitute for the more costly product of the cane. The sugar-cane can only be raised in the extreme southern latitudes of the United States, whereas the sugar maple flourishes in the greater part of the inhabited sections, and though the sugar produced from it is inferior to that of the cane, yet, as it requires but little care, it is much cheaper.

In 1850 the production in the States was officially given at 15,520 tons, in 1855 at 14,500 tons, in 1858 at 24,000 tons, in 1860 and 1861 at an average of 27,000 tons, and in 1872 it was only 16,000 tons.

Maple sugar as an article of merchandise seems, however, in a fair way of extinction. The maple forests of New England are being yearly cut down and converted into broom handles. Thousands of splendid trees are annually felled. At the present rate of destruction, maple sugar will before long be unknown in the trade. The whole amount of maple sugar reported in the States was, according to the latest official agricultural statistics, about forty million pounds annually, but this was considered to be one-third below the actual quantity made. According to the last census returns, Vermont reported a yield of almost ten million pounds. The production of New York is somewhat larger, but nothing compared with the difference in area. The only other States which return more than one million pounds are Michigan four million, Ohio three and a quarter million, Pennsylvania nearly three million, New Hampshire two and a quarter million, Indiana one and a half million, Massachusetts a few pounds more than a million. The total production of maple molasses is one and a half million gallons, of which Ohio returns nearly four hundred thousand gallons, Indiana nearly three hundred thousand, Kentucky one hundred and forty thousand, and Vermont only sixteen thousand gallons. In addition to the large production of maple sugar in the States, the estimated quantity manufactured by the Indians living east of the Mississippi is ten million pounds per annum, and the quantity manufactured by those living west of the river is set down at twenty million pounds, but is probably much greater. Of the American States, Vermont makes by far the largest quantity in proportion to its territory, and in some of the northern districts of this State the use of cane sugar is almost unknown. Many improvements have been made in the manufacture of maple sugar during the last few years; formerly the highest attainments in this manufacture only resulted in the production of a fine muscovado-like sugar; but now, by improved processes, specimens are annually exhibited at the various agricultural fairs, vying with the most beautiful loaf sugar. This has been effected by greater attention to cleanliness in the preparation of the sap, and the improvements in the graining and refining the sugar. A few years ago a premium was awarded by the Oswego County Agricultural Society, New York, to Mr. R. Tinkor, for the following improved method of preparing maple sugar. The sap is boiled in a potash caldron kettle to a thick syrup; strain it when warm, let it stand twenty-four hours to settle, then pour it off, leaving back all that is impure. To clarify fifty pounds take one quart of milk, one ounce of saleratus, and the whites of two eggs, well mixed; boil the sugar again until it is hard enough to lay upon a saucer, then let it stand in the kettle and cool. Stir it a very little to prevent it caking in the kettle. For draining use a tube, funnel shaped, fifteen inches square at the top, and coming to a point at the bottom. Put in the sugar when cold, tap at the bottom, and keep a damp flannel cloth of two or three thicknesses on the top of the mass. When drained dissolve the sugar in pure warm water, and clarify and drain as before.

It is about the close of April that the collection of the sap is made. Réaumur's thermometer rises about midday to 50°, and falls each night to zero, or below. In Canada an incision or a hole is cut in the trunk a few feet from the ground; in the United States the large branches are also punctured; a recipient is placed to catch the sap. To save transport and to accelerate and simplify the manufacture, a rough shed is run up in the woods and a large boiler is suspended over a brisk fire. The sap is thrown into it and stirred with a wooden spade. When it boils, it thickens, changes its white colour into a golden yellow, and is poured out into wooden moulds, in which it solidifies on cooling; sometimes it is turned out into earthen pots, which bleaches it, but the quality is sacrificed to colour. In the work of Michaux on 'The Forest Trees of North America,' some interesting details will be found of the process as carried on in the States. They commence there, tapping the trees in February and March; a cold and dry winter is much more productive of sap than a humid and variable one; and a fine sunny day after a frosty night causes the sap to flow more abundantly, and a tree will occasionally yield two or three gallons. Michaux states that three persons can attend to 250 trees, which would yield 1000 lbs. of sugar, or about 4 lbs. per tree. The period during which the sap flows from the trees is about six weeks, at a time when there is little to be done in farming or other operations. In the State of New York there were in 1860 about ten million acres planted with the sugar maple, in the proportion of about thirty trees to the acre. The maple sugar product of Canada was stated in 1849 at 2,303,000 lbs. for the Lower Province, and 4,161,000 lbs. for Upper Canada. The census of 1851 gave the total at 10,000,000 lbs., exclusive of what was used locally without being brought to market.

PALM SUGAR.

In British India and several parts of the Eastern Archipelago sugar is made from the sap of some of the palms, such as the wild date palm (*Phœnix sylvestris*), the Palmyra palm (*Bŏrassus flabelliformis*), the cocoanut palm (*Cocos nucifera*), the Gomuti palm (*Saguerus* [*Arenga*] *saccharifera*), the Nipah palm (*Nipa fruticans*), and the Kittool palm (*Càryota urens*). About 50,000 tons of palm sugar are produced in Bengal alone, and a good deal in Siam; probably 150,000 tons is below the mark for the entire produce. I have preferred to treat of this manufacture under the head of "The Useful Palms," to which section the reader is referred for full details.

BEETROOT SUGAR.

Of all the plants experimentally tried for sugar the beet proved the most promising, but forty years elapsed before the manufacture of beet sugar was enabled to cope successfully with colonial sugars. From France, the culture spread through Belgium, Germany, and far into the interior of Russia, and now there is produced on the continent of Europe 1,200,000 tons, of which about one-fourth is manufactured in France.

The progress in the different countries is shown by the following statistics of factories and production:

Country.	Number of Manufactories.	Beet consumed in Cwts.	Sugar Production in Cwts.	Average Production of each Mill.
France	434	82,850,000	5,800,000	190,915
Germany	266	51,495,494	4,319,640	172,619
Russia	300	42,400,000	3,792,000	141,334
Austria	212	42,300,000	3,400,000	199,530
Belgium	106	14,200,000	1,000,000	131,482
Holland	18	2,143,000	150,000	119,060
Sweden	6	770,000	61,600	192,500
Total	1,372	236,158,404	18,523,240	173,380

Year.	France.		Zollverein.		Belgium.	
	Factories.	Tons.	Factories.	Tons.	Factories.	Tons.
1850	390	67,000	184	45,000	281	5,800
1860	341	108,000	247	145,000	65	17,000
1870	458	285,000	284	215,000	131	48,000
1875	500	500,000	300	346,000	200	80,000

Year.	Austria.		Russia and Poland.		Holland, Sweden, and Italy.	
	Factories.	Tons.	Factories.	Tons.	Factories.	Tons.
1860	140	76,000	..	87,000	..	..
1870	181	152,000	300	132,500	20	16,000
1875	236	154,000	..	245,000	25	30,000

The manufacture has been unsuccessfully attempted in England and Ireland. In New Jersey, California, Canada, and parts of Australia attempts have also been made to grow the beet for sugar production. Owing to the smaller quantity of saccharine in beetroots than in sugar-cane, and owing also to the more intricate and complex combinations in which that saccharine matter is found in the root than in the cane, greater ingenuity and a more careful application of scientific processes are needed in the one than in the other.

A beetroot sugar manufacturer must not only be supplied with a large capital, as the "plant" required for his industry is both heavy and expensive, but his mind must be stored with an amount of scientific and practical knowledge of no ordinary character. He must be a thorough, practical agriculturist; as the cultivation of the root, to be successfully carried out, must enter into a well-organized rotation of crops, and take its rank in that rotation according to local conditions of climate and soil, which it requires a thorough, practical mind to determine. He must also be a good chemist; not only to ascertain the capabilities of the soil on which he operates, and determine the special manures necessary—for the saccharine quality of the roots wholly depends on the food on which they grow—but he must also be able to conduct the nice chemical processes essential to extract sugar from the root, and meet many accidental contingencies with which these processes are beset at every stage of their progress. He must also be familiar with the arts of the engineer and mechanic, so as to be able to plan and carry out all the improvements which are daily suggested by enlarged experience and practice, in order to meet, by simpler and less expensive mechanical means, the increased salaries of labourers, the fresh taxes laid on sugar, and the large competition of home and foreign antagonists and rivals. He must also be a prudent and active commercial man, carefully watching the state of the market, both in the purchase of raw materials, and the disposal of his produce.

In 1700 there was not consumed in France 1,000,000 kilogrammes of sugar. In 1861 the consumption had reached 120,000,000, and in 1874 it was 258,000,000. It would supersede and annihilate the consumption of colonial sugar if it were not taxed by the Government. Free from duty it could be sold with profit to the manufacturer at 2*d.* the pound.

"The art of extracting sugar from beetroots," remarks Walkhoff, "is a northern, and especially a German discovery. It was not the result of a blind chance, for its extraction required a manipulation far more complex than the treatment of the sugar-cane. Whilst the Indian reed, ripening under a tropical climate, aided by a powerful and energetic growth, offered, so to speak, of its own accord, and without expense to man, a sweet juice almost pure, it required, to extract the same substance from beetroots, the slower but steadier combination of reflection, sustained thought, and labour of the man of the north, struggling against a less favoured climate."

From an article in the London paper called 'Engineering,' I take the following statistical facts:

"An acre planted with sugar-cane in the West Indies will produce about 20 tons of cane on an average. This cane contains about 90 per cent. of juice, and the percentage of saccharine matter in the sugar-cane juice varies from 18 to 22 per cent. Taking an average percentage of sugar in the cane as 18 per cent., the weight of sugar grown upon an acre in the West Indies is 72 cwts. The average of modern beetroot cultivation in Europe may be taken as 20 tons of beetroot per acre; and the percentage of sugar in a favourable season at 10 per cent. An acre of beetroot in Europe therefore raises 40 cwts. of sugar, and that sugar is diluted to a much higher degree with water, and contaminated with impurities of all kinds, which render it much more difficult and costly to extract and crystallize than the cane sugar. Modern improvements in agriculture have gradually raised the yield of beetroot crops, and may do so still further, but in a similar degree is the agriculture of sugar plantations capable of further important improvements, and the yield of cane capable of being considerably increased. So far as the production of sugar is concerned, the advantage is so greatly and obviously on the side of the sugar-cane, that the decision against beetroot cultivation is arrived at as an *a priori* judgment, which has hitherto been held with considerable tenacity by the majority of the agriculturists and practical men in this country. The actual success and rapid growth of beetroot industry on the Continent has for a long time been ascribed to accidental causes, and it is only at a very recent date that other opinions have gained ground amongst a small number of scientific and practical men. The element of success which has been so frequently overlooked, and which still is powerful enough to turn the scale in the competition between sugar-cane and beetroot in the open market of the world, is the refuse material from the beetroot plants. The extracted sugar-cane is a mass of woody fibre saturated more or less with juice, according to the greater or less degree of imperfection in the process of extraction. The proper application of this sugar-cane trash or bagasse, would be for manuring the cane fields, but the actual use which is made of it in the colonies is for fuel, and in many localities it forms the only fuel available for the different purposes of raising the steam and evaporating the juice. In either of the above applications the value which this cane trash represents over and above the value of the sugar itself is practically *nil*. The case is different, however, with regard to beetroot. The material of the root is of a complex character, and the solid residue of the extraction of the juice is the well-known beetroot pulp, a material of great value for cattle feeding. The weight of the pulp is about 18 per cent. of that of the beet; the yield of pulp from an acre of land is therefore about 72 cwts.

"The total produce of an acre of beet may therefore be considered equivalent to two distinct crops, say a crop of sugar-cane from somewhat more than half an acre of a West Indian plantation, and a crop of mangel-wurzel from somewhat less than half an acre of European farm land growing mangel. It is obvious that the cultivation of beet must pay therefore in a similar ratio as the two branches of agriculture are remunerative in their respective districts; but this is not all. The raw sugar once obtained from the soil is of a higher value in Europe than in the cane-growing colonies. The sugar requires extracting, boiling down, and refining, and for all these operations the cheap coal, abundant supply of intelligent labour, modern machinery, and cheap capital give a marked and decisive advantage to European industry, as compared with that of the colonies. The money value of a ton of green sugar held in the cells of beetroot is, when delivered at sugar works in Europe, considerably higher than the value of a ton of green sugar contained in the cane delivered in the factory of a West Indian sugar manufacturer. These are some of the principal elements which enable beetroot cultivation in Europe, within certain limits, to compete with advantage against the sugar manufacture of colonial cane plantations. In reviewing the different advantages and disadvantages of beetroot cultivation, as compared with cane cultivation, we have purposely avoided raising the question of yield from a given weight of the plant. In this respect the present methods of cane extraction are sadly behind those applied to the beetroot. The best sugar mills at present hardly reach as high a yield as 70 per cent. of juice on the weight of the cane, leaving fully 20 per cent. of juice in the cane trash. This represents an extraction of 77 per cent. of the sugar actually contained in the cane. From beetroot the hydraulic press extracts about 94 per cent. of the saccharine matter contained in the beet, and M. Robert's beautiful process of diffusion comes nearer to perfection.

"It is probable, however, that before long the diffusion process will find its way into the cane-growing colonies in a more extensive manner than has been hitherto the case, and will remove the disadvantages of insufficient yield. The competition between sugar-cane and beetroot will then be upon a more advantageous basis, so far as cane is concerned, but it will still leave a wide field open to the competition of beetroot in Europe."

The *Production* of beet sugar in France in kilogrammes, according to the official returns, has been as follows:

	Kilos.		Kilos.
1840	26,939,857	1865	209,648,000
1855	67,709,000	1870	277,731,000
1860	108,782,000	1874	431,913,000

In 1871, only 79,666 tons were exported; in 1874, 185,124 tons.

According to the French official returns, in 1875 the importations of sugar into France were:

	Kilos.
Raw sugar from the French colonies	66,002,000
Raw sugar from foreign countries	115,794,748
White sugar from French colonies	37,077,331
„ „ foreign countries	702,157

The general exports of refined sugars from France were in

	Kilos.
1873	153,643,032
1874	185,643,032
1875	215,671,403

The shipments to England were returned at, for

	Kilos.		Kilos.
1873	54,818,208	1875	90,489,660
1874	70,413,070	1876	99,111,936

In 1852 the yield of beetroot was 32,000,000 cwts.; in 1862, 44,000,000 cwts.; in 1872 it was 118,183,758 cwts., valued at 2 fr. 15 c. the cwt., making a total value for the raw material of about 10,150,000*l.* The duty paid on beet sugar in France was, in

	Francs.
1860	37,606,000
1870	54,953,000
1874	105,437,000

Progress of sugar *Consumption* in France, distinguishing the foreign or cane sugar from the home production of beet:

Year.	Cane Sugar.	Beet.
	kilos.	kilos.
1870	95,805,210	192,411,885
1871	79,688,738	145,707,349
1872	90,678,552	166,062,460
1873	95,208,542	176,193,577
1874	77,113,591	257,943,198
Total	438,494,633	938,313,469
Average	87,298,925	187,663,693

In the Zollverein the progress of beetroot sugar manufacture is shown by the following figures. In 1863 there were but 253 sugar works; in 1873, 328; and the quantity of roots delivered to the manufacturers has risen in the same period from 19,955,760 cwts. to 31,815,590 cwts. About 12½ cwts. of roots are required to make 1 cwt. of raw sugar.

GLUCOSE, OR STARCH SUGAR.

There is another description of sugar now manufactured largely, which has to be taken into consideration by the sugar planters, as it is used a good deal in brewing, by confectioners and others, and that is glucose or sugar made from potato and other starch. The quantity of starch used in Germany in 1873 for this purpose amounted to 885,000 cwts., of which 561,000 was liquid starch, and the rest dry. There were fifty works, and those made the following quantities of sugar:

	Cwts.
1. Solid glucose	202,610
2. Molasses or syrup	295,658
3. Coloured starch	28,995
Total	527,263

The price for the solid sugars was 24 fr. 12 c., for molasses 22 fr. 62 c., for the coloured sugars 26 fr. 25 c.

In the United States a large quantity of glucose is made from maize. Those who are interested in the chemical manufacture of this product will find full details given in my 'Journal of Applied Science,' vol. i. p. 181, and vol. iv. p. 38.

The cultivation of potatoes, for the purpose of obtaining their starch, covers a large extent of territory on the Continent. The method pursued in nearly all of the refineries is identical. The wet starch is first put in a large mash-tub, where, under constant stirring for an hour, it is entirely dissolved in water and dilute acid. From the mash-tub it is run in vats, where it can be boiled by steam; here it remains if for sugar four or five hours, for syrup two or three hours. It is then put into the neutralizing tanks, to be treated with carbonate of lime, and left until the sediment, chiefly composed of gypsum, has settled—this usually requires six hours. The sweet liquid thus obtained is evaporated in vacuum pans, filtered, and left to crystallize, if sugar is to be made, or is else manufactured into syrup. The great increase in the vine-growing districts of America has occasioned an enlarged demand for glucose, and the manufacture of this article appears destined to assume very large proportions in the United States, where Indian corn can be obtained in unlimited quantity at a very low price.

SORGHUM SUGAR.

Attempts have been made from time to time to introduce and extend the cultivation for sugar of a species of millet or sweet cane, the *Sorghum saccharatum*, Pers., *Andropogon saccharatus*, Roxb. This grass, allied to the *Sorghum vulgare*, or Dhurra plant of North Africa and the Guinea corn of the West Indies, is grown in the north of China for the extraction of sugar. In New South Wales it has been found to stand frost better than the sugar-cane proper, and is little affected by floods. It comes to maturity in five months, and therefore may be employed as an interval crop, alternating with sugar-cane, and keeping the sugar mills going. In 1868 there were 296 acres planted with sorghum imphee in various districts, but in 1872 this was reduced to 32 acres. Present experiments lead the growers to expect from $1\frac{3}{4}$ to 2 tons of sugar to the acre. When not grown for sugar, the plant yields abundance of valuable food for cattle, at the rate of 30 to 40 tons of cane per acre.

In France M. Vilmoren states that it is capable of yielding on an average, from an acre of land, 26,000 lbs. of juice, containing from 10 to 13 per cent. of sugar; and that this is more than the average yield of the sugar beet. It is alleged, however, that the plant is adapted to only a few parts of the south of France.

Mr. Leonard Wray asserts that some of the varieties of Sorghum which he introduced from Natal gave 30 cwts. of sugar per acre, that it has yielded from a poor handmill 68 per cent. of juice, containing 15 per cent. of sugar. Where the sugar-cane has yielded 30 it has given 25, but then there is often a second and a third crop to be obtained within the year. This plant can in many localities be advantageously utilized for preparing treacle. For this purpose the sap is expressed at the time of flowering and simply evaporated; the yield is about 100 gallons from the acre.

Since 1855 its cultivation has steadily increased in many countries. It is grown in France and Algeria for alcohol chiefly, in Italy for its syrup in wine making.

In the North-western States of America where it flourishes, there were in 1864, 366,670 acres under sorghum, and sorghum sugar was selling at Chicago at 4½*d.* per lb. In 1860 nearly seven millions of gallons of sorghum treacle were produced in the United States. This had increased in 1870 to 16,050,089 gallons, and 24 hogsheads of sorghum sugar were made.

In the state of Kansas there were 23,026 acres under sorghum in 1875. The produce was 2,542,512 gallons of syrup.

Sorghum is cultivated to a considerable extent in the Ohio belt of counties, Western Virginia. It is used entirely for the manufacture of molasses for home consumption, where the locality has been more or less denuded of its maple trees. Most persons prefer the syrup prepared from the maple to the molasses from sorghum, as the latter has too commonly from imperfect ripening an acid taste. This cane succeeds well, and in good soil, when well matured, yields from 200 to 300 gallons per acre. The total production for the state of West Virginia was given in 1876 at 780,829 gallons.*

The chief merit of the sorghum is, however, as a forage plant, and its value for feeding stock cannot be surpassed by any other crop, since a greater amount of nutritious fodder can be obtained by it in a shorter time, within a given space, and more cheaply. It cannot be propagated by cuttings like the cane, but ratoons when the stems are cut down.

Those interested in the culture of this plant will find a good practical and chemical description in a work by Mr. F. L. Stewart, of Philadelphia, 'Sorghum and its Products,' 1867. In the 'Indian Agriculturist' of Calcutta, vol. i. p. 222 (1876) there is an account of its value as a forage plant; and further useful details will be found in the 'Bulletin of the Society of Acclimatization,' Paris, vols. iii. v. vi. and vii.

* 'Resources of West Virginia,' by Professor Maury, 1876.

SECTION II.

THE USEFUL PALMS, AND THEIR ECONOMIC PRODUCTS.

The number of known species of palms is over one thousand. Although chiefly natives of tropical regions, we may learn from Von Martius's great work that there are many extra-tropical members of this princely order which were known to him in 1850, when that masterly work was concluded. Several of the latter furnish useful products to commerce, such as the dwarf palm (*Chamærops humilis*).

There is scarcely any family of trees that are more generally useful in tropical regions than the palm tribe. Many a single member of this family has numerous special and important economic uses, rendering it invaluable to the natives. Some palms are very widely diffused over the globe, others are at present restricted to certain countries, but there is no reason to doubt that by a little careful management several of the most useful could be introduced and acclimatized in other quarters. Numerous races depend almost entirely upon the palms for many important products; wood and leaves for habitations, bark and leaves for fabrics and cordage, buds and fruit for food, and sap for sugar and spirit. With the view of diffusing practical information concerning their growth and useful products, I give such information concerning the principal palms as I have been able to collect.

The Cocoanut Palm (*Cocos nucifera*) is one of the most useful trees of tropical regions; all its parts are utilized, but its fruit is the most important product. In preparing plantations, the nuts for sprouting should be chosen from those fully ripe, having full, large eyes, and such as have been gathered from trees past the middle age—not, however, from aged ones—and from clusters containing few fruits. These, if carefully planted, are said to ensure the timely sprouting and steady growth of the plant as well as future luxuriance, longevity, and unintermitting fruitfulness. Such nuts as are gathered from February to May are generally the richest in oleaginous properties, and hence should be preferred. Nuts taken from older trees have the eyes small, and the sprout will in consequence be thin, weak, and disproportionately long; and the future tree, if able to bear fruit, irregular and deficient in produce. Those nuts which may be taken from trees of immature age will, if planted, rot away at the eye;

and the plants, if any be successfully reared, on transplanting will grow very rapidly and acquire bulk, but the fruit will drop before the kernel acquires consistency, the root stalks break, and the trees entirely fail before mid age.

The nuts for seed should not, on being gathered, be allowed to fall to the earth, but be lowered in a basket or fastened to a rope. If let fall, the polished cover to the fibres will be injured and collect damp about the nut, or the shell inside may be cracked, and the water disturbed. These are fatal injuries, or even if the plants still grow, they will on being transplanted not make fresh shoots, but produce weak trees having their fronds constantly drying up, nuts rarely matured, and often are even without kernel in those which appear perfect. If the nuts are allowed to dry on the tree before gathering, the plants are liable to be lost, not having water inside to cherish the growth of the sprout (before the actual roots shoot into the soil).

The seed nuts, after being gathered, should be carefully kept for not less than a month before they are planted (in order that some of the moisture be absorbed, and the hard outer skin or rind be rendered dry and waterproof). If the seed be immediately planted, the outer pod with the containing fibres will rot, and there will be no sprout. The eye will rot, or be a long time sending out the shoot, which will inevitably produce a weak, profitless plant. On the other hand, should a longer time intervene between gathering and planting seed than prescribed, the capsule of the fruit will fall off, and consequently the exposure to damp and rain will affect the eyes; there will then be no plants, or very indifferent ones. The seeds should be planted on an elevated plot or bed of land, where water will not stagnate. The plants will be strong if the nuts are placed on the hard sandy court-yard of the planter's dwelling house; or if placed in flower-pots with good soil and sand in them, no damage will be done by white ants, and very few will fail to germinate. If, however, they are placed on a hard soil which the roots cannot penetrate, and exposed to the sun, the water inside will dry up, damage will be done by ants, and those few that throw out shoots will be weak, and on transplanting, the roots will break and the sprouts be severed from the nuts. If, on the other hand, they are deposited on uneven ground or too moist soils, both the fibrous covering and the eyes will rot, and the seeds come to grief.

Nurseries should be somewhat exposed to the influence of the sun, though not too much heat; plants thus grown will even, though deficient in stature, be strong, and when transplanted will not fail nor suffer from heat. Should plants, however, have but little sun, no great harm is done; but if they be grown entirely under cover, insects will infest them, the stems will be long, tapering, and weak, the fronds will be often unable to sustain their own weight, and when transplanted, each successive hot season will affect the trees.

The planting of the nuts should take place from January to April, and also in August, provided the rains are not heavy, and then the planter may expect fruitful trees to be produced when grown; but nurseries formed during the heavy monsoon will generally fail, or produce trees which will yield small nuts. Too much moisture of every kind is injurious to plants.

The seed beds, where the plants are to be nursed, should be well dug to about two feet deep, and all stones, roots of trees, &c., removed; the cocoanuts should then be laid along flat on their side in the soil, in such a way that all but two inches of them be buried, the interval between the nuts being about a foot at least. Should the spaces be too great, the plants will have too many roots, and the sun will not be shaded from them by the fronds, which will be shown by the pale green of the leaf. But should the nuts be placed too close to each other, the young shoots will be then meagre and quickly spindle up; the roots too will twist together and be broken when the plants are taken up to be transplanted. Though manuring is of little use before they have taken root, yet in order to prevent white ants, &c., a mixture of salt and ashes, or ashes alone, should be put into the trenches made in the beds for receiving the cocoanut. Sand alone, or salt with ashes, sand, and paddy husk, form another mixture to be placed between the earth of the bed and the nuts, which latter should be covered with the compost. Black salt, ashes made from the cocoanut husk, and fronds with sea sand, is the best mixture. If this precaution be not used, many of the nuts will be injured and the plants grow pale and weak.

Some, however, are of opinion that these composts should not be used in the nursery, as they tend to force the plant, which, when transplanted, will then decline, but that the application is best after transplanting; and that in the nursery beds, black salt dissolved in water is sufficient to keep off white ants; early manuring, in their opinion, lessening its after effects.

The next care is to water the nursery, which should be done only every second or fourth day according to the dryness of the weather, simply keeping the soil moist; for if the ground is too damp, rot is engendered, but if too dry the cocoanut water inside the nuts will evaporate and the shoots dry up. A careful observance of these instructions will cause the shoots to sprout generally within six months from the time they are placed in the ground.

Some place those cocoanuts intended for seed, tied together in pairs by a strip of the covering on the cadjan, over the roof tree of the dwelling house, or on branches of jack trees, freely exposing them to sun, dew, and rain. But when the shoots are a few inches long, they are taken down and placed in a nursery till transplanted. Such plants are seldom lost, and make no great delay in yielding fruit. Once the tender shoots begin to appear, no great care is necessary for manuring, but the greatest attention should be given that no cattle or insect, &c., injure the shoot itself, else the slightest blow or abrasion will cause a want of vigour; but on the other hand, some suppose that unless either ashes alone, or mixed with salt and sand, or these separately, be applied to the plants every month, a want of colour will be visible in the opening leaves, or ants and other destructive insects will be fostered. Plants are removed for transplanting generally in the second or third month, sometimes even in the ninth month, but rarely so late as the fifth month; but in ordinary cases, if they be transplanted six months after the shoot makes its first appearance, their safe growth and vigour may be looked for. In low-lying lands, however, it is preferable to have plants of one year's growth, though they are more difficult in managing. The only benefit to be expected in transplanting older plants is that the planter looks for an earlier return, and in planting these on the banks of rivers or low lands formed from the wash of the monsoons, the crops will not be deficient. Plants left too long in the nursery and then removed are apt to have the fibrous supports at the foot of the fronds decay, so that these hang down, wither, and dry up, and new fronds and leaves do not make their appearance for four or more months, and these generally die prematurely. Some of the planters give it as their opinion that the transplanting may be effected from January to May, and again in August, October, and November (i. e. omitting the wet months). Perhaps, however, the general rule should be, that in low, damp situations, planting may be effected during the hot season, in salt marshes and on hill-sides during the monsoon. It is said that those trees planted from January to June will yield fruit for eight months in the year, and those planted in October for six months, while those planted in June and July in the heavy rains will scarcely be fruitful at all. Different places and soils require different seasons for this operation, to be learned only from experience or observation of neighbouring gardens. Soils suitable for a cocoanut plantation are variously described as below, particularly observing that stony grounds, or those overlying rocky foundations, are to be avoided:

1. Soils mixed with sand, either dark-coloured or river-washed.
2. Where sand is mixed with clay, ferruginous earth, or black mould.
3. Clayey soils where the under strata consist of sand.
4. Sand and clay, even when mixed with gravel and pebbles.
5. The sea-shore banks of backwaters, rivers, tanks, and paddy-fields.
6. Alluvium of rivers and backwaters, provided a yard and a half of land is to be generally seen above water level.
7. Marshy land even in brackish soils (but not where salt is formed in crystals by evaporation).
8. All level lands exposed to the sea breeze where the soil is good, as the valleys between hills, tanks, and ditches, which have been filled up.
9. Lastly, even the floors of ruined houses well worked up, and any places much frequented by cattle and human beings, on account of the ashes and salts of ammonia from the urine, &c., deposited day by day in the soil.

Sunlight is most beneficial to the cocoanut tree; it increases the number of successive fronds and the crops of fruit, while if much shade is caused by trees of other kinds, there is a tendency in the lower part of the cocoanut stem to thicken, while the upper part grows thin and attenuated, with fronds at considerable intervals and little fruit.

Exposure to regular breezes is also beneficial, for the constant movements of the tree tops have a tendency to strengthen and enliven the whole tree. The difference is easily seen by comparison with those in sheltered positions. The holes or pits into which the plants are to be transplanted, should be severally 12 yards distant on back-waters, but where a deep alluvial soil is found, 8 or 10 yards are enough. These distances are necessary, otherwise the trees not having room to expand their tops, repel each other and grow in diagonal positions, and are easily blown down or overset. Too close a neighbourhood also tends to draw up the trees into long feeble stems, shoots, fronds, and small fruit. In a level, loose soil, the hole should be a cube, of a yard and a half, on hill-sides 2 to 2½ yards, but in low grounds half or three-quarters of a yard deep with one yard square is sufficient. If the pits are not wide and sufficiently deep, the roots soon appear above the surface of the surrounding ground, and the hold upon the earth is weak, nor is sufficient nourishment obtained, and the monsoon storms quickly overturn the tree where the soil is marshy, though the hole need only be large enough to contain the seed and roots, and in a cold clayed ground, the holes are filled with sand and the plant deposited in it. Again, in low marshes, banks or terraces should be thrown up and consolidated previous to planting. If in any of these cases plants of two or three years old are used, the pits must be at least 2½ yards every way. The pits should be dug from two to six months before planting, and then prepared first by having heaps of fuel and weeds burned in them, and subsequently by manuring. The fresh earth is supposed to be full of ants and worms, and itself injurious to the new plant, and to hinder growth; on the contrary, there are some planters who deny this statement and think the burning and manure not to be necessary. In low situated plantations new holes may be preferred and quick planting. No time should be lost in the removal from the nursery to the pits, indeed the day should not pass,—in which case within the month new roots and fronds may be looked for; but where this proves impracticable, if the plants are kept cool and in shade, four to six or eight days have been known to intervene, but followed by very great loss in the number of successful trees. Inside the pits smaller ones should be made and filled with salt and ashes mixed with mould, into which the young plants are to be planted, with the nuts just covered with this compost. Some shade must be afforded, and care taken that the plants be not shaken or removed from their first position, and occasionally water should be sprinkled over them. The compost must be used when there is but a small proportion of sand in the soil. Ashes will suffice on the sea-shore, and sand in marshy and loamy soils. The roots of a plant under a year which are broken (but according to many planters all found on the nuts in the nursery) should have their ends cut, as new ones are supposed to be hastened by the process. Turmeric and arrowroot are often planted in the same pits with the cocoanut, as they are supposed in some way to repel white ants, rats, &c. After the plants are in, little pandals or sheds with twigs and branches should be made to protect them for the next six months, from too great heat of noon-day sun; this prevents withering of the leaves or any check to the growth of the roots.

On dry soils the plants ought to be watered twice a day for the first month, once a day will suffice for the next five, or until the monsoon showers come on, and once every two or three days during the dry seasons of three following years, according to circumstances. On hill-sides it is usual to water during the hot weather, even till the first buds appear; and on sandy plains on the sea-coast, when the trees are in full bearing, eight or ten feet of bamboo (with the divisions at the joints broken to form the pipe) is often driven down by the side of the cocoanut tree, and cool water from weed-covered tanks is poured down to refresh the roots and lower soil. The soil round the young plant is often kept damp by a bed of leaves, particularly such as will not be eaten by white ants. If the soil is naturally poor or of a hungry nature, salt, ashes, paddy husks, goats' dung, and dry manures may be applied for the first year, but in after seasons, fresh ashes, decayed fish, carrion, or other refuse, is preferable, also oil-cake.

If the soil at the foot become too rich, the larva of a beetle, a large grub with a reddish-brown head, soon finds its way to the roots and into the stem, hence though the foot of the tree may enlarge, the stem does not develop itself, the new leaf-spike at the crown becomes yellow, fades, and is not replaced, nor does it open out into the usual frond, and in two or three months, sometimes a little longer, the whole tree top is affected and drops down piecemeal to the ground. It would appear that fear of this evil is the reason why ashes alone are recommended by so many cultivators.

As soon as the new fronds have divided into the long side leaflets or lost their connected form, which is at the end of the first year, the soil should be dug up and ashes applied about once a month. When the tree is two years old, and henceforward at the commencement of every monsoon in May and June, the whole of the soil, a yard or two round the stem, must be opened out and ashes with dry manure applied and left open to the air; and in October, when the rains have ceased, this freshened earth should be replaced and levelled. As the tree gets older and the depression at the foot is gradually filled up, it may not in after years be necessary to dig so deep as for the earlier growths. If the opening out of the roots and manuring be thus annually attended to, the tendency to form a sort of bulb on the surface and throw roots above the soil will be checked; the old worn-out rootlets are cut away, strong roots from other trees and all weeds are removed, and the process acts both as "a wintering and pruning," as recommended by scientific gardeners in Europe to productions of their own gardens. Cattle are most destructive the first two years, in eating off the ends of the fronds and stripping the leaflets; if the plants suffer often in this way, the growth is entirely stopped; sometimes the new leaf-spike is pulled out, and the tree dies. Should the heart of the stem and top not be injured, the tree will still remain an unsightly object, and often entirely profitless and barren.

From the time that the leaflets become fully developed and distinct from each other, till the period that the spathes (or covers to the flower) make their appearance, the fronds should be shaken and weighed or pressed downwards each month, so as to keep them from each other and make them spread, and careful examination should be made lest rats, beetles, or worms have made nests upon the head, or bored into the cabbage heart of the palm, and this often. Some planters sprinkle ashes and salt about the spike shoots to keep insects away. The dried fronds, old spathes, fruit and blossom stalks, and ragged fibres should be removed at stated periods of perhaps a month, or as often as the nuts may hereafter be gathered. The application of salt and ashes to the tree tops is usual at least in March and October to keep off the swarms of insects, particularly red ants, which live upon the juices of the tree and render them fruitless.

The cocoanut tree is at all periods of its life endangered by the attacks of enemies. While one beetle bores into the tender shooting leaf, and lays its eggs there, to be hatched into grubs which will eat their way in all directions, another will bore round holes into the stem itself and live there; rats climb up and make their nests in the hollows of the branching fronds, and eat the cabbage itself or feast upon the young kernels. The common flying fox, or rousette, (*Pteropus*) gnaws round holes through husk and shell of the mature cocoanut, and will attack the young cocoanut, biting away large pieces from the tender part under the capsule, and, burying its head in the nut, will revel in the sweets within. The flying squirrel (*Pteromys*) will also make his abode in some cocoanut topes near woods or forest trees, and at nightfall attack the nuts, and two or three dozen may be picked up every morning with the marks of his teeth upon them, or partly destroyed. The common striped palm squirrel is also sometimes found destroying the nuts and blossom—while red ants and parrots attack the blossoms only. The most effective method of obviating these evils is to shoot the flying foxes and squirrels by moonlight, to use arsenic with grated cocoanut pulp, or pounded glass, oil, and black sugar mixed in cocoanut shells, left in the tree tops. In one plantation of about 15,000 trees, six to seven hundred rats were taken month after month in trap falls. The red ant's nest should be sought out and destroyed. A large wasp will attack the very small nut, taking it for the material of its nest. Besides using ashes sprinkled often with salt between the fronds, some natives place onions, garlic, or even asafœtida and fenugreek there, thinking the scent will keep off beetles and grubs. When the spathe is cut for drawing toddy, the frequent visits of the men will tend to keep other intruders away, but the smell of the toddy is said to invite rats and wild cats. If any of the extracted juice falls from the receiving vessel on to the young spike or leaf, it is said to cause it to decay by attracting insects to bore into the fronds. Grass should be kept down by feeding off with goats and cattle. In marshy lands cattle are apt to make deep tracks and break down the margins of the terraces, hence goats or calves only are allowed; and the undergrowth is to be annually cut for the repairs of paddy fields, and this is another source of profit.

Planting jack, mango, tamarind, punna, coffee, and other trees, as is often done, close to the cocoanut palm, is thought to be detrimental, as is also allowing the pepper and betel vines to climb the tree, or even the sowing of maize, gram, or any of the dry pulses under the shade.

But areca-nut trees may be planted and all other palms, and the ground may be dug, and various kinds of yams and tuberous roots cultivated with advantage.

If the instructions given are followed, distinct leaflets will begin to show themselves at the end of the first year, and be completed at the end of the second, on each frond, which will be 3 inches thick in the stem or leaf stalk next the parent trunk.

In the third year the bottom of the frond will assume somewhat the form of a horse-shoe where it clasps the main tree; and in the fourth year the trunk of the tree will appear slightly above ground, and is then called "a cocoanut tree with the elephant's foot," and will have not less than twelve fronds. About the fifth year the trunk is fully manifested, and there should be about twenty to twenty-four fronds; when a luxuriant well-grown tree begins to bear fruit, there will be no less than thirty-six of these branches or fronds. If a tree receives much attention, and is close to a hut or stall for cattle, these processes may be hastened, but on a rocky hill-side they will be much delayed, two or more years being required in addition to each stage.

Spathes (chotta) or shoots, from which eventually the flowers are to appear, will begin to make their appearance in the sixth year, but some kinds of cocoa palm, as the Nicobar, even before this; but on other soils seven to fifteen years may pass without the slighest appearance of the spathes. The height of the stems at this important period, in some kinds of tree usually, and in all when influenced by the soil, will be only a foot or two above the ground; while in other places the stem may be 16 feet high. For the first few months these flower shoots are deceptive and only dry up, but within the year begin to retain their blossoms and bear a few fruit, yielding abundantly in three or four years after their first appearance.

In six months from blossoming the nuts will have the kernel begin to solidify, and in a year the fruit is fully ripe—even sooner if the season is very hot and dry.

The produce of the tree in full health and properly tended is much dependent on soil and climate. The average may be put down at 120 nuts in the twelve months, while in a low and sandy soil it will amount to 200, and when planted in gravel and laterite foundations not 60; the most productive months are from January to June, that is for ripe nuts, the heat bringing them quickly to maturity.

It is calculated that where the roots of the trees can reach water, and the soil is alluvial, the trees will bear from eight to ten bunches or crops of fruit; in other and higher lands not more than six.

One hundred cocoanuts perfectly grown and carefully dried will, it is generally calculated, yield when pressed ten to thirteen edangalies (each containing 92 cubic inches) of oil (40 nuts to an imperial gallon). Inferior cocoanuts will vary from three to nine edangalies; fruit taken from trees on salt marshes have the least oil.

When the trees begin to show the fruit-shoot, or spathe, it is often thought advisable to extract the juices for toddy, and not allow the blossoms to be grown; but this only in the monsoon, and for that season only. This is supposed to render the future fruit bunches more numerous and give the sap a tendency to flow. In some places trees are never allowed to bear fruit, but toddy is always extracted.

Drawing toddy for a few months is thought to check the habit in some trees of dropping immature fruit, and again of preventing injurious animals and insects from infesting plantations, the frequent visits of the men to the trees being a check to their forming nests and otherwise remaining hid in the tree tops.

Overdrawing of toddy will cause the luxuriant trees to dwindle away and acquire very sickly habits, and may make them barren; hence, if a tree is allowed to be drawn for toddy for six months, this should not be repeated till another five years at least have elapsed, otherwise they become exhausted and short-lived. Ants, bees, and other creatures are attracted by the sweet toddy: not only should the vessel be protected from them, but the liquid, as before noticed, should not be spilled over the young leaves.

While certain of the fruit-shoots are cut for toddy the others will still produce cocoanuts, as well as those previously developed; but if three or four be used for this purpose, the others will dry away or be of very little use. Even when a spathe is partly used for toddy and left, provided the part containing the buds remains undestroyed, a few fruit may be produced on that stalk.

Five parras, of ten edangalies each, of good arrack may be made from a single tree devoted to this purpose during a single year; but some very good trees will give, though rarely, eight to ten parras.

Gathering some of the tender cocoanuts from the earlier bunches will develop the succeeding bunches greatly, and strengthen the whole tree very materially. It is not, however, recommended to cut the fruit stems or stalks out before they are matured and dry, as it causes the tree to bleed and lose its most valuable juices; hence, in order to prevent the possibility of injury to the tree, owners should permit none but mature fruit to be taken.

The number of fronds which dry and fall off from a tree is eight or ten in the course of the year, principally in the hot season. It is usual to cut these off, but if done too early those next the one cut are affected and fade; hence only those turning brown should be removed, and leaving a small portion of the foot stalk on the tree. It must be remembered that the drooping leaves are intended to protect the tree stem from the burning sun.

Thirty species of the cocoanut are described and named in the East as in the subjoined list; but cultivation and incidental natural causes have much to do with this diversity, and in a few cases these are but imaginary distinctions:

Names.	Description.
1. The green cocoanut ..	The fruit and fronds are of a bright green.
2. The black or dark ..	These are of a dark green.
3. The native	The fruit has a yellow tinge.
4. (*a*) Goulpatra	This name is given to what is supposed to be the best kinds, one variety yellow and the other a light brown or light colour, and of beautiful form.
5. (*b*) Ditto	
6. The reddish cocoanut	The nut has a strong red tinge.
7. The red ditto	Is brighter than the last.
8. The crimson	Even the pulp and fresh fibres of the husk round the nut are pink, and the fronds are reddish.

Names.	Description.
9. The sunbright	The nut has a beautiful fading blush, the fruit being small in size, but numerous.
10. The white	The nut and fronds have a grey bloom.
11. The milky	The pulp is creamy and thick.
12. Oblong oval	The fruit is long, and the ridges well developed.
13. The Tanjore	The nut is long and pointed, with a large base.
14. The Oora	The nut is pointed at each end, and oblong.
15. The globular	The bunches contain many large round fruit.
16. Small round	Fruit more numerous, but also very round.
17. Minute cocoanut ..	A diminutive fruit, but made up by number.
18. The weighty cocoanut	Fruit few, but large and heavy, with thick kernel.
19. The heavy ditto ..	The eyes of the fruit are small, but the copra or dried kernel is very full of oil.
20. Male cocoanut	There is a peculiarity in the fronds, and the leaflets do not separate from each other.
21. Foreign cocoanut .. } 22. The island cocoanut .. }	Evidently from the Maldives; both the nut and fruit-stems reddish.
23. The Portuguese ..	The same as above.
24. Shanar or Ceylon ..	Nut large and red, fronds slightly bluish.
25. The Dutch	Fruit, &c., a red pale colour.
26. The Goa	Two fruits only on each bunch, and these dark green.
27. Jaffna cocoanut ..	Here again the fruit is large, but few in number.
28. Palamcotta	The fronds of this tree are pale yellow.
29. The ship cocoanut ..	Stem or trunk of the tree and leaves small, and all tinted with black spots as if blighted.
30. The Maldive	The covering of the fruit is of a whitish or washed-out blue.

The red and the black kinds are generally supposed to be the most fruitful, although with careful cultivation of any of the above described none need be disappointed in the returns, and this will be in proportion to the labour bestowed.

Trees growing in the most fertile soils will live for a century, others less favoured from sixty to eighty years only; the former will yield their fruit commencing at the tenth year, and with rare intervals continue until their sixtieth year, and then gradually decrease in fruitfulness till they decay.*

Although its real locality is bordered by the tropics, and the tree is an inhabitant of the coast regions, it grows in India up to Lucknow, 26° 50′ N., and is cultivated far in the interior of the peninsula, yet in the first case it does not fruit, and in the second it becomes stunted and languishes. Its tall trunk often attains a height of 90 feet, with a diameter of 3 feet at the base, and 1 foot at the summit. In favourable localities each peduncle will bear from five to fifteen nuts, and a tree in full vigour may have eight, ten, or a dozen of these peduncles flourishing in the course of five or six weeks, so that a tree can yield 80 to 100 nuts in the year. These ripen successively, and there may thus be seen at the same time flowers and fruits.

* 'Agricultural Gazette of India,' vol. iii.

From the fruit is obtained many articles of luxury and trade, thus, first, the husk. After the thick green external pellicle is stripped off the shell, it is placed to dry in the sun; this being fibrous is beat into a sort of hemp, and is known in this state by the name of *Coir*. It is spun into cables, ropes, and yarn of every dimension and size, from a single pack-thread to a cable for a first-rate man-of-war; and it is preferable for ship's use, as it is elastic and becomes as hard as iron when tarred and soaked in salt water, but it is more unwieldy for stowage than hemp rope. Large quantities of it are annually sent from Ceylon, Bombay, and parts of the Malabar and Coromandel coast.

The albumen, or kernel, produces oil by boiling it in water, after it has been pounded or rasped. Grated, a sweet milk, used as a substitute for cow's or goat's milk, is produced, by various preparations. Jelly, copra, butter, candles, and sugar are produced, and, by fermentation, vinegar. The oil it yields is used at table, and is equal in quality to oil of almonds when fresh, but it soon becomes rancid, and in this state is only used locally by painters, or to burn in lamps. The natives of India use it in quantities for anointing their persons; it gives a fine gloss to the skin. A soap is also manufactured from it, which, with the exception of one prepared from the coratoe (*Agave Americana*), and discovered by Dr. Robinson about eighty years ago, is the only one known soluble in salt water.

The kernel is used as a fattening substance in the dairy, aviary, &c.; and there is not any description of animal, graminivorous, carnivorous, or herbivorous, that does not feed on it with avidity. It is wholesome food for man, beast, and bird.

Medicinal Properties.—The oil is given in plethora and as a vermifuge in Jamaica. It is given while fasting, warmed and with a little sugar, in flux. An emulsion of the oil and kernel is prescribed in coughs and pulmonary diseases generally. Pound the kernel with water, place it to settle, and skim off the cream. It is preferable to the expressed oil.* The outside, scraping of the husk, and branches applied to ulcers will cleanse and heal them rapidly if soaked in proof rum; the efficacy of this application was proved by the cure of two bad ulcers occasioned by the bite of a negro's teeth. The young roots boiled with ginger and salt are efficacious in fevers, same as the bamboo.† In the Maldives, where it is indigenous, the cocoanut oil is esteemed a powerful antidote against the bite of poisonous reptiles; indeed in such cases most oils are.

Its chemical properties are as follows: The milk of the cocoanut effervesces with an acid extract of that plant, and the acid then precipitates in a greyish hue, which becomes of a rich violet colour by the addition of a fixed alkali. It is with this that most cottons are dyed. This emulsion mixed with quicklime causes the alkali to become rose-coloured. Dyers use this milk with great advantage in dyeing black linens, silks, and cotton stuffs.

The nut when it is gathered young contains an opaline water, which is quite clear if filtered, and is utilized for drinking. In countries where potable water is not obtained, only the milk or water

* Dancer. † Hort. Jamaic.

of the cocoanut is drunk; it is an agreeable, nutritive, and healthy beverage. The gelatinous albumen when young is easily detached from the shell with a spoon, and may be eaten with satisfaction. It is a delicate food, which is too little appreciated by Europeans, as it contains all the constituents of wholesome nourishment. As it ripens the albumen hardens and becomes almost horny, and the oil increases, although in this state it is still edible, but indigestible, and only eaten associated with other food. The following shows the composition of a young cocoanut and a ripe cocoanut:

	Young Nut.	Ripe Nut.
Husk and shell	1·760	816
Kernel	0·090	434
Water	0·300	250
Total	2·150	1·500

The percentage of the albuminous and alimentary portions of the young and mature fruit is as follows, according to the analysis of Mr. J. Lepine, of Pondicherry:

Water.	Young Nut.	Ripe Nut.
Sugar	1·40	1·64
Gum	0·47	0·26
Phosphate of lime	0·05	0·06
Chloride of sodium	0·09	0·10
Acetic acid	0·06	..
Pectic acid	..	0·08
Acetate of lime and potash	0·31	0·33
Albumen	..	0·16
Water	97·62	97·47
Albumen.		
Sugar	1·00	0·48
Gum	0·33	0·71
Albumen	1·46	0·30
Oil	2·31	30·00
Cellulose	4·40	14·41
Potash and other salts	0·12	1·10
Pectine	0·04	..
Water	90·34	53·00

Cocoanut Oil.—Copra or copperah, the dry albuminous pulp, contains 54·3 per cent. of oil; dried at 100° it yields 66 per cent. This oil, which is the most important product, is prepared in various ways. If it is intended for perfumery use, and is required colourless, the following process is employed. The kernel is plunged in water and boiled for a few minutes, then taken out and grated and placed in the oil press; the emulsion thus obtained is boiled until the oil rises to the surface. This process, however, is not cheap enough for the ordinary practice of commerce, and common rude oil mills are used. These cost about 10*l.*, and will last for five years. They are worked by a man, a boy, and two oxen; working eight hours a day they will operate on 130 lbs. of copra, from which they will obtain 41 litres.

The characteristics for determining the purity of the cocoanut oil are its points of congelation and density. It solidifies at 18°. Taking the mean of the three following averages, the weight may be easily ascertained:

Degrees.	Density.	Weight of Hectolitre.
		kilos.
25	0·9188	91·880
30	0·9150	91·500
35	0·9116	91·166

Vast quantities of the oil are burned in lamps throughout the whole Indian Archipelago and the Pacific Isles. A tumbler half filled with water has oil poured in to the brim. Two lighted sticks are the wicks, which burn brilliantly. Every native glories in a display of lamps in the house and about the grounds at the approach of night. When first taken out of the boiling pot the oil has a rich flavour, but soon becomes rancid. So copious is the supply, however, it can always be had fresh and sweet for the table. Like olive oil in Syria, it is butter, lard, or oil, according to circumstances, in cookery. Soap is made with it, lamps supplied, leather dressed, hair and skin anointed, and cosmetics are fabricated for beautifying the homely faces of women.

The following have been the imports of cocoanut oil into the United Kingdom in the last quarter of a century:

	Cwts.		Cwts.
1840	42,428	1859	184,758
1841	38,262	1860	194,309
1842	49,742	1861	274,992
1843	67,610	1862	170,485
1844	87,866	1863	320,180
1845	42,974	1864	375,218
1846	48,322	1865	190,228
1847	32,513	1866	110,046
1848	85,453	1867	124,314
1849	64,452	1868	194,752
1850	98,040	1869	264,365
1851	55,994	1870	198,602
1852	101,863	1871	190,492
1853	164,196	1872	433,883
1854	208,827	1873	266,798
1855	252,550	1874	137,374
1856	130,690	1875	219,925
1857	207,239	1876	199,431
1858	197,788		

Oil Machinery.—The manufacture of cocoanut oil may be very profitably combined with the preparation of the fibre in one factory.

The following machines and apparatus are necessary for producing the oil:

Improved circular cutting machines, for reducing the kernel to small thin slices or shavings.

Edge stone runners for grinding down the kernel to pulp.

Improved steam pans, fitted with agitators, so arranged that every part of the pulp or copra is thoroughly separated, and exposed to a temperature varying (according to operator's desire) from 120° to 180° Fahr., or higher if required. Valves, cocks, and all other suitable fittings for the discharge of pulp or copra.

Steam heater for receiving pulp from steam agitator.

Hydraulic presses for expressing the oil, specially designed for the purpose and of unusual strength, including plates and woollen bags and fibre mats, as may be required.

Pumps for presses, made in the most improved and superior manner, with all necessary safety and self-acting relief valves, cocks, and mountings, pressure gauge, &c. If required, one set of pumps and gearing may be arranged to work two or more presses.

Iron tanks for receiving the oil from the presses, of capacity to contain one day's make of oil. A gun-metal pump is employed for raising the contents to large settling tanks. These are generally made of cast iron, in plates of a convenient size, and properly prepared for re-erection, with bolts, nuts, washers, &c.

The settling tanks should be of sufficient capacity to contain four days' produce of oil from the presses, and fitted with the necessary gun-metal test cocks and glass gauges, draw-off cocks, and valves.

The following estimate of machinery, capable of producing about 250 gallons per day, is furnished by Messrs. Priestman Bros., of Hull. In calculating production, 1000 nuts will average 32 gallons of oil:

	£
Two improved disc cutting machines	58
Granite edge stone runners, with entablature, self-contained and complete	168
One improved steam pan, with stirrers and driving gear ..	50
Steam receiving pan	29
Two hydraulic presses, with double pumps, stop valves, and connections	380
Connecting pipes, or oil conductors from presses to oil receiving or spell tanks	15
Oil receiving or spell tanks, to contain say 400 gallons each, with fittings	36
Gun-metal lift and force pump, for raising oil to settling or storing tank	20
Large cast-iron storing tank, to contain 1000 gallons, with gun-metal cocks complete	86
Ten horse-power horizontal steam engine, of first-class make and finish, steam boiler, fitted with all mountings and furnace fittings complete, also steam and feed-water pipes and feed-water heater	330
Complete set of best shafting, with pulleys, plummer blocks, couplings and leather belting for the machines	80
Set of plates, mats, and bags for the hydraulic presses ..	60
Packing and delivery in London	50

If it is desired to erect a factory to manufacture both coir fibre and cocoanut oil, one engine can readily be adapted to work the whole of the machines. To drive the machines specified in the foregoing estimate, and also the coir-fibre machines, a 14 horse-power engine would be required for the combined arrangement. The engine, complete with Cornish boiler and all necessary mountings, fittings, and connections, all of best materials and workmanship, would cost 450*l*. Packing and delivery in London, 10*l*.

The cocoanut shell furnishes cups, which, carved on and set in silver, are a great ornament. It also makes small baskets, cups, ladles, spoons, and other such domestic articles, and fanciful ornaments. By being burnt and pulverized, and prepared with other ingredients, it produces blacking not inferior to Day and Martin's, lampblack, black paint, &c.

Cocoanut Fibre or Coir.—The fibrous husk of the cocoanut is not its least valuable product, and gives rise to a very large trade, both in the East and to Europe. At first it was only used in this country for stuffing mattresses and cushions, but its applications have been enlarged and its value greatly increased by mechanical processes; and in a small pamphlet, issued by Mr. Treloar more than twenty years ago, he stated that its natural capabilities having been brought out, coir has been found suited for the production of a variety of articles of great utility and elegance of workmanship, table mats, fancy baskets, and bonnets. Instead of being formed into rough cordage only, and mats made by hand, by means of ingeniously constructed machinery, the fibre is rendered sufficiently fine for the loom, and matting of different textures and coloured figures is produced, while a combination of wool in pleasing designs gives the richness and effect of hearthrugs and carpeting. Brushes and brooms for household and stable purposes, matting for sheepfolds, pheasantries, and poultry yards, church cushions and hassocks, hammocks, clothes lines, cordage of all sizes, and string for nurserymen and others; for tying up trees and other garden purposes; nose bags for horses, mats and bags for seed crushers, oil pressers and candle manufacturers, are only a few of the varied purposes to which the fibrous coating of the cocoanut is now applied.

When the landholder gets his nuts down from the tree, they are given over to be peeled. The peeling process is done in a very quick and dexterous manner by the natives. A crowbar, or a sharp-pointed piece of wood, is fixed erect on the ground, and the upright end serves to remove the husks; the charge for peeling off the husks is trifling. For breaking the nuts and drying the kernels, nothing is charged; but, according to the usage of the country, the breaker and preparer get the shells of the nuts. The husks, however, remain the property of the owner, and formerly used to be sold off for local consumption. But since coir yarn began to be so largely exported to England, it is seldom that the owners sell off husks as fuel, as they find that by burying them and then offering them for sale, they realise double the amount that they would when fresh. The best place for burying the husks is the river bank where there are strong currents. At ebb-tide large pits are dug, and the husks counted and thrown in; and before the flood commences, they are covered up with mud, leaves, &c., and made quite secure. When the monsoon sets in, and the freshes come down, the pits are under fresh water, and from husks so rotted, the best coloured fibre is made. The reddish stuff known in the market as Codangaloor fibre, is generally prepared from husks buried in places where the water is throughout the year saltish. The older the pits the better the quality of the fibre, and shrewd purchasers always bear this fact in mind when speculating in the article. Some years back, the husks used to be kept in the pits for more than a year, but now they are not kept above six to eight months, for as soon as it is believed that they are rotten enough to throw out the fibre when beaten, they are removed. If kept above fifteen months, however, they spoil, and the fibre obtained is generally of a bluish colour, and of thin, poor staple, which is unsaleable in England. The price of rotten husks during the last few years has greatly advanced, and has fluctuated between 7 to 10 Rs. per 1000. When a purchaser comes forward, the husks are either counted and delivered over, or, as is more usually done, the cadjan specifying the number buried in each pit is handed over and the bargain is supposed to be concluded. The stench emanating from the pits is often intolerable, and during the fibre season, travelling along the banks of the backwater is not a very pleasant thing. The purchaser hands over the husks to women, who beat out all the fibre with short heavy clubs; and as labour is very cheap in the interior, this process is not a very expensive one. They have to clear the fibre of all pith, wash it clean and expose it to be dried, and in a half-dried state it is bundled up and brought into market for sale. In Calicut and other ports on the Malabar coast, the fibre is prepared by a different process, and hence the very undesirable quality of the yarn of those places. In Cochin and Travancore the natives seem to be more alive to the importance of bringing the article to market in its best condition, as they find that it pays them to do so.

The constantly increasing demand for the prepared fibre is sufficient to induce many planters to cultivate largely the growth of the cocoanut.

The short, woody, and apparently intractable fibres lining the inside of the husk of the cocoanut constitute the material which Hindoo ingenuity had long since converted into excellent cordage. A quarter of a century ago this was its only use; now a large industry has been created in it for matmaking and brushmaking, and we now import into the United Kingdom coir fibre, yarn, and cordage to the collective value of about 170,000*l.*

In 1845 under 10,000 cwts. of coir rope and fibre of all kinds were shipped from Ceylon; in 1870 it had increased to 58,000 cwts.

The following figures give the shipments for a few years:

Year.	Coir Yarn.		Coir Rope.	
	Cwts.	£	Cwts.	£
1866	46,869	28,122	8,097	10,121
1867	42,949	26,039	6,242	7,803
1868	57,961	34,776	6,692	8,370
1869	59,489	35,687	6,183	7,730
1870	46,764	28,616	9,635	12,072

The pericarp of forty nuts furnishes about 6 lbs. of coir. There are several ways of stripping the fibre from the husk. One is by placing a stake or iron spike in the ground, and by striking the nut on the point the fibre is easily stripped. The tannin which this substance contains prevents the fibre from rotting. The fibre is rather difficult to twist, but coir yarn is made into ropes and forms the strongest, lightest, and most elastic cables for ships. Before the husk is put into water to steep it should be well beaten, for the purpose of loosening its texture, principally that of the outer surface, which is hard and compact, so that the water may pènetrate it with more ease. It is then left to steep for two or three days, and again beaten, until the separation is accomplished. Care should be taken that the husk is kept moist, because if allowed to become dry, the ligneous fecula or spongy pulp, which is found intermixed with the fibre, adheres still more strongly to it. In some islands and parts of the coast where there are no running streams, holes are dug in the sand below high-water mark, and the husk buried several days previous to being beat.

The separation of the husk is commonly done by tearing it off with the hands, aided by an axe. A simple application of the foot-power, used in the common turning-lathe or knife-grinding wheel, would enable one man to do the work at present the task of several. A double knife acting crosswise could be made to cut the nut and husk in two, and so prepare it for the extraction of the substance. Small, flat, pliant instruments would then easily extract the pulp from the shell of the nut, and leave it fit for the oil press.

About four days' maceration in fresh water is requisite. After this the husk must be beaten till the fibres separate, when it should be well washed, dried, and packed in pressed bales. For the purpose of beating it out, an instrument in the form of bars, somewhat in the form of a gridiron, should be used. It is obvious that this process might also be advantageously performed by machinery. One person can beat out with the hand, according to the age of the nut furnishing the husk, from 7 lbs. to 14 lbs. per day,—say on an average 10 lbs., but by the use of proper instruments his work might be increased fourfold.

Value of the imports of cordage and twine into the United Kingdom from Madras and Ceylon, chiefly coir:

Year.	Madras.	Ceylon.	Year.	Madras.	Ceylon.
	£	£		£	£
1866	81,397	67,418	1871	96,735	48,419
1867	73,005	60,100	1872	156,079	76,542
1868	76,187	67,929	1873	126,037	70,288
1869	113,462	64,126	1874	178,196	63,560
1870	106,338	52,263	1875	107,698	59,594

Machines.—The requisite machinery is simple in construction, and is easily worked by ordinary labourers. The following are required for the cleaning and preparation of the fibre, viz.:

Tanks for soaking the shells or husks, for "roller mill."

Roller mill for straightening the husks and preparing the fibre for the "breaking-down" machine. This is made on the most approved design, with fluted rollers, self-acting adjusting blocks, and screws, wheel gearing, driving pulleys, &c., the whole complete and supported in a massive cast-iron frame.

Breaking-down mill, of improved construction, the revolving drum accurately centred on shaft, and fitted with best selected steel "spikes" (so arranged that, if required, any number of these "spikes" may be easily removed, repaired, and replaced), "feed" and "fence" motion, with wheels and hopper gearings, brush fence, and driving pulleys complete, all mounted on substantial cast-iron frame.

"Willy" machine, designed and constructed for receiving the fibre from the "breaking-down mill." This machine separates the different qualities of the fibre, and removes all dust, shorts, and refuse, leaving clean fibre. The machine is made in a very substantial manner, is self-contained, fitted with all gearing complete, and mounted on strong cast-iron frame.

Hydraulic press, for baling coir fibre for shipment, of the most improved design, and fitted with pumps and gearing complete.

Shaftings, pulleys, plummer blocks, bolts, leather belting, &c.

The following will be the approximate cost delivered in London of the plant, to clean say 7000 to 8000 husks per day:

	£	s.
One crusher mill	32	0
Six breaking-down mills	185	0
One Willy machine	39	10
Superior hydraulic press, with double pumps and fittings	230	0
Shafting, belting, pulleys, &c.	70	0
Twelve combs, assorted	5	0
Eight horse-power high-pressure engine, with large boiler	270	0
Packing for shipment	27	0

The foregoing machines, when all working properly, and with nuts of good quality, should produce from 32 to 35 cwts. of fibre, and 7 to 8 cwts. of brush fibre per day of ten hours.

One thousand husks of average size and good quality prepared by this machinery should produce 4½ to 5½ cwts. of fibre, and about 1 cwt. of brush fibre.

It is assumed that "soaking tanks" of wood or brickwork in cement can be made on the spot, and used in place of iron tanks, and therefore these are omitted in this estimate.

The cost of a single "breaking-down mill" will be found from the price given in above estimate for six machines.

Considering the wide-spread range of this palm, it is strange that the import of cocoanut oil has made such little progress compared with its great rival, the African oil palm. One reason may possibly be that the fruit is more generally used for food, and for the refreshing drink in the nuts when young. The cocoanut palm is cultivated in great abundance on the Malabar and Coromandel coasts, Ceylon, the Laccadives, and everywhere in the Straits Settlements, and the islands of the Eastern Archipelago. In the Madras Presidency there are no less than 218,000 acres under cocoanuts.

In the West Indies, Central America, and Brazil, the cocoanut is extensively grown; there are groves of it for about 280 miles along the coast of Brazil. From Para alone 7½ million cocoanuts, worth 130,000*l.*, are annually shipped to the United States and elsewhere.

The annual produce of the plantations on the island of Itamarca, on that coast, is about 400,000 nuts, which would yield more than 2100 cwts. of coir. This island is but three leagues in length, and as the coast alone is planted with these palms, and they are thus productive, what might not all the cocoanut groves yield, which extend along the coast from the river San Francisco to the bar of Maranguape, a distance of 94 leagues, all cultivated with cocoanut trees?

Many years ago Dr. Royle estimated the average produce of cocoanuts from the whole of Malabar at from 300,000,000 to 400,000,000 annually, valued at 50,000*l.*, and copperah, or the dried kernels, was exported for as much more. Thirty years ago there were in Travancore more than 5½ million cocoanut trees, and since that period the cultivation has largely increased, as the demand for the oil and the coir has advanced. From Cochin more than 3000 tons of oil are exported. During the last fifteen years the natives of Cochin have been bestowing a vast amount of attention on cocoanut cultivation, and some idea of the rate at which this is carried on may be realised from the fact that paddy (rice) land is converted into cocoanut plantations, and large portions of the backwater are reclaimed, and at once planted with cocoanut trees.

Besides those grown, there is a large annual import of cocoanuts into Bengal, as the following return shows:

Year.	Number.	Cwts.
1871	16,999,964	24,291
1872	22,271,904	49,509
1873	16,812,444	20,274
1874	13,190,494	60,462
1875	11,688,854	25,108

The most valuable product of commerce in Malabar is that from the cocoanut tree. In 1873 the value of the oil exported was 356,187*l.*, and of the coir, yarn, and rope, 176,482*l.*, making a total of 552,669*l.*

Exports of coir, yarn, and rope from British India:

Year.	Quantity.	Value.
	cwts.	£
1871	103,264	92,751
1872	128,954	119,601
1873	181,456	167,613
1874	162,576	153,371
1875	152,745	137,280

Ceylon.—The great importance of the cocoanut in this island may be estimated from the fact that the value of the cocoanut plantations in the island are estimated at 15,000,000*l.* In 1865 there were 332,890 acres under cocoanuts, chiefly situated in the north-western, northern, and southern provinces; but this acreage has been reduced by one-half of late years.

Sir Charles Dilke states that 200,000 acres of Ceylon land are shaded by cocoa palms, yielding from 700,000,000 to 800,000,000 nuts a year, worth 2,000,000*l.* sterling. This value is equal to 2*l.* 10*s.* a thousand, which is higher than one expects to find the nut is worth in the East. At 21 feet distance apart, an acre holds 98½ trees, and at an annual yield of forty nuts per tree (all ages), 200,000 acres would yield 788,000,000 nuts—being about the crop-quantity cited. The numbers hold together, but the distance apart is too near. Healthy trees are, in the West Indies, held to average 100 nuts annually, and extraordinary ones more than double that number. If one island can yield so great a quantity, what possibilities are in store for such a widely-spread tree, nowhere else yet grown in any such extraordinary amount, but for which immense areas peculiarly suited to it, await its enriching groves. Trinidad has as yet only about 3000 acres in cocoanuts, if as much.

Cocoanuts exported from Ceylon :

Year.	Number.	Value.
		£
1866	2,055,453	6,468
1867	4,568,871	13,646
1868	1,738,199	5,256
1869	1,584,011	5,063
1870	{ 5,478,677 and 623 bags }	17,185

The production of nuts in the island seems to vary greatly. In 1866, 128,660,280 nuts were collected, besides others not enumerated, but valued at nearly 25,000*l.* In 1866, 115,435,370 was the number reported, and others to the value of 26,000*l.* In 1868, only 30,672,624 and 28,000*l.* worth were returned.

Copperah or cocoanut kernels exported from Ceylon :

Year.	Quantity.	Value.
	cwts.	£
1866	55,569	33,032
1867	23,302	13,981
1868	5,338	3,203
1869	17,649	10,589
1870	40,638	31,678

So far back as 1857, the value of the products of the cocoanut shipped from Ceylon, exclusive of those used in the island, was 274,462*l.*, thus made up :

	Quantity.	Value.
		£
Cocoanuts	420,857 No.	3,717
Coir rope	18,881 cwts.	13,984
Coir yarn	31,652 „	21,364
Copperah or dried pulp ..	20,381 „	12,143
Oil	1,767,431 galls.	223,254

In 1866 the collective products exported were to the value of 294,718*l.*, and in 1870 they consisted of the following:

	Quantity.	Value.
		£
Nuts	478,677 No.	17,185
Rope	9,635 cwts.	12,072
Yarn	46,764 „	28,616
Copperah	40,638 „	31,678
Oil	135,658 „	170,217
Arrack	237,009 galls.	20,326
Total	..	280,094

Not only does Ceylon use up the poonac or oil cake left from the local oil-presses for manure and feeding poultry, but it also imported 186,207 cwts., valued at 69,829*l.*, in 1874.

The following table gives the export and value of the chief products of the cocoanut from Ceylon:

Year.	Oil.		Coir.	
	Galls.	Value.	Cwts.	Value.
		£		£
1859	1,118,638	111,864	38,086	25,945
1860	1,549,089	154,909	36,616	24,864
1861	1,040,428	104,043	43,168	31,883
1862	1,429,531	142,953	46,595	37,648
1863	1,878,585	187,858	51,785	39,103
1864	2,249,402	224,948	36,313	27,386
1865	1,176,784	120,678	41,378	31,637
1866	1,042,853	104,400	46,687	33,035
1867	1,345,485	134,548	49,675	34,446
1868	1,423,853	142,385	68,804	46,607
1869	1,292,065	129,206	64,998	43,013
1870	1,688,199	168,819	61,666	43,430
1871	2,577,700	257,770	65,424	45,448

In the ten years ending 1871 the total quantity of oil exported was over 16,000,000 gallons, and of coir 533,325 cwts., the aggregate value of the two being 1,995,318*l.* The oil shipped in the three years following was as follows:

Year.	Quantity.	Value.
	cwts.	£
1872	278,216	330,689
1873	113,872	141,818
1874	145,078	169,373

In French Cochin China there are more than 33,000 hectares of land under culture with cocoanut and areca palms.

The cocoanut is extensively grown over all parts of the Eastern

Archipelago. The natives have it generally about their dwellings. The annual value of the produce from the trees in the Archipelago is estimated at 2,500,000*l.*, and by greater care and attention it might be double. There were in 1874 in Amboyna 507,349 trees; in Banca, 122,898; in Minahassa, 605,300; in Gorontalo, 261,950, and 405 piculs of oil were there made.

In Java and Madura there are more than 20,000,000 trees. There are large plantations of cocoanuts in the Seychelles, and a good many in the Mauritius; 40,000 or 50,000 nuts are shipped yearly from that island, and 100 to 400 cwts. of coir cordage. 125,532 gallons of cocoanut oil, valued at 17,187*l.*, were shipped in 1874.

Cocoanuts are grown in small quantities throughout the Straits Settlements, but it is only here and there that plantations of any magnitude are met with.

There is, perhaps, no tropical colony that has so many advantages for coir making as the island of Penang. At present all the use the palm is put to, with the exception of making a rope for a well bucket, or for some other trifling domestic purpose, is for fuel. In the oil factories the husk is used as firing in boiling the kernel into oil, as well as in boiling rice and curry in the kitchens. About a couple of million nuts are also shipped from the Straits Settlements with the husk on.

The 'Penang Gazette' observes: Cocoanuts growing in mangrove soil on the side of creeks, and more or less saturated with salt, have their milk brackish, and the sap from which it is secreted must be saline also. These trees do not suffer from the attacks of the rhinoceros beetle. Trees planted in such a situation are found to bear much sooner than those planted on a sandy soil. As an illustration of this, the 'Penang Gazette' states that, while trees planted as far back as thirty years ago, on sandy soil, have not yet borne fruit—although they are fine-looking trees—other trees in the same plantation, only ten years old, but planted on low ground, where the sea tide comes up daily, washes the roots and runs off again, are in full bearing, giving from 50 to 100 nuts annually. It is true that the milk of the nuts produced by such trees is slightly brackish, but the kernel is as thick as that of cocoanuts grown on sandy soil, and produces as much oil. The chief requisite with regard to a plantation in such a situation, is attention to the drainage. Drains should be cut longitudinally between each row of trees and cross ones at greater intervals. These drains must be kept clear, so as to allow the salt water to flow in and out freely. The tide is found to deposit amongst the trees a very fertilizing matter. If the drains are not attended to and the water stagnates, the trees get dwarfed and become thin towards the top, thereby preventing them from having a large crown.

In New Caledonia this palm is abundant on the north-east coast of the island, but is rare on the opposite coast, and while it flourishes on the northern aspect, it declines towards the south. It may be added, however, that nowhere does it vegetate so well as on the islands approaching the Line. It bears from 60 to 80 fruit. This palm is widely spread over the Pacific Islands, and a considerable trade is carried on in cocoanut oil.

At Tahiti there are about 200,000 cocoanut palms, which produced in 1874 more than 12,500,000 nuts. About 600,000 only were exported, and nearly 2,000,000 kilos. of copperah, or dried cocoanut pulp. In 1868, 690 tons of cocoanut oil were shipped from Tahiti; in 1873, 420 tons of oil and 1368 tons of copperah. 19,000 kilos. of copperah were shipped in the same year from the Marquesas. In 1864, 900 tons of cocoanut oil and 10 tons of coir were shipped from the Navigators' Islands, and within the last year or two a cocoanut-fibre machine has been set in full working order at Apia, Samoa Islands.

The Friendly Islands exported in 1866, 704 tons of cocoanut oil, worth 21*l.* per ton. The manufacture is carried on there in the rudest manner. The nut is scraped and placed, mixed with a little sea water, in hollow logs to putrefy. The oil disengages itself, and is collected at the bottom of the trough.

The following has been the shipments of oil from the Feejee Islands:

Year.	Quantity.	Value.
	tons.	£
1864	600	13,200
1865	500	11,000
1866	459	9,000
1867	150	3,260
1868	250	5,000
1869	260	5,500
1870	200	4,950

From the Tuamotus Archipelago 3000 tons of copperah were shipped in 1873, but this is nothing to what may be expected. The single island of Anaa, it is stated, has more than 7,000,000 cocoa palms.* Assuming half of these are too old or too young to fruit, there remain 3,500,000, and supposing 1,500,000 of these required to nourish the 1500 inhabitants and their live stock, there would remain 2,000,000 to furnish the raw materials of commerce. As a very ordinary tree would furnish 25 nuts yearly, this would give 50,000,000, and as 100 nuts yield 50 lbs. of copperah, we have a total of 25,000,000 lbs. available for export. It might yield 12,000 tons with proper management. The number of trees in the Tuamotus will have more than trebled by 1879, for large plantations were made in 1866, and it takes ten years to bring the tree into full fruiting.

For preparing copperah it is well to collect only ripe nuts, and not to break the nut until a month or six weeks after it has been gathered, the copperah then dries more quickly, is richer in oil, and does not turn mouldy.

Jamaica.—In a recent report by Mr. R. Thomson, the colonial botanist, he states, that within the last few years no less than 18,500 cocoanut palms have been planted on the long sandy spit known as the Palisadoes, running from Kingston to Port Royal, and about 4000 more were to be planted. He adds: "I have already estimated

* 'Revue Maritime et Coloniale,' April 1875, p. 81. Paris.

the value, after seven or eight years' growth, of the total number of cocoanuts which the Palisadoes is capable of containing, at 2000*l.*; and this estimate I think moderate, as it gives the value of each tree at a little under 2*s.* It is a generally accepted opinion that this tree flourishes luxuriantly in all maritime tropical regions, on the arid sandy sea-shore as well as in the richest valleys. There can, however, be no doubt that the tree grows with far greater luxuriance under favourable conditions of abundant moisture and rich soil, and it is in consideration of this that I estimate the annual yield of each tree at the low rate of 2*s.* The land on the Palisadoes is composed chiefly of sand, with an admixture throughout its greater extent of a rich vegetable mould. Severe droughts of from six to nine months' duration are frequently experienced, and although the tree may flourish in proximity to the sea, I consider that a greater rainfall on this sandy soil would double the return mentioned. The extremely arid condition of the Palisadoes and the neighbourhood of Kingston, probably the driest spot in the West Indies, has been brought about by the wholesale destruction of the primeval forest over hills and plains to the extent, including the continuation of the plain to the west, of from four to five hundred square miles. Along the line of the shore the palm luxuriates throughout this district, but on receding to the distance of half a mile it ceases to present a flourishing aspect, until we reach the hills or the plain beyond the arid region where it again acquires the necessary condition—moisture. It would be a matter of some importance for statistical as well as utilitarian purposes, to ascertain what number of cocoanut trees there are in the island. I am not aware that any steps have ever been taken to determine this; and if this be so, it seems all the more remarkable, when it is remembered that the nut is one of our most important products, and that the average of many of far less importance has been carefully ascertained. In the East Indies these trees are carefully enumerated, and in some parts a yearly tax is levied on each tree, and even mortgages are commonly secured to the extent of 2*s.* a tree. The 2,000,000 nuts, worth about 5000*l.*, exported annually from Jamaica, give a very imperfect idea of the value of the tree to the colony. In each of several parishes, for instance, St. Thomas, Portland, and St. Mary, there must be over 100,000 fruiting trees, and the number is being constantly increased. Wherever the tree abounds, the nuts form an important article of food among the peasantry, either in their natural state or manufactured into oil. By the peasantry, however, the husk is not turned to any account, and is only manufactured to a very trifling extent in prisons, whilst if, at a moderate computation, we estimate the number of bearing trees at 1,000,000, each yielding, on an average, sixty nuts, the husks, if utilized, would give at least 50,000*l.* Cocoanuts abound around nearly the whole seaboard of the island; and within thirty miles of Kingston they are obtainable in large quantities, at 100 per cent. less than they are bought for in town. It is a pity that the highly valuable products of this palm are not turned to better account, and it would be a great boon to the colony if private enterprise would initiate a system of manufacturing oil for island consumption and coir for exportation, as the nuts could be obtained in quantities to meet any demand, and brought to town in the coasting droghers. How many hundreds of acres are now covered with this stately palm, and how many thousands of the nuts annually fall to the ground, almost useless to the proprietor!"

It is a low and safe estimate to take the value of the produce of an acre of cocoanuts in bearing at from 8*l.* to 10*l.* On the sea-shore these trees begin to bear in six or seven years. A great part of the waste shores of this island is very suitable for the growth of the cocoanut; and the demand for this most useful of all fruits, even where no machinery has been erected for the preparation of its products, is unlimited. The disease which destroyed the cocoanut tree in some West Indian islands, is unknown here. Within the last three or four years cocoanut trees have been planted, especially on the north side of the island, more extensively than ever before.

In *Trinidad* great attention has of late years been given to cocoanut production. In 1863 and 1864 only 250,000 were shipped annually, but in 1876 the number had risen to over 4,500,000. The value of the export is now over 18,000*l.* The civilized world of the temperate zone can absorb all the oil and fibre the tropics are likely to send for generations to come, however great the supply. The trees are always in bearing, but we learn that in some quarters at least, the Trinidad planters confine themselves to three great regular pluckings, at four months apart—namely, in April, August, and December. The cultivation is extending on the shores of the colony.

The value of the cocoanuts and cocoanut fibre exported from Trinidad in 1871 was estimated at 8732*l.* against 2863*l.* in 1870. The cocoanut can be grown in unlimited quantities on the eastern coast of the island, where two factories have been established for some time for the preparation of oil and fibre. The difficulties of procuring labour in that remote part of the island, and of shipping the produce on an exposed coast, have hitherto retarded the commercial success of these establishments; but if these difficulties can be overcome, a large extension may be given to this branch of colonial industry.

There is a considerable demand for cocoanuts in the United States, but then the American captains require them to be delivered husked, and that they be large and spherical. Cocoanuts can be had in Trinidad at 10 to 13 dollars a thousand; in Jamaica they sell at 18 dollars, and in Central America at 25 dollars. A Trinidad paper well remarks that "as the fibre could be so readily utilized in the States, it is rather singular the traders do not offer to buy the nuts, as picked, at the low rates current in these islands, and husk and sort them after arrival in America, selling the large handsome nuts to the first-class fruiterers, confectioners, and grocers; the smaller nuts to the street seller, and the husk to the mat, mattress, and brushmaker, the rancid nuts, if any, going to the soap-boiler. There is good reason to believe we grow a goodly proportion of lusty, handsome nuts, having first-class soils for the tree, an equatorial climate and prolific bearers. Planting is always extending, at Mayaro, Icacos, Irois, Carenage, and other places, leaving many virgin beaches, along which, sooner or later, they will be dotted. We have at least as good conditions for producing prime nuts as any colony in these seas."

The African Oil Palm (*Elæis guineensis*, Lin.) is, after the cocoa-nut palm, one of the most important in a commercial point of view, since it furnishes to British commerce about 50,000 tons of oil annually, of the value of one and a half to one and three-quarters of a million sterling, besides the quantity locally consumed as food in Africa, and sent to other countries. It is distinguished by its decumbent trunk, and bears clusters of one-seeded fruits (drupes), with oily husks of a bright vermilion or a more or less yellow colour. The range of this palm is not as yet well defined, but appears to extend from the coast of Guinea to the south of Fernando Po, and grows as far up in the interior as Zheru, a distance of 400 miles from the sea, or the mouth of the Min, one of the embouchures of the Niger.

Captain Burton, in his 'Lake Regions of Central Africa,' states that this palm is known by the Arabs to grow in the islands of Zanzibar and Pemba, and more rarely in the mountains of Usagona. It springs up apparently uncultivated in large dark groves on the shores of the Tanganyika, where it hugs the margin, rarely growing at any distance inland. This fine palm, he adds, is also tapped, as the date palm is in Western India, for toddy, and the cheapness of this timbo—the *sura* of Western Africa—accounts for the prevalence of intoxication, and the consequent demoralization of the Lake tribes.

The principal ports in the Bight of Benin from which palm oil is exported are, Badagry, Porto Novo, Whydah, Aliquah, Lagos, and Palmas.

Palm oil is exported from the following rivers: Brass, New Calabar, Bonny, Old Calabar, Bemba, Cameroons, and also from Fernando Po. Independent of these, in the rivers Malunba, Boreah, and Kampo palm oil is brought by coasting vessels. Bonny supplies the largest amount of palm oil that is brought from any river in West Africa.

The process of extracting the oil is simple. The clusters or branches of fruit, which contain perhaps as many as 4000, are gathered by the men, and thrown indiscriminately into a trench or pit, and so left until they become somewhat decayed. The fruit is afterwards pounded in a mortar to loosen the husky fibre covering the nut. This done, they are placed in large clay vats filled with water, and two or three women tread out the semi-liquid oil, which comes to the surface as disengaged from the fibre, when it is collected and boiled to get rid of the water. The inner surface of these clay vats having at first absorbed a small quantity of oil, is not afterwards affected either by the water or oil. The oil is collected in pots, containing from three to twenty gallons.

M. Boussingalt has shown, from information collected,* that the average production of oil from palms is at the rate of 900 kilos. per hectare, that is to say, superior by a third to the production of oil from the olive in the south of Europe.

This vegetable fat is stated by A. C. Oudemans, jun., to have the following remarkable composition: stearin, palmitin, myristin, laurein, elain, caprin, caproin, and caprylin. It is used with the other solid fats for making soap and candles, and for railway grease. The price of the oil at the close of 1876 was 41*l*. per ton. The enormous

* 'Economie Rurale,' t. i. p. 350.

progress that has been made in the commerce in this article is shown by comparing the imports of 1840 with those of the last six years, which have averaged one million hundredweights, and this is only the British imports.

	Cwts.		Cwts.
1840	315,504	1870	868,270
1850	447,797	1875	904,562
1860	804,326		

Marseilles also receives about 1000 tons, and the United States some quantity.

The oil rivers of Biafra and Benin extend over 800 miles of coast, and include the island of Fernando Po. The chief exports consist of palm oil and palm kernels.

In 1872 the number of British traders was twenty-four, and there were two foreign. These twenty-six palm-oil traders have fifty-five trading establishments in seven rivers, and employ 207 white agents, clerks, &c., 419 blacks, and 2000 kroomen. The Fernando Po oil crop never exceeds 400 tons a year, and yet from the number of oil palms there at least 4000 tons might be obtained, but the 25,000 aborigines do not care to produce more. More oil palms might be grown, for there is abundance of room for them in the oil district, though it is but a mere fringe of the African continent. But the natives never think of planting oil palms. The river chiefs, now oil brokers, were slave brokers formerly.

The following table gives the quantity of palm oil imported into the United Kingdom for a series of years:

	Cwts.		Cwts.
1840	315,504	1859	685,794
1841	402,126	1860	804,326
1842	424,242	1861	740,332
1843	418,429	1862	865,890
1844	414,648	1863	790,224
1845	505,704	1864	666,582
1846	366,853	1865	798,724
1847	476,301	1866	799,210
1848	510,218	1867	812,080
1849	493,331	1868	960,059
1850	447,797	1869	814,520
1851	608,550	1870	868,270
1852	523,813	1871	1,047,882
1853	636,628	1872	1,006,497
1854	752,618	1873	1,017,947
1855	810,394	1874	1,067,767
1856	786,701	1875	904,562
1857	854,791	1876	864,472
1858	778,230		

Palm-kernel Oil.—The kernels, with the exception of an insignificant quantity used for the manufacture of oil for domestic purposes in Africa, were formerly thrown away. Attention was first drawn to their utilization in Liberia. Within the last fifteen years they have been more generally collected and employed. The shell being broken, the kernels are shipped to be pressed for oil, &c. Vast extension of the African trade has arisen out of this new article of export.

It has been estimated by competent authorities that from the 50,000 tons of palm oil shipped there must be 10,000,000 bushels of kernels, equal to 223,000 tons in weight. The average yield from these kernels being about 30 per cent., if all were utilized this would furnish 76,000 tons more of oil, worth at the price of cocoanut oil (which it closely resembles) about 2,700,000*l.* If we add to this the value of the oilcake, 112,000 tons at 6*l.* per ton, we should have a very large increase to the value of the oil-palm trade with Western Africa.

Palm-nut oil is obtained on the coast from the seed or kernel, by roasting, beating, and boiling. In Liberia, on a small scale, a bushel of kernels was found to yield two gallons of oil, but with good presses a very much larger yield than this is obtained.

The palm kernels are quoted in London, January, 1877, at 12*l.* 10*s.* to 14*l.* per ton. The kernel, which is nearly white, is covered by a thin brownish layer of woody fibre, and in consequence of this the palm-nut meal has a light-brown or dirt-coloured appearance. The size of the kernels varies from that of a hazel nut to that of a small pigeon's egg. They are very hard, nearly inodorous, rather insipid to the taste, and extremely rich in fatty matter, possessing the consistency of butter, with the useful property of not readily turning rancid. The extraction of the oil necessitates the reduction of the kernels into a tolerably fine powder, and the application of powerful crushing machinery and gentle heat. Notwithstanding these means, the cake or meal left in presses contains usually a larger proportion of fat than is found in most other kinds of oilcake. It surpasses all other articles of cattle food in its theoretical value as a fat producer, as the following analysis by Dr. Voelcker will show. In the best linseed cake the percentage of oil rarely amounts to 12 per cent., indeed 10 per cent. may be taken as a fair average:

Moisture	7·49
Fatty matters	26·57
Albuminous compounds * (flesh-forming matters)	15·75
Starch, mucilage, sugar, and digestible fibre	37·89
Woody fibre (cellulose)	8·40
Mineral matters (ash)	3·90
Total	100·

* Containing nitrogen, 2·52.

In 1863 the palm-kernel trade, then newly introduced, furnished 2665 tons of kernels from Lagos. The progress that has been made since is shown by the following figures:

	Tons.		Tons.
1865	2,631	1870	15,894
1866	7,216	1871	19,375
1867	13,619	1872	16,870
1868	15,498¼	1873	16,410
1869	20,394	1874	25,192

The value of the palm kernels now shipped from this single port averages nearly 300,000*l.*, or double that of the palm oil; and of those shipped from the Gold Coast in the two years ending 1870 was

60,916*l*. From Sierra Leone there were also shipped in 1870, 110,243 tons and 2502 bushels of palm kernels.

THE GOMUTI PALM (*Arenga saccharifera*, Lab.; *Saguerus Rumphii*, Roxb.; *Borassus Gomutus*, Lour., *Gomutus saccharifera*, Spr.) is one of the most useful palms, and occurs in a wild state throughout the islands of the Indian Archipelago, but is more common in the interior, principally in the hilly districts, than on the sea-coast, and is also very generally cultivated by the various people who inhabit that region. This palm attains a height of thirty or forty feet, and besides its saccharine sap furnishes a highly valuable black fibrous substance, Ejoo fibre, superior in quality, cheapness, and durability to that obtained from the husk of the cocoanut, and renowned for its power of resisting wet. It is used by the natives of the Indian islands for every purpose of cordage, domestic and naval. Underneath this material is found a substance of a soft gossamer-like texture, which is imported into China. It is applied as oakum in caulking the seams of ships, and more generally as tinder for kindling fire; it is for the latter purpose that it is chiefly in request among the Chinese.

The principal production of this palm is the toddy (from the Sanscrit *Táde*), which is obtained according to Crawfurd in the following manner: One of the spadices is on the first appearance of fruit beaten on three successive days with a small stick, with the view of determining the sap to the wounded part. The spadix is then cut a little way from its root (base), and the liquor which pours out is received in pots of earthenware, in bamboos, or other vessels. The Gomuti palm is fit to yield toddy when nine or ten years old, and continues to yield it for two years, at the average rate of three quarts a day.

When newly drawn the liquor is clear, and in taste resembles fresh must. In a very short time it becomes turbid, whitish, and somewhat acid, and quickly runs into the vinous fermentation, acquiring an intoxicating quality. In this state great quantities are consumed; a still larger quantity is applied to the purpose of yielding sugar. With this view the liquor is boiled to a syrup, and thrown out to cool in small vessels, the form of which it takes, and in this shape it is sold in the markets. This sugar is of a dark colour and greasy consistence, with a peculiar flavour; it is the only sugar used by the native population. The wine of this palm is also used by the Chinese residing in the Indian islands in the preparation of the celebrated Batavian arrack.

In Malacca, the Gomuti, there termed Kabong, is principally cultivated for the juice which it yields for the manufacture of sugar. Like the cocoanut palm it comes into bearing after the seventh year. It produces two kinds of "mayams" or spadices, male and female. The female spadix yields fruit, but no juice, and the male *vice versâ*. Some trees will produce five or six female spadices before they yield a single male one, and such trees are considered unprofitable by the toddy collectors; but it is said that in this case they yield sago equal in quality, though not in quantity, to the *Cycas circinnalis*, though it is not always put to such a requisition by the natives; others will produce only one or two female spadices, and the rest male, from each of which the quantity of juice extracted is the same as that obtained from the cocoanut spadices. A single tree will yield in one day sufficient juice for the manufacture of five bundles of jaggery, valued at two cents each. The number of mayams shooting out at any one time may be averaged at two, although three is not an uncommon case. When other occupation or sickness prevents the owner from manufacturing jaggery, the juice is put into a jar, where in a few days it is converted into excellent vinegar, equal in strength to that produced by the vinous fermentation of Europe. Each mayam will yield toddy for at least three months, often for five, and fresh mayams make their appearance before the old ones are exhausted; in this way a tree is kept in a state of productiveness for a number of years, the first mayam opening at the top of the stem, the next lower down, and so on, until at last it yields one at the bottom of the trunk, with which the tree terminates its existence.

Dr. J. E. de Vry states, that although the natives in Java extract it by a very rude and entirely primitive mode, this palm contains a great proportion of cane sugar. He thus describes the process, which differs little from that pursued for obtaining sap and sugar from other palms.

"As soon as the palm begins to blossom, they cut off the part of the stem that bears the flower; there flows from the cut a sap containing sugar, which they collect in tubes made of bamboo cane, previously exposed to smoke, in order to prevent the fermentation of the juice, which, without this precaution, would take place very quickly under the double influence of the heat of the climate and the presence of a nitrogenous matter.

"The juice thus obtained is immediately poured into shallow iron basins, heated by fire, and is thickened by evaporation, till a drop falling on a cold surface solidifies; this degree of concentration attained, the contents of the kettle are put in forms or great prismatic lozenges. Several thousand pounds of sugar are thus obtained yearly. I have collected some of the sap in a clean glass bottle, and I found that the unaltered juice does not contain any glucose, but a nitrogenous matter, which, by the heat of the climate, quickly converts a part of the cane sugar into glucose. In order to prove, without employing any artificial means, that the juice exuding from the tree contains pure cane sugar, I collected a sample directly in alcohol; the nitrogenous principle is thus eliminated by coagulation; a mixture of equal parts of juice and alcohol has been, after filtration, evaporated on the sand-bath to the consistence of syrup. I brought this syrup with me on returning from Java; and during the voyage it became solid, presenting very fine and well-defined crystals of cane sugar, immediately recognized as such by all the experts. At the Congress of Giessen, I spoke of the preparation of sugar from palms as the only rational mode of obtaining sugar in the future, basing my opinion on the following grounds: Sugar, by itself, being only composed, in a state of purity, of carbon, hydrogen, and oxygen, does not take anything from the soil; but the plants now mainly cultivated for extracting sugar, viz. the *Beta vulgaris* and the *Saccharum officinarum*, require for their development a great amount of substances from the soil in which they grow, whence it follows that their culture exhausts the soil. But this is not the only evil; what is worse is, that the space now occupied by beetroots in Europe, and by sugar-cane between the tropics, might and ought to serve for the culture of wheat or of forage in Europe, and for rice under the tropics; and it is my opinion that, considering the increase of population, the time is not far distant when it will be absolutely necessary to devote to the culture of wheat or rice the lands now employed for beetroot or cane. While the cane and beetroot require a soil fit for cereals, the Aren palm prospers on soils entirely unfit for their culture, so unfit, indeed, that one might try in vain to grow on them rice or cereals; the Aren palm thrives in the profound valleys of Java, and in some parts of the island extends from the shores of the sea to the interior, where the tree is found in groups, and it is very possible to make rich plantations of that fine tree. There is one drawback, but not a very serious one; the tree must be eleven or twelve years old before it will yield sugar. When, however, it commences, the operation can be repeated during several years, and the preparation of the sugar becomes a continuous industry, and not an interrupted one, as it is now. According to my average, a field of thirty ares ($\frac{3}{4}$ acre) planted with those trees should produce yearly 2400 kilogrammes of sugar in a soil quite unfit for any other kind of culture."

Like the true sago palm, the Gomuti affords a medullary matter from which a farina is prepared. In Java it is the only source of this substance, which in the western and poorer part of the island is used in considerable quantity and offered for sale in all the markets. It is smaller in quantity than the pith of the true sago tree, more difficult to extract, and inferior in quality; having a certain peculiar flavour from which the farina of the true sago is free. Dr. Roxburgh observes, "I cannot avoid recommending to everyone who possesses land in India, particularly such as is low and near the coasts, to extend the cultivation of this useful and elegant palm as much as possible. The wine itself and the sugar it yields, the black fibres for cables and cordages, and the pith for sago, independent of many other uses, are objects of very great importance. From observations made in the Botanic Garden at Calcutta, well-grown thriving trees produce about six leaves annually, and each leaf yields from 8 to 16 ounces of the clean fibre. They are in blossom all the year; one lately cut down yielded about 150 lbs. of good sago meal."

The interior of the small fruit are prepared and extensively used as sweetmeats by the Chinese in Sumatra.

The Wild Date Palm of India.—The following paper, on "The Manufacture of Date Sugar," is by Mr. S. H. Robinson, of Calcutta.

Phœnix, the genus to which the date palm belongs, comprises nine known species, of which six are indigenous in India, and are distinguished as: 1, *acaulis;* 2, *dactylifera;* 3, *pusilla;* 4, *farinifera;* 5, *sylvestris;* 6, *paludosa*. Of these No. 4 produces sago of an inferior quality; and the leaves of all the species furnish materials for mats or thatch for houses. The sugar-yielding variety, *Phœnix sylvestris*, is known as the wild date of Bengal. *Phœnix dactylifera* is the name given to the true date palm of Arabia and Africa; but as it appears to be undistinguishable from the Bengal variety, except in size and vigour of growth, there seems little doubt that any apparent difference is due only to superior cultivation and variety of climate or soil, and to its being always a cultivated tree in Bengal; the specific name *sylvestris* may have been originally given, owing to its inferiority in size to the African or Arabian tree, with which European botanists were more early familiar.

The date palm, when not stunted in its growth by extraction of its juice for sugar, is a very handsome tree, rising in Bengal to from thirty to forty feet in height, with a dense crown of leaves spreading in a hemispherical form from its summit. These leaves are from ten to fifteen feet long, and composed of numerous leaflets or pinnules about eighteen inches long. The trunk is rough, from the adherence of the bases of the falling leaves, which serves to distinguish it at a glance from the smooth-trunked cocoanut palm, which in its leaves only it resembles. Like all of the *Phœnix* genus the trees are diœcious, and the fruit hangs in dense bunches from the centre of the crown of the female tree; it flowers about April or May, and the fruit ripens in July or August; the latter is, however, of a very inferior description in Bengal, and is seldom gathered except for seed, from which the young trees are raised. The fruit, indeed, consists more of seed than of pulp, and altogether is only about one-fourth the size of the Arabian kind brought annually to Calcutta for sale, and, when fresh imported, a rich and favourite fruit there. This inferiority of the Bengal fruit may no doubt be attributed to the entire neglect of its improvement there from time immemorial, and, perhaps, in some measure to the practice of tapping the trees for their sap, so universally followed in the districts around Calcutta, its principal range of growth.

The date tree is met with in almost every part of Bengal Proper, but it flourishes most congenially, and is found plentifully only in the alluvial soils which cover its south-eastern portion, excepting only such tracts as suffer entire submersion annually from the overflow of the rivers, as is common in portions of the Dacca, Mymunsing, and Sunderbund districts. The extent of country best suited for its growth, and over which it is found most plentifully as above indicated, may therefore be taken as within an area stretching east and west about 200 miles, and north and south about 100 miles, and comprehending by a rough estimate about 9000 square miles—within an irregular triangular space.

The practice of extracting its juice, however, for the production of sugar, extends at present over a much smaller area, probably not more than two-thirds of the above-described space; and if we consider further, how small a portion of these favourite date districts are as yet occupied by date tree cultivation, the room for its future extension, even if confined to these tracts alone, appears a wide one indeed. If we trace an irregular parallelogram, stretching eastward from Kishengunge, in the Nuddea district, to Backergunge, and from Mahduppore, in Furreedpore district southward to the borders of the

Sunderbunds, we shall find a space of about 100 miles long, by 80 broad, and comprehending the district of Jessore, with portions of Furreedpore, Nuddea, and Burrisaul, to which the product of date sugar is mainly confined, although the goor—or the first raw produce made by boiling down the juice—is found commonly manufactured for native consumption on the spot, in many localities situated beyond these assumed limits.

Throughout the present date tract, the quantity and quality of the sugar produced vary considerably. The high and dry lands of parts of Kishnaghur and Pubna yield a strong well-crystallized product, though less in quantity than from trees of the Jessore and Sunderbunds soils; in which, with a more rapid growth of the tree and a greater flow of sap, a less rich, though still good and grainy sugar is produced. The cultivation in these districts is accompanied by a great advantage, in the cheap and abundant supply of fuel for boiling the juice and refining the sugar; and there is probably no part of Bengal where the cultivation may be extended, with more profit than in the more elevated lands of the Sunderbund grants.

The young plants are raised from seed sown during the rains, and are ready for planting out in the following April or May, after the first showers of the season have moistened the ground sufficiently. Before the date sugars became important as a staple for export, and the cultivation extended, the trees were seldom seen planted elsewhere than along the hedge-rows or boundaries of the fields, or on other spots where they did not interfere with the growth of cereals or other field crops. Gradually as date produce became more valuable, systematic plantations appeared, and fields were set with trees ten and fifteen feet apart, but without much regard to order or regularity of distance. After planting, no manuring or further expense was incurred, except, perhaps, in supplying fresh plants in place of those destroyed by cattle.

The spaces between the trees are generally occupied by oil-seeds or other dry-weather crops, and thus the cost of a native plantation is reduced, whilst the trees benefit by the ploughing, which loosens the earth, and the ground is kept free from weeds.

At the expiry of the fifth year from the planting of the young tree in the field, it is ready to be tapped for its juice. This is the average time allowed, though it may be varied a year sooner or later by the difference of soil and climate. The first year a young tree is tapped, it is reckoned to yield only half the usual quantity of juice produced by a full-grown tree; in the second year of tapping it is reckoned to yield three-fourths of full average quantity; and it is not till the third year of bearing that it is considered as in full yield.

The process of tapping and extracting the juice commences about the 1st of November. Some days previously the lower leaves of the crown are stripped off all round, and a few extra leaves from the side of the tree intended to be tapped. On the part thus denuded a triangular incision is made with a knife about an inch deep, so as to penetrate through the cortex, and divide the sap vessels; each side of the triangle measuring about six inches, with one point downwards, in which is inserted a piece of grooved bamboo, along which the sap trickles, and from thence drops into an earthen pot suspended underneath it by a string. The pots are suspended in the evening, and removed very early the following morning, ere the sun has sufficient power to warm the juice, which would cause it immediately to ferment, and destroy its quality of crystallizing into sugar.

A plantation is always divided by the cultivator into seven equal sections, and one such section is tapped daily. The cutting is made in the afternoon, and the pot suspended as above mentioned. Next morning the pot is found to contain, from a full-grown tree, ten seers of juice, the second morning four seers, and the third morning two seers of juice (the seer is about 2 lbs.); the quantity exuding afterwards is so small, that no pot is suspended for the next four days. On the evening of the seventh day it again comes to the turn of this section of trees to be cut, which is effected by a thin slice being pared from the triangular face, which, by again dividing the sap vessels, causes the juice to flow afresh as at first. Each section is thus cut in succession, and the process is repeated throughout the goor season, which usually terminates about the 15th of February, after which the heat of the weather causes the juice to ferment so rapidly, that it is no more convertible into sugar, and consequently not worth the labour of extraction and evaporation of its water, as molasses only would be the product. Juice produced during the day-time of the cold season is of similar quality, and for the same reason is allowed to run to waste.

Daily at sunrise, throughout the goor season, the industrious ryot may be seen climbing his trees, and collecting at a convenient spot beneath them the earthen pots containing the juice yielded during the past night. Under a rude shed, covered with the leaves of the date tree itself, and erected under the shade of the plantation, is prepared the boiling apparatus to serve for the goor season. It consists of a hole of about three feet in diameter sunk two feet in the ground, over which are supported by mud arches, four thin earthen pans of a semi-globular shape, and eighteen inches in diameter; the hole itself is the furnace, and has two apertures on opposite sides for feeding in the fuel, and for escape of the smoke. The fire is lit as soon as the juice is collected, and poured into the four pans, which are kept constantly supplied with fresh juice as the water evaporates, until the whole produce of the morning is boiled down to the required density. As the contents of each pan become sufficiently boiled, they are ladled out into other earthen pots or jars, of various sizes, from five to twenty seers of contents, according to local custom, and in these the boiled extract cools, crystallizes into a hard compound of granulated sugar and molasses, and is brought to market for sale as goor.

The subsequent processes by which the goor is deprived more or less of its molasses and impurities, and the drier and more merchantable kinds of sugar are prepared for market, will now be briefly described. These processes are always conducted by a distinct class of operators, who purchase the goor from the cultivators, and bring it to various stages of purity and dryness under different denominations.

1st. Khaur is made by filling the goor into coarse sacks or gunny bags, and pressing them between bamboos lashed together, or beneath heavy weights, until 30 or 40 per cent. of the entire weight is forced out in the shape of molasses. The residue is then mixed, packed in clean bags, and is ready for sale.

2nd. Fine khaur or nimphool is made by repeating the above process for making khaur; the only difference being that the khaur is sprinkled and mixed with water before subjecting it to the second packing and pressure. This causes a further portion of the molasses to be washed out and separated from the mass, and the product is lighter coloured and finer than the khaur, and about 50 per cent. only of the original weight of goor remains. A third application of the same process is sometimes resorted to, which carries away another 5 per cent. of the original weight, and leaves a residue still drier and lighter coloured than the ordinary nimphool.

In all nimphool and khaur sugars, however, a certain portion of water or moisture remains, it being never subjected to any sun-drying or other process for evaporating the water, and this renders it liable to deliquesce and sweat through the bags in which it is usually packed. This is specially the case in damp weather, and loss of colour and acidity follow in a few weeks.

3rd. Dullooah, or doloo, is made by filling the goor into round baskets or conical earthen vessels, holding two or three maunds each. The baskets being of an open fabric, and the cones made with a hole at the apex, the molasses drains from the goor into a vessel placed beneath, the process being encouraged by a stratum of three or four inches thick of a wet grass or aquatic weed called "seala" placed on the surface of the goor. The moisture from this attenuates the molasses in the goor, and assists the draining. As soon as the weed is dry it is removed, and the upper stratum of the goor, now deprived of its molasses, is scraped off with a knife to the depth of two or three inches; and a fresh top of seala or wet weed is applied. When dry, a further portion of sugar is cut off as before, and this is repeated until the basket or cone is emptied. The sugar, as scraped off, is exposed in the sun on mats to dry, and is then mixed and packed for sale; and is, when well made, a dry, light, sand-coloured dullooah. Thirty to forty per cent. of produce, varying with the quality of the goor, is made in this way from a given quantity of the latter. The resulting molasses having by the operation of the weed a small portion of the sugar crystal melted with it, is subjected to a boiling to evaporate the water, and an inferior, weak-grained, and dark-coloured goor is the result. This is again subjected to the weed-draining as before, and a further portion of 10 to 15 per cent. weight of the original goor is obtained. Dullooahs, if well dried before being packed, may be kept without deteriorating for several months if the weather be dry; but they always imbibe moisture, and sustain consequent injury from the damp air of the rainy season in Bengal.

4th. Pucka Cheenee, or gurpatta, is the native refined sugar, made by subjecting khaur to a process somewhat resembling that of the English refiner. The khaur is melted in water to the consistency of thin syrup, which is then placed over a fire in an earthen pan, and brought to boiling point, the defecation being assisted by potash temper and sprinkling in of cold water. After skimming, it is filtered through a cotton cloth, and the clarified syrup boiled briskly until the water is evaporated to such a degree as to allow the sugar to form a hard crystal as it cools. It is then poured into an earthen cone, and, when cold, the plug is withdrawn, and the syrup allowed to drain from it, assisted, as in the dullooah process, by the application of the damp weed or seala. As it becomes whitened by the latter, it is scraped off, sun-dried, and packed for sale. The syrup, as it collects from the cones, is boiled up with fresh goor, and produces, by the same process, an inferior or second quality of gurpatta; the syrups of the latter are once more boiled alone, and produce a still inferior weak and reddish sugar, called by the manufacturers "jerunnee," which is literally "lasts." Gurpatta, if well made, and pure from mixture of other kinds, is of a bright and clean aspect, fine and dry; and, if protected from the weather, will keep without injury throughout the rainy season. The ordinary yield of gurpatta from three maunds (40 seers each) of good goor is reckoned as follows:

	Mds.	srs.
First or white gurpatta	0	20
Inferior or mixed ditto	0	10
Syrup or jerunnee	0	10
Molasses	1	28
Loss	0	12
Total	3	0

5th. Dobarah is a quality superior to gurpatta, being a good white, dry, and well-crystallized sugar. The process is similar to that of the gurpatta; but the material used being dullooah instead of khaur, a purer sugar is obtained, which much resembles the crushed refined sugar of the European refiner.

The following further details are given by Babu Ramshunker, Sen, Deputy Magistrate and Deputy Collector, Jessore:

After all that has been written on this subject by Colonel Gastrell in his Statistical Report, dated 1868, and by Mr. Westland in his account of Jessore, dated 1870, very little remains to be said on this most important branch of native industry; but still, as my investigations were directed towards the ascertainment of the present state of date cultivation and the manufacture of sugar from the juice of the tree, I shall attempt to record the results of these inquiries.

In May and June seeds are gathered from under old date trees and sown broadcast in a nursery near enough to the ryot's house. They sprout forth within fifteen to thirty days, and sooner if there is an intervening downpour. The seedlings are then fenced round in order to save the tender leaves from the bite of the goat or cattle. As soon as two leaves appear a weeding begins, which is kept up twice in the year as long as the plants continue in the nursery for two or three years. After this term, when the rains begin to fall copiously, they are transplanted into an open garden, which is prepared by four or five ploughings and manured with sweepings and cowdung. A high and rich ground is always preferred; but soils which are of a mixed nature and easily yield to the plough, are better adapted than the low and saline.

The trees are planted in even rows seven or eight cubits apart in order to allow sufficient space for intermediate ventilation and the turning of the plough and ladder within the intervening space. The ground is ploughed, and the soil around the tree is turned up with the spade twice a year, as otherwise the overgrowth of the straw grass (*ulu*) chokes up and kills the tender plants. The side leaves of the plant are cut off every year in winter for the convenience of cultivating the gardens with cold-weather crops, which are generally sown therein as long as the plants are young and their leaves short; but when they have spread out so much as to obstruct heat and light, the cultivation of other crops is put off. The raising of these crops in the date gardens, instead of interfering with the trees, is rather conducive to their growth, as the soil is kept clean thereby and *ulu* grass (*Saccharum cylindricum*) kept back. In gardens where the trees are wide apart, the *aus dhan* is cultivated, and an average crop is always obtained.

Inundations injure the trees when they are young; for if the water rises high, it deposits its loam on the tender head leaves, and thus suffocates the plant to death. The fouler and higher the water, the greater is the danger to the date tree. Young and robust trees escape storms and cyclones scatheless, but the tall ones are many a time and oft pressed down by the force of the wind, and although not quite uprooted, placed permanently in a slanting position. There is a kind of larva called *maira* or *kora*, which destroys the plant in large numbers by boring out the heads and eating up the top leaves.

When seven or eight years of age, the tree is fit for yielding the sap. Ordinarily the east or west side of the tree, being better exposed to the influence of the sun, is chosen for tapping; but in some cases the north and south sides are also taken up if more convenient for the purpose of ascent and descent. The position and bend of the tree, as well as its accessibility to the climber, determine the side on which the first cutting is to be made. If it stands at an acute angle with the surface of the soil, the side uppermost is subjected to the paring knife. Sometimes a tree in which the first parings were east and west has its subsequent cuttings gradually brought round to north and south, if it has been beaten down by a cyclone. The tapping continues on from year to year until the head of the tree presents a withered and half-dead appearance. In three trees I counted as many as forty-two, forty-three, and forty-four alternate notches, thus showing that they had been continually tapped for those long series of years, and they appeared still capable of being subjected to that process for two or three years more. When on these high and tall trees the head is no longer erect in position, the tapping must cease.

The implements used in cutting the tree are (1) the *gachua dao*, a sharp and broad instrument with which the paring is made; (2) the *kolach* or goatskin cover which the *gachi* or cutter fits to his waist in order to prevent friction of the rope, (3), called *dara*, with which he attaches himself to the tree as he climbs up; (4) the *thungi* or narrow wicker basket hanging from his waist like a quiver and intended to hold the *dao* and *nullies ;* (5) the *akra* or hook, on which the juice pot is hung when he gets up and down the tree with it.

Besides the cluster of date trees in and around a ryot's tenement, large open gardens occupying broad areas of land are planted with them. Sometimes they are planted along hedges and the boundary ridges of fields. The tract of country south and west of the Nabagunga abounds with large date gardens, particularly the line of country west of Magurah, where the land gradually rises higher and higher as we approach the confines of the Nuddea district.

South and west of Jhenidah the country may be said to be bristling with date trees planted in square plots of ten or fifteen beegahs, and these increase in number as we come nearer and nearer to the Kabadak. The line north of the Kumar, being subject to inundation, is not a well-planted date tract, the sugar-cane also having retained its hold there to some extent.

In October the side of the tree chosen for tapping is cleared of the leaves, and the bark just below the head is cut into, so as to form an oblong bare surface 15 inches by 12 inches, in proportion to the circumference of the tree. After a week, when this surface is perfectly dry, its upper part is skilfully pared off, till the white and softer wood becomes visible. An indenture is then made in the lower part of the pared-off surface, along the sides of what appears to be an obtuse angle, with the angular point turned downwards. An inch below this point a split bamboo twig, seven or eight inches long, is inserted into the tree in order to conduct the sap into the juice pot as it oozes out of the white surfaces and passes in a thin slow stream through the two sides of the angle as it were through two drains. If there be not sufficient juice in the pared-off surface, it is left untouched for a week and cut anew after its being well dried up. If the cut is deep before the surface is dry, the head of the tree pines away and the juice decreases in quantity. Careless insertion of the bamboo tube sometimes injures the young plant, which may cause its death.

Date trees are divided into three classes, according to their age :

(1) The *comra* or *chara*, or young plant, yielding from half to one and a half seer of sap in the first year, and two to three seers subsequently per night.

(2) The *majhari*, or middle-aged, called also *utit* or *nalgas*—a tree in the full swing of its juice-yielding career, supplying seven to nine seers per night.

(3) The *kakni* or *daria*, so named from its age and yielding its juice late in the season.

The trees are also classed as male and female—the former, which bears no fruit, yielding the sap early in the season, being called *chotna ;* while the latter is called *baron*, bearing fruits and yielding the sap somewhat late. Middle-aged trees with robust heads yield the largest quantity of juice ; the age at which it arrives at maturity being five or six years after the first tapping.

The trees of a date grove are divided into six portions (called *palas*) for the convenience of tapping them by turns, which goes on in the order described below. I should, however, mention here that the first night's juice is called *jeeran*, which is richer in quality and larger in quantity than that of subsequent nights, the second and third night's juice is called *dokat* (second cut) and *tekat* (third cut).

Juice collected in the fourth night is called *jhurrah*, and the day juice is called *ola*. The colder the night, the more the yield of the tree. Foggy and cloudy nights, which serve to decrease the cold of the weather, tend to diminish the sap. High winds dry up the moisture of the surface, and rain washes it off and lessens the sweetness of the sap. I have not been able to ascertain if the influence of the moon has anything to do with its increase or decrease.

Various artifices are resorted to in order to prevent thefts of the sap from juice pots, usually committed by boys at the commencement of the date season. The cutter puts slices of *kachari*, a species of poisonous *Arum*, *purmula*, a nauseating leaf, and other pungent vegetables into the juice pots, in order to punish such night marauders who drink off the juice stealthily, and in the morning the cutter's clamorously abusive language towards the female relations of the young delinquents scares away the whole neighbourhood.

Early every morning the cutter (*gachi*) and his mate (*kheri*) go round from tree to tree, take down the pots, and collect the juice in order to be boiled down into *goor* (molasses). Boiling goes on in the date grove itself, or in some open space close by. A large stove called *bain*, with two to sixteen eyes, over which the boiling pans are placed, is fed by a strong fire. As the boiling goes on in earthen pans, the scum is taken off with a ladle formed out of a date branch, and green date leaves are put into the boiler in order to prevent overflowing. The bubbles which appear in the boiler mark the different stages of boiling, they are styled respectively spider (*makarsha*) bubbles, mustard flower (*sarsa fuli*) bubbles, tiger (*baghai*) bubbles, and treacle (*guria*) bubbles, which last indicate that the process is nearly complete. The boiled juice is then tested by pouring down a stream from the ladle. If it drops slow and thick, the pan is taken off the fire, and a small quantity of the boiled juice is triturated into powder on the margin of the pan and mixed up with its contents, when they all granulate and coagulate into goor. This process is known as *bijmara*.

There are three sorts of goor made from the date juice.

(1) The *patali*, or hard cake, which is used for local consumption, and sold at Rs. 2-8 to Rs. 3 per maund.

(2) *Khan goor* is the goor of commerce, called also *nagree*, locally consumed, but principally used in manufacturing sugar, sold at Rs. 1-12 and Rs. 2-2 per maund.

(3) *Ola goor*, prepared from the date juice—syrupy and devoid of granules; chiefly used in sweetening tobacco, and sold at ten or twelve annas per maund. It is sometimes mixed up with khan goor as an adulteration.

Let us now see what is the actual produce of each tree, and the average income of the ryot from his date garden; although on this point no two accounts agree.

The tapping season generally extends from 5th Aghran (20th November) to 13th Falgun (22nd February), over one hundred and ten days. From this we have to deduct foggy and cloudy nights, which may amount to ten in all during the season. The juice-yielding days amount therefore to fifty in all.

Now counting according to the Bengali months, and taking the average produce month by month, as in the under-mentioned table, we find the yield of a full-grown tree to be—

				Seers.
25 days of	Aghran,	at 2 seers per day	.. .. ..	50
29 „	Pous	5 „	.. .. ..	145
30 „	Magh	8 „	.. .. ..	240
15 „	Falgun	3 „	.. .. ..	45
	Total in ninety-nine days		.. .. ..	480

Or deducting the days of rest, we have for fifty days 240 seers, which is equal to 24 seers of goor, 10 seers of juice being capable of producing 1 seer of goor. The price of these 24 seers would equal Rs. 1-3 and Rs. 2 per maund.

Another, and perhaps a more correct and safe way of calculation, is the following:

There are 5 turns of tapping in Aghran, as rest is given to the tree for six days after jeeran, which at 2 seers per turn would give only—
10 seers of juice = 1 seer of goor, price 2 annas.
In Pous 6 turns of jeeran at 5 seers yield 30 seers.
6 turns of rubbed juice at 2 seers = 12 seers.
Total 42 seers of juice = $4\frac{1}{4}$ seers of goor; price 3 annas 6 pie, at Rs. 2–2 per maund.
In Magh 6 turns of jeeran at 8 seers each turn yield 48 seers of juice.
6 turns of dokat at 6 seers each turn yield 36 seers of juice.
6 turns of rubbed (puccha) juice at 2 seers each turn yield 12 seers of juice.
Total 96 seers of juice = $9\frac{1}{2}$ seers of goor; price 7 annas 6 pie, at Rs. 2 per maund.
In Falgun 3 turns of jeeran at 3 seers each turn yield 9 seers of juice.
3 turns of dokat at 2 seers each turn yield 6 seers of juice.
3 turns of tekat at 1 seer each turn yield 3 seers of juice.
18 seers of juice = 2 seers of goor; price 1 anna 3 pie.
Total 17 seers of goor; price 14 annas 3 pie.

Taking contingencies into account, the yield of a good tree may fairly be estimated at 12 annas a year. Both Colonel Gastrell and Mr. Westland calculate the average produce at 5 seers per tree, while the former makes the tapping nights sixty-five and the latter sixty-seven. My own calculation, counting the number of days from beginning to end, is fifty-five, without deducting foggy and cloudy nights. According to Colonel Gastrell's estimate the average yield of a tree is Rs. 1-2-6, which is very near my first estimate. Mr. Westland's estimate of each tree yielding one maund of goor, valued at Rs. 2 and 2-4, appears to me to be too high. Dr. Forbes Royle, in his work on 'The Fibrous Plants of India,' page 96, quoting from Dr. Roxburgh, states that each date tree on an average yields one hundred and eighty pints of juice, of which every twelve pints are boiled down to one of goor or jagri, and four of goor yield one of good powder sugar; so that the average yield of each tree is seven or eight pounds of sugar annually. Now taking a pint to be equal to $1\frac{1}{2}$ pow or Bengali liquid measure, each tree according to this calculation would appear to yield one maund and $27\frac{1}{2}$ seers of juice; and if 9 seers or 24 pints produce three-fourths of a seer of goor, we have $5\frac{5}{8}$ seers of goor as the average yield of a tree, which at Rs. 2 per maund would amount to 4 annas 8 pie per tree; this is a rather low estimate, looking to the fact that the expenses have yet to be taken into account. In estimating 12 annas as the more correct basis of the average yield of a tree, I have not taken into consideration the expenses that are incurred by the ryot in the preparation of goor. In a garden of two hundred trees the ryot has to lay out—

	Rs.	a.	p.
For fuel	10	0	0
For two *dao*	0	6	0
For purchasing jute	0	8	0
Pots and pans	5	5	0
Rent of two beegahs of land, at 2–8 per beegah	5	0	0
Rent paid to zemindar for keeping up a *bain* (sugar-boiling stove), at 1 anna 3 pie per eye; 6 pie for two side eyes, sixteen openings in all	1	3	0
Total	22	6	0

Or 1 anna 9 pie per tree.

This supposes that the ryot cuts his own trees, assisted by his sons, but this is seldom the case. He has to engage a *gachi* (cutter) and a *kheri* (his assistant) for the season, to whom he has to pay at the following rate—

	Rs.	a.	p.
Gachi (cutter) for the season	22	0	0
Food for five months, at Rs. 2–8	12	8	0
Cloths	1	2	0
Shoes	0	8	0
Total	36	2	0

	Rs.	a.	p.
Kheri (assistant) Rs. 9 for the season ..	9	0	0
Food for five months, at Rs. 2–8	12	8	0
Two cloths	1	8	0
Total	22	0	0

Total servant charge, Rs. 58–2, or 4 annas per tree.

Total expense for two hundred trees, Rs. 80-8, or 6 annas per tree, which leaves a clear profit of 6 annas for every tree to the ryot, besides the advantage he enjoys for raising a cold-weather or *dhan* crop in the soil occupied by the date garden.

The wood of the date tree is used as beams and posts in mat houses, and as ladders in tanks and ghats; it is also employed in constructing temporary bridges over khals and drains.

The leaves cut off before tapping season are used as fuel in the manufacture of goor, and answer the purpose a month. At Kaligunge *bedia patis* (leaf mats) are manufactured from the leaves and sewn into bags, into which sugar is put before being carried to Nalchith and other places. In the two subdivisions I have gone over, 4205 acres of land are occupied by date trees, exclusive of those growing all round the corners of ryots' houses. The approximate number of date trees in these two subdivisions is 1,033,825, or about two hundred and forty trees per acre. A beegah of land (one-third of an acre) is generally planted with one hundred trees; but as some of them die in the course of time, the above estimate is not beyond the mark. In both these subdivisions there are 2720 juice-boiling stoves or bains. For each opening in which a boiler is placed, the zemindar levies a tax of 1 anna 3 pie, and 6 pie for each of the side openings through which fuel is applied. Although the cultivation of the date tree has gone on increasing from year to year, on account of the increased demand for sugar and the shipments made to Europe, still there are no accurate data available for the purpose of ascertaining the actual proportion of increase. In Mr. Westland's Treatise, p. 207, it is stated that in 1791 the annual produce of sugar cultivation was 20,000 maunds, of which half was exported to Calcutta. The increase in cultivation within the last eighty-four years may be imagined from the fact that in the subdivisions of Jhenidah and Magurah alone, comprising as they do only one-third of the district, the production was 391,780 maunds of goor and 137,000 maunds (82 lbs.) of sugar in the year 1873, of which nearly 50,000 maunds have been sent down to Calcutta. There is an extensive date cultivation in the subdivisions of Jessore and Nurrail, which has not been taken into account in this estimate.

Manufacture of Date Sugar from Goor.—The season for manufacturing powdered sugar from goor begins about the 20th Aghran (1st December) and ends on the 15th or 20th of Jyet (end of May), extending over a full period of six months.

The most important place in this district (Jessore) with regard to the manufacture of sugar is Chandpur. The process adopted is easier than at first may be imagined.

The earthen jars into which the cultivator puts his goor are broken up by the sugar manufacturer and the contents poured into a wicker basket, through which the scum oozes out below into a pan. On the fifth day, a river weed, called *patta seala*, found in abundance in the bed of the Bhyrab and Kabadak, is placed over the goor in the basket and kept for eight days. When the seala dries up, it is thrown away, and the upper stratum in the basket, consisting of about 5 seers, is scraped off the surface. New seala is again put and kept on for eight days, and the above process repeated. In the second and third processes the sugar is about 10 seers each time; in the fourth process the yield is 7 seers, and in the fifth 5 seers. In the last stage the yield is about 13 seers of inferior sugar. So from $3\frac{1}{2}$ maunds of goor $1\frac{1}{4}$ maund of sugar (sold at times at Rs. 10 per maund) is thus obtained. The average price of a maund of goor being Rs. 2, Rs. 7 worth of goor produces Rs. 12-8 worth of sugar.

The scum which has oozed and is called *mat*, is again boiled, and sugar is manufactured from it under the above process. The second mat or scum is called *chitta goor*, used for sweetening tobacco and manufacturing rum.

The sugar thus obtained is called *dalua*—from its being produced in clods which are beaten and reduced to powder.

The manufacture of *schachi* (or real) sugar is carried on in the following manner :—Goor purchased in *tillias* (pots) is transferred into gunny bags, which are pressed betwixt bamboos in a hanging posture. The granular goor which remains in the bag is called *khar*, and the droppings—*mat khar*—are then boiled in a pan mixed up with milk water and passed through gunny and cloth sieves, and reboiled and transferred to semi-elliptical pots called *bharneas* with a hole at the bottom. These pots are arranged over shelves and subjected to a course of seala refining as in the case of dalua sugar. The oozing during this process is called mat goor. When the second course of seala is put on, the droppings are called *jherani*, and so on. The process is repeated until the pot is well-nigh exhausted. The sugar produced is called (real) sugar No. 1. The mat goor of the bags and of the first refining process are boiled together and become chitta goor. By boiling the *jherani goor*, (*jherani*) sugar No. 2 is produced by same process as the real sugar. Loaf-sugar or *dobara chini* is manufactured from the dalua, which is boiled in water and skimmed with milk. It is then put into an open earthen pot perforated below. After the scum has dropped out two days, seala is placed on the surface of the sugar, and after eight days it arrives at its refined state. The droppings are boiled and a kind of sugar inferior to the above, called *ekbara chini*, is manufactured from the same. The second droppings are again manufactured into a sugar called *petiar* (basket) sugar. The sugar crop is a large one this year (1873), but owing to low rates in the English market the article is moving slowly. In 1872, 170,000 bazaar maunds of sugar were sold off in the Chandpur market, of which 30,000 maunds were for consumption in the Mofussil.

In the Madras Presidency sugar is extracted from the sap of the palmyra palm, and there are 10,000 acres covered with this tree, chiefly in Bellary. The spadix or young flowering branch is cut off near the top, and an earthen pitcher tied on to the stump. The sap runs into this pitcher, which is emptied and replaced every morning after the stump has been again cut; and this process is repeated until the supply of the sap has been completely exhausted. Powdered chunam (lime), which has the property of preventing fermentation, is sprinkled on the outside of the earthen vessel in which the sap is collected. This juice is then boiled down, and the sugar obtained on drying the sediment by exposure. A tribe called Shanars draw the toddy or juice from the tree.

In Bengal the juice of the date palm, which is so much more abundant in saccharine matter, is preferred for the manufacture of sugar; though it is not apparent why, in parts of the country where the palmyra palm abounds and the people do not drink toddy, its vinous sap is not utilized in the same way as in Madras.

The Palmyra Palm* (*Borassus flabelliformis*, Lin.) is one of those enjoying the widest geographical distribution. A glance at one of the maps in Berghaus's or Johnston's Physical Atlas, showing the range of the most remarkable plants, will help to illustrate this fact.

In the Madras Presidency there are 10,000 acres under culture with this palm.

The number of uses for which the palmyra is employed may be said to be almost infinite; indeed one of the Eastern languages, the Tamil, spoken in a portion of the region which the tree acknowledges as its native country, possesses a poem entitled 'Tala Vilásam,' enumerating no fewer than eight hundred different purposes to which the palmyra may be applied, and this poem by no means exhausts the catalogue.

The spadix bearing the fruits is generally simple, and covered with a single sheath or spathe, as in the areca, catechu, and cocoanut palms, but it is sometimes compound, and bearing two bunches of fruit in a compound spathe. The fruits are, with beautiful regularity, arranged round the spadix in three rows, and whichever way examined are found in nearly opposite pairs. Each spadix bears from ten to twenty fruits, and one of these spadices, with the fruits ripe, would be nearly as much as a man could carry. Each palm bears seven or eight of these spadices, so that a tree often bears about one hundred and fifty fruits in one season; each fruit is about the size of a young child's head. The fruits, when young, are pretty distinctly three-cornered, but when old, the pulp round the nuts swells so as to give the fruit the appearance of a perfect globe.

The ripe fruits or drupes contain two or three nuts imbedded in a mass of soft yellow pulp, intermixed with dark, straw-coloured fibre or coir. These nuts are oblong, and a good deal flattened, and covered with a mass of short fibre which adheres to them. Besides this fibre they are covered with a thick shell, so difficult of fracture that the Tamils say an elephant cannot break them.

The fronds are fan-leaved, armed with spines radiating from a common centre, and the stipes serrated at their edges. The fan part is about 4 feet in diameter. It answers as a kind of umbrella when held by the stem over one's head. The spines are cut off, and the middle is formed into large fans, called vissaries and punkahs. These are lacquered for sale, or used plain, as may suit the taste of the purchaser, but one never sees a Buddhist priest without one of the smaller sort, or a fan of some kind or other; of which some are heart-shaped, others circular, with handles of carved ivory.

The leaves of this tree, as well as those of the talapat tree, are used instead of paper by the natives. They write letters upon them, which, neatly rolled up, and sometimes sealed with a little gum lac, pass through the post-office. During the operation of writing the leaf is supported by the left hand, and the letters scratched upon the surface with the stylus. Instead of moving towards the right hand, which performs the writing, the leaf is moved in a contrary direction, by means of the thumb.

All their olas or books, treating of religion and the healing

* By W. Ferguson.

art, &c., are transcribed on them, but in a language elevated above the common idiom. The leaves of both these palm trees lie in folds like a fan, and the slips stand in need of no other preparation than merely to be separated, and cut smooth and even with a knife, after having been slowly dried in the shade and rubbed with oil. Their mode of writing upon them consists in carving the letters with a fine pointed style, and in order that the characters may be the better seen and read, they rub them over with an ink made of lampblack, or some other substance, and a solution of gum, so that the letters have altogether the appearance of being engraved.

The iron point made use of on these occasions is set either in a brass handle, which the Moormen and others carry about them in a wooden case, and which is sometimes six inches in length, or else it is formed entirely of iron, and together with the blade of a knife, designed for the purpose of cutting the leaves and making them even, set in a knife handle, common to them both, into which handle it shuts up, so that it may be carried by the owner about with him, and be always ready at hand.

On such slips all the letters and edicts of the Dutch Government used to be written, and sent round open and unsealed. When a single slip was not sufficient, several were bound together by means of a hole made at one end, and a thread on which they were strung. If a book had to be made for the use of the Wihares or any other purpose, they sought for broad and handsome slips of talapat leaves, upon which they engraved the characters very elegantly and accurately, with the addition of various figures delineated upon them by way of ornament. All the slips had then two holes made in them, and were strung upon an elegantly twisted silken cord, and covered with two thin wooden boards. By means of the cord the leaves are held even together, and by being drawn out when required for use they are separated from each other at pleasure. In the finer binding of these kind of books the boards are lacquered, the edges of the leaves cut smooth and gilded, and the title is written on the upper board; the two cords are fastened by a knot or jewel secured at a little distance from the boards, so as to prevent the book from falling to pieces, but sufficiently distant to admit of the upper leaves being turned back while the lower ones are read. The more elegant books are in general wrapped up in silk cloth, and bound round by a riband, in which the Burmese have the art to weave the title of the book. The palmyra books are never much beyond 2 feet in length and 2 inches in breadth, as the parchment-like ribs between the little ribs will not admit of their increase in size.

Narrow strips of the leaf are braided into sieves, hats and caps, baskets, mats, and bags; the baskets are used for drawing water as well as other purposes, and the bags not only for carrying rice, salt, &c., in small quantities, but for storing grain, being made very large and strong, while the mats are necessary for the natives, not only to sit, eat, and sleep on, but for drying various kinds of fruit, treading out grain, and many other purposes. On the stem of the leaf is a very hard and strong covering, like that on the bamboo or rattan, which, slit off, is formed into coarse, strong ropes.

Each tree has from twenty-five to forty fresh green leaves upon it at a time, and of these the natives frequently cut off twelve or fifteen annually, or a greater number once in two years, to be devoted to various purposes, as well as to enable the fruit to ripen and increase in size. When the leaves are intended for thatch, or for making fences, they are placed flat on the ground in layers over each other, and often with weights upon them to assist in the process of flattening them. The thatch formed of these does not last longer than two years, nor is it so handsome as that made from the plaited cocoanut leaves. The leaves make very close and elegant fences.

Toddy.—At the season when the inflorescence begins to appear, when the spathes have had time to burst, the "toddy drawer" is at work in the palmyra groves. His practised eye soon fixes on those trees fit for the "scalping knife," and if they have not dropped the foot-stalk of the leaves, the first operation, if the trees are valuable, is to wrench them off. This done, the toddy drawer, armed with his leathern protector for his breast, his raceme-batten of wood, his small thongs, straight and crooked knives, with the side leather pouch to contain them, procures a piece of tough jungle vine, or a strip of the stalk of a young palmyra or cocoanut tree, which he converts into a sort of loop, of such dimensions as to admit of his feet getting through to a space large enough to allow them to clasp the tree. This done, he puts his feet in this thong, stands close to the tree, stretches himself at full length, clasps it with his hands, and pulls his feet up as close to his arms as possible; again he slides up his hands, and repeats the process, until, by a species of screw process, he ascends to the summit of the tree. An expert climber can draw toddy from about forty trees in a few hours. In Jaffna a distinction is made between toddy and sweet toddy, the former, called by the Tamils "culloo," is the fermented, the latter the unfermented juice. Toddy serves extensively as yeast, and throughout Ceylon no other is employed by the bakers; large quantities of it are also converted into vinegar, used for pickling gherkins, limes, the undeveloped leaves of the cocoanut and palmyra trees, and other substances; but by far the greatest quantity is boiled down for jaggery or sugar. About 1000 tons are said to be manufactured of it in Ceylon.

According to Forbes, three quarts of toddy will make 1 lb. of jaggery. Malcolm remarks that jaggery resembles maple sugar, and that in the neighbourhood of Ava, 1 lb. sells for the third of a penny. In Jaffna 3 lbs. are sold for 2*d.* The usual process of making jaggery, as pursued at Jaffna, is exceedingly simple. The sweet toddy is boiled until it becomes a thick syrup, a small quantity of scraped cocoanut kernel is thrown in that it may be ascertained by the feel if the syrup has reached the proper consistency, and then it is poured into small baskets of palmyra leaf, where it cools and hardens into jaggery. In these small plaited palmyra baskets it is kept for home consumption; sent coastwise, chiefly to Colombo, or exported beyond seas to be refined. To make vellum or crystallized jaggery, which is extensively used as a medicine, the process is nearly the same as for the common sugar, only the syrup is not boiled for so long a period.

The pot which contains it is covered and put aside for some months, at the end of which period the crystals are formed in abundance. The juice of the palmyra is richer in saccharine matter than that of most other palms, in consequence, perhaps, of the tree more generally growing in dry sandy soil, and in a dry climate. The great fault of the jaggery made at Jaffna seems to arise from the too free application of lime, a small quantity of which is absolutely necessary to prevent fermentation. Jaggery forms an article of commerce from the upper to the lower provinces of Burmah, and is also of importance in some of the islands of the Indian Archipelago. Besides being exported in large quantities from Ceylon, it forms a considerable portion of the food of the Tamil people of Jaffna. Amongst a variety of purposes to which it is put, is that of being mixed with the white of eggs, and with lime from burnt coral or shells. The result is a tenacious mortar, capable of receiving so beautiful a polish that it can with difficulty be distinguished from the finest white marble.

Timber.—A full-grown palmyra is from sixty to seventy feet high, its trunk at the bottom is about five and a half feet in circumference. The wood is generally known in Ceylon and the maritime ports of India. Large quantities of it are exported from Point Pedro, and other ports of Jaffna, to Madras and Colombo. At certain seasons of the year the felling, splitting, dressing, and exporting of it give work to thousands of the Tamil people of the northern peninsula of Ceylon. The trees have to arrive at a considerable age before they are of use for timber; when a hundred years old they are excellent. The wood of this palm near the circumference, when of sufficient age, is remarkably hard, black, heavy, and durable, and universally used for rafters in pent-roofed houses, for which purpose Roxburgh states it is the best wood in India. The centre is soft and spongy, containing little else than a coarse kind of farinaceous matter, intermixed with some soft, white woody fibres, and is cut out, as the black exterior hard part only is employed. The wood is capable of taking a fine polish. Its specific gravity is, according to Mr. Mendis, 65 lbs. per solid foot. For house building, and various domestic purposes, the timber is the most generally used of the palm tribe. Pillars and posts for the verandahs of houses, well sweeps, joists, and reepers, or laths, &c., are made from it. The trunk is split into four for rafters, into eight for reepers or laths, and these are dressed with an adze. From the structure of the fibres, it splits easily in the direction of its length, but supports a greater cross strain than any other wood; iron nails, however, will rust rapidly in it.

Palmyra trunks split into halves, with the heart scooped out, are used as spouts for various purposes, but more especially for carrying away the water from the eaves of houses. The dark outside wood of very old trees is used to some extent in Europe for umbrella handles, walking canes, paper rulers, fancy boxes, wafer stamps, and other articles.

Kelingoes.—The nuts are collected and buried in heaps in the ground. When dug up after the space of three months, the young shoots called kelingoes supply the inhabitants with a nourishing aliment. In size, colour, and shape they resemble a parsnip, and look like a cold potato. In its fresh state it will keep good for a couple of months, and when well dried in the sun, for a whole year.

In this state they are called odials. When reduced to flour or meal, the favourite cool or gruel is made of it.

Punatoo.—The pulp of the fruit is preserved for use in the following manner:—The ripe fruits are put into baskets containing water, and are then squeezed by the hand till the pulp forms a jelly. Layers of this jelly are spread on palmyra leaf mats to dry on stages. Layer after layer is deposited to the number of about fifteen. These are left in the sun about a fortnight or three weeks, only covered at night, and protected from the dew and rain. The best sort is called Pimatos, and the tough withery kind made from the remaining fruits gathered at the end of the season, which is much in favour, Tot Punatoo. Punatoo is sold by the mat at 3*s.* to 6*s.* each, and is the chief food of the islanders of Ceylon, and of the poorer classes of the peninsula, for several months of the year.

The Sago Palm (*Sagus Rumphii*, Willd., *Metroxylon Sagus*, Koen.) is a tree from which the inhabitants of the eastern portion of the Indian Archipelago derive the farinaceous nutriment which other nations of the world obtain from cereal grains, or farinaceous roots. Marco Polo (A.D. 1475) says of this tree:—"And I will tell you another great marvel; they have a kind of trees that produce flour, and excellent flour it is for food. These trees are very tall and thick, but have a very thin bark, and inside this bark they are crammed with flour." Friar Odoricus, of the Minorites, who visited the Indian Archipelago about 1518 A.D., describes the process by which sago meal was obtained, thus:—"Meal is produced out of the said trees after this manner. They be mighty huge trees, and when they are cut with an axe by the ground, there cometh out of the stock a certain liquor like unto gum, which they take and put into bags made of leaves, laying them for fifteen days together abroad in the sun, and at the end of those fifteen days, when the said liquor is thoroughly parched, it becometh meal. Then they steep it first in sea water, washing it afterwards with fresh water, and so it is made very good and savoury paste, whereof they make either meat or bread, as they think good."

After the Nipa, the Sago is in stature the smallest of the palm tribe, its extreme height seldom exceeding thirty feet, but it is the thickest, except the Gomuti (*Arenga saccharifera*), and a full-grown tree can with difficulty be clasped between both arms. In the early period of its growth, and before the stem has formed, this palm appears altogether like a cluster of so many shoots. Until the stem has attained the height of five or six feet, it is covered with sharp spines, which afford it protection from the attacks of the wild hog, or other wild beasts. When, from the strength and maturity of the wood, this protection is no longer necessary, the spines drop off. Before the tree has attained its full growth, and previous to the formation of the fruit, the stem consists of a thin hard wall, about two inches thick, and of an enormous volume of a spongy, medullary substance. This medullary substance is the edible farina, from which the inhabitants of the Archipelago make their bread. As the fruit forms, the farinaceous pith disappears, and when the tree attains full maturity the stem is no more than a hollow shell. The utmost age of the tree does not exceed thirty years. The sago palm loves low, marshy situations, and will not flourish on dry or mountainous places. Rumphius says:—"This tree grows best in miry or watery soil, where men sink to the knee in mud. It will also grow in gravelly soil, if only it is charged with moisture, and hence no plantation of the sago tree will thrive where there are not one or more rivulets of water." A bog knee-deep is consequently the best site for a sago plantation. There are four well-marked varieties of this palm, namely:

(1) The cultivated, *S. Rumphii* or *S. Konigii*, spinous, both on the trunk and leaves. (2) The wild. (3) One distinguished by the length of the spines on the branches. (4) Another destitute of spines (*S. lœvis*, Reinw.), and usually called by the islanders the female sago.

The first and last varieties yield the best farina; the second a hard pith, from which the farina is extracted with difficulty; while the third, which has a comparatively slender trunk, contains but a small quantity of farina. The sago, like other palms, is propagated from the seed or fruit, which is of inconstant shape and size, from a prune to a pigeon's or a pullet's egg.

The Sago and Nipa palms furnish in the Amboyna Isles a wholesome and abundant nourishment, for a basket of their fruit will support seven or eight persons for a week. A good tree will furnish thirty baskets as an average harvest; the fruits keep well in water.

The sago of the Arenga palm is more palatable than that of the sago palm, but the culture involves more care, and the product does not keep so well.

The word *sagu* is said to be the Malay name for bread or meal.

Sago meal is eaten by the natives in the form of pottage, and also partially baked in earthenware moulds into small square biscuits about two inches long, two broad, and half an inch thick, which will keep a considerable time. Large quantities of the sago meal in its raw state are received at Singapore from the Eastern Islands to be granulated or pearled and bleached for shipment to Europe.

Sago is much used during their sea voyages by the natives; it is cooked by simply dipping the cake in warm water, which softens it, it is also sometimes made into soup.

The sago tree is found, in one or other of its species, throughout the whole length of the Eastern Archipelago, from the islands off the west coast of Sumatra to New Guinea. It is probably capable of flourishing with complete vigour across nearly the entire breadth, wherever its natural soil occurs, and certainly within 10° north and south of the Equator, a band which includes all the Archipelago, except the Philippines. The only countries, however, where it is found growing in large forests are, New Guinea, the Moluccas, Celebes, Mindanao, Borneo, and Sumatra, being widely spread over the Moluccas, but confined to particular parts of the others.

The native country of the sago palm appears to be that portion of the Archipelago in which the easterly monsoon is boisterous and rainy. It is most abundant in the islands distinguished for the production of the clove and nutmeg, and is to be found in its wild state in immense forests. Of all the plants which afford a supply of nutritious farina for human food the sago is at once the most obviously easy, and abundant. The mass of nutritive matter which a single tree yields is certainly prodigious. Five and six hundred pounds weight, it appears, is not an unusual produce for one tree.

Allowing for destroyed, barren, and unproductive trees, the average rate of produce may be assumed at 300 lbs. avoirdupois.

Forrest states the average produce of a Molucca tree to be 336 lbs., but Rumphius makes it from 600 lbs. to 800 lbs.; and according to a writer in a Singapore paper, good Sumatra trees yield from 760 lbs. to 950 lbs., and the very worst 475 lbs. Perhaps, therefore, 700 lbs. may be assumed as an average for the Sumatra trees, which at 10 feet apart (the distance stated by Forrest and followed by Crawfurd) would give 300,000 lbs. for the harvest from one acre; and allowing that the harvests are fifteen years apart, and not seven as Forrest assumes, this will give an annual average produce of 20,000 lbs. I believe, however, that five or six feet is about the average distance of the large stems in the Sumatra forests. When a plantation has once arrived at maturity there will be a constant harvest, because the natural mode of growth secures a constant succession of new plants from the time those first planted have begun to extend their roots, and the succession can be regulated by the knife in any way the planter desires.

There is no regular fixed season for extracting the pith, which is taken as occasion requires and as the individual tree becomes ripe. The period of maturity depends on the nature of the soil on which the palm grows. Fifteen years may be reckoned an average time for the tree to come to maturity. It is not, however, by a calculation of the tree's age, but by its appearance, or by an actual experiment on the pith, that the period of maturity is determined. The inhabitants of the Moluccas mark six stages in the progress of the ripening process of the medullary substance, the first of which is known by the appearance of a mealy efflorescence on the branches, and the last by the commencement of fructification. The pith may be extracted at any of these stages; and sometimes the natives, trusting to their experience, proceed to the harvest from the mere appearance which the tree presents. More frequently, however, a hole is bored in the trunk and a small quantity of the pith extracted for the purpose of ascertaining the degree of its maturity. When the pith is ascertained to be ripe, the tree is cut down near the root and the trunk subdivided into portions of six or seven feet long, each of which is split into two parts; from these last pieces the medullary substance is extracted and at once reduced to a powder-like sawdust with an instrument of bamboo or hard wood. The process of separating the farina from the accompanying bran and filaments is simple and obvious, and consists merely in mixing the powdered pith with water and passing the water charged with the farina through a sieve at one end of the trough in which the mixture is made. This water is again passed into a second vessel, where the farina settles down to the bottom, and, after two or more washings, is fit for use. This substance is the raw sago meal which keeps without further preparation for a month. For further use the meal is made into cakes, which remain sweet for a long time. But for exportation the finest sago meal is mixed with water, and the paste is rubbed into small grains of the shape and size of coriander seeds.

Each tree yields about 50 lbs. of flour; and considering that after cutting down the tree new suckers are sent out from the root, which in their turn render a harvest, and that the culture requires little care, it must be admitted that this palm is for the natives a vegetable food more rich and less variable in its produce than rice.

The sago palm is grown in different parts of the Indian continent as an ornamental tree; and as it is easy of propagation and not difficult to cultivate, it might be of advantage to the country if private enterprise would set on foot plantations of this valuable tree in suitable localities in the plains of India.

In *Borneo* the sago palm is found thriving along the north coast at Kaluka, Oya, Muka, and Bentulu. It is cultivated chiefly by the Millanù population. This tree requires eight years to attain its full growth; it is then cut down and the heart of it extracted. One tree produces about 800 lbs. of raw sago, which, after being washed and dried, gives 330 lbs. of sago flour. During its growth it throws out numerous shoots, which are capable of being transplanted, and thus a plantation is easily increased. The quality of the Sarawak sago flour is considered to be exceedingly good.

The supply of this product is at present abundant, and so easily is the tree capable of propagation that the country between the Rijang and Bentulu could, without much difficulty, be made equal to the supply of almost any demand. As much of the sago is now wasted, owing to the careless and imperfect manner in which the tree is worked by the natives, the employment of machinery would no doubt tend greatly to the economy of this valuable commodity.

There are now several sago factories at Sarawak, all belonging to Chinamen, and worked solely by manual labour. The number of hands employed in each of these is from thirty-six to forty, who manage to turn out 7000 lbs. to 8000 lbs. of sago daily.

Muka not only supplies Sarawak with the sago which it requires for export, but also shipped raw sago direct to Singapore of the value of 31,000 dollars in 1865.

Value of the sago exported in dollars from Sarawak:

Year.	Raw.	Flour.	Pearl.
1863	7,050	64,634	..
1864	21,000	111,509	19,039
1865	11,622	67,207	13,301
1866	21,054	56,647	9,557
1867	18,472	97,309	1,250
1870	11,859	128,025	5,066
1875	720	306,464	..

The export of sago flour from Brunei in 1864 was 16,773 piculs.

From Sarawak in 1864 the exports were 2667 tons of sago flour; pearl sago to the value of 20,000 dollars; and raw sago, value 21,000 dollars.

In 1874 the combined value of the raw sago, pearl sago, and sago flour shipped from Borneo was about 19,000*l.*

The raw sago is brought down by natives from the interior to Brunei, and is there washed and undergoes a refining process before being shipped. The labour employed in the washing and manufacturing process is exclusively Chinese; and the three sago manufactories in Brunei were established by and belong to Chinese traders.

Whether this palm is an indigenous plant, or whether it was originally introduced and cultivated, is perhaps a question: but so abundant is its natural growth, that so long as it was only required for native consumption there was never any occasion for its cultivation. The palm grew wild and in luxuriance, and trees were cut down whenever required. With the increasing demand by foreign markets for sago flour, the inhabitants of the more accessible and more populous districts have been induced to extend the existing area of the natural growth of the palm, by planting new ground with young shoots. No further cultivation is required. Once planted, the young shoot in about seven years becomes a tree of sufficient maturity for the extraction of the medullary pith out of which the sago flour is made, and already propagating itself by sending out fresh shoots in all directions.

In the colony of Labuan the sago traders have largely increased their business, owing to the Sultan of Borneo having removed some of the obstructions to the transit of sago in the neighbouring rivers, and it is not improbable that this island may yet become the centre of the sago manufacture of the Eastern Archipelago. In 1867 sago was imported into Labuan of the value of 9811*l.*; in the following year the trade increased 100 per cent., the value of the imported sago being 19,841*l.*, and the process of manufacture added 8764*l.* more to the value of the sago.

In Celebes all the inhabitants feed upon sago of a very coarse quality, which may be said to grow spontaneously, affording them abundance of subsistence. The sago plantations are situated in the valleys between the mountains, in swampy ground. There are several kinds of sago tree, some of which will not produce any useful fecula or starch for the first 16 years. It is collected from trees of 8 years up to 32 or 35 years of age, after which the tree becomes perfectly hollow, and rots away from the top downwards. A sago tree of 10 years growth will be about 27 feet high, and from 5 feet to 8 feet girth at the bottom, and is continually yielding its crop. When the substance of the edible sago is 3 inches to 5 inches thick they cut it, and this will be in two or three months, according to the nature of the soil, and the oftener it is cut the faster it grows.

There were in 1874, in the district of Tonsawang, Menado, 353,600 sago palms, and their produce was about 2500 piculs of sago; the price of the raw sago was half a florin the picul, and of purified sago two and a half florins the picul. There were in Billiton in the same year 20,630 sago trees. The produce of sago in Riouw is about 57,700 piculs.

There are four or five species of palms which yield sago; those most cultivated are, however, the *Sagus Konigii* and the *Sagus lævis*. These palms are found in every part of the Malayan Archipelago and Philippines as far as Mindanao, wherever there is a genial soil for them, and this consists of a marsh or bog, composed of decayed vegetables, near the sea. They are most abundant in the eastern parts of the Malay Archipelago, at the Moluccas and neighbouring islands, with New Guinea and Borneo, and in the Philippines at Mindanao. In all these sago is more or less the bread of the inhabitants. These palms propagate themselves by lateral shoots as well as by seed, and they die after producing fruit. From the first of these properties it follows that a sago plantation once formed is perpetual.

The sago tree, when cut down and the top severed from it, is a cylinder about 20 inches in diameter, and from 15 feet to 20 feet in height. The contents would, therefore, be nearly 26 bushels, and, allowing one-half for woody fibre, there will remain 13 bushels of starch, or say 700 lbs.

It may give some idea of the enormous rate of this produce, if it be considered that three trees yield more food-matter than an acre of wheat, and six times more than an acre of potatoes. An acre of sago, if cut down at one harvest, will yield 5220 bushels, or as much as 163 acres of wheat, so that, according as we allow seven or fifteen years for the growth of a tree, an acre of sago is equal in annual produce to 23 or 30 acres of wheat.* It is far from being either so palatable or nutritious as it is prolific, and is never preferred, even where it is most abundant, to rice.

Singapore is at present the chief place of manufacture and principal mart for granulated sago and "sago flour," as it is termed in commerce, but which is, in fact, the fecula, or ungranulated starch. The granulated fecula, or sago, of a dirty brown colour, used to be exported from the Archipelago in small quantities, but when the trade in Europe was thrown open, in 1814, the Chinese of Malacca began to prepare a superior starch, known in commerce under the name of pearl sago.

All the raw sago manufactured at Singapore is brought from islands to the eastward, principally from the north-west coast of Borneo and the north-eastern part of Sumatra, with its adjacent isles, from Siak to Indragari, but a considerable portion comes from places more than 1000 miles distant.

This article is very easily prepared for exportation in its raw state; the tree is cut down, then the cellular tissue is taken out and made up into bundles. In this form some 18,000 or 20,000 tons are annually imported at Singapore, where it is prepared by the Chinese, who clear the meal or farina from the fibres of the cellular tissue, when the flour is either made up for exportation in its natural state, or granulated into pearl sago.

Manufacture of Pearl Sago in Singapore, by the Chinese.—The

* 'Journal of the Indian Archipelago,' vol. iii. p. 312.

tampins or leaf bags of sago having been placed in heaps in the shed, the first step is to open them, cast the contents on an inclined plane, about 12 feet square, surrounded by a rim rising about 2 inches from the surface; the sago, massed together by having remained compressed in the tampin, is here broken up by the common *chăutzăl* (a kind of hoe).

The raw sago having been thus made ready for the manufactory, the first process to which it is subjected is that of a thorough washing, without which it would remain impure and coloured. For this purpose strong tubs are employed, about 12 inches deep, 40 inches in diameter at the top, and 6 inches or more at the bottom; they are bound by three hoops, each formed of about six rattans twisted together. A piece of thin coarse cloth is fastened by its four corners over each tub when used, and hung loosely into it. The moist sago being poured into this strainer, and there broken and bruised by the hand, is agitated until all its fine particles pass through the cloth and descend to the bottom of the tub, while the fragments of leaf, fibre, and other impurities which remain in the cloth are shaken into a rude mass, which is taken up in a bowl and thrown aside. The rapidity and deftness with which this and all the other manipulations are performed are very striking. The sago is next stirred with an oar for about an hour, after which it is left to stand for twelve hours, when the water is ladled out, and the sago, which fills about half the tub, is removed to undergo the last purifying process which precedes the granulation. This is performed in a mode at once simple and ingenious, the same principle being availed of which serves the gold and tin miners of the Archipelago to clean the ore; the more precious matter happening in all three cases to be heavier than that with which it is mixed, and being thus readily separable by the action of running water.

Two tubs are placed at a distance of 10 or 12 feet from each other, and connected by troughs, raised by a framework above them. These troughs are about 10 inches deep, 14 inches broad at the top and 11 inches at the bottom, one end being closed and the other open, but having grooves in their sides and bottom, like those of a sluice, into which a series of horizontal pieces of wood or stick fit, each being about three-eighths of an inch in thickness. The end of a piece of cloth, of the breadth of the trough, being placed over the groove at the bottom, the shortest of the sticks is pressed down upon it, and the cloth, thus fastened, is made to hang down over the edge of the trough into the tub below it. The tub at the after end now receives the sago to about two-thirds of its depth, when it is filled up nearly to the top with water. A man now stirs up a portion of the sago with an oar till the water attains a milky appearance, when he proceeds to pour it into the troughs. To prevent its falling abruptly an inclined piece of wood, 8 inches broad, is fixed across the trough, so as to leave only a narrow slit between it and the end of the trough. The water poured on this descends into the trough, and slowly flowing to the other end deposits a portion of the sago in its progress. The suspended cloth, becoming saturated, serves at once to maintain and equalize the overflow of the water into the tub below it. When the water is poured in the first waves advance rapidly and carry away much of the sago, but those that succeed deposit the greater part of their more solid contents, transporting into the tub only the lighter fibrous particles which it is the object of this operation to separate from the farina, and by the time the man has performed a similar service at the other trough, and is ready to pour a fresh supply into the first, the water flowing down the cloth has lost its whiteness. This process is continued until the deposit rises nearly to the level of the stick, when the sago next to it, which generally contains some impure sediment, is taken up with the fingers or thrown into the tub. The second stick is now fixed above the first, a fold of the cloth being interposed between them to prevent any liquid sago escaping through the seam, and the operation goes on as before. When the milk in the upper tub begins to grow shallow it is again filled up with water and more sago stirred up and mixed with it. During the interval and at other more prolonged interruptions, the water in the troughs has had time to deposit all its contents, the last being a fine fibrous matter, which, if not run over, would leave a thin yellow layer. The surface is therefore washed with the hand until this layer is effaced and held in suspension. When the troughs have been gradually filled up in the manner described, by a succession of deposits, and the wall built up to the top by the last stick, the sago is left to consolidate for twelve or fourteen hours. The fecule which passes out of the troughs in the current is afterwards thrown into one of the tubs, whose contents are to be washed and deposited in their turn, and some of it may even be destined to pass through the process many times before it sinks in the trough.

In order to give it the degree of dryness required, it is exposed for one day to the sun, in lumps about a cubic foot in size, which are placed on tables standing in the open air. Large kajans (or mats) are kept in readiness to cover it when a shower of rain falls. It is next carried to the large shed, where it is thrown in a heap on a long table and broken down into a pulverulent state. It then passes through an oblong sieve, 30 inches by 20 inches, of which the bottom is formed of parallel fibres from the stem of the cocoanut leaf, kept in their position by strings, which cross them at distances of about 2 inches. The lumps which do not pass through the long interstices between the fibres are thrown back into the heap.

The granulation or *pearling* now takes place. The sifted sago is placed in a cloth, of which the ends are tied to a long stick, and that is kept expanded in a bag-shape by a short cross-stick. A horizontal vibratory motion is given to this, the whole mass being kept in constant agitation and every part successively driven along the sides of the bag. This lasts for about a minute, when the now granular sago is again passed through a sieve similar to the preceding one, but the smaller grains which pass through are those which are rejected. Those that remain are transferred to a circular sieve, of which the bottom is formed of fine strips of bamboo crossing each other. The grains which pass through the square holes thus produced form the pearl sago of commerce in the unroasted state. Those that are larger than the holes are thrown back into the heap to run through the same course again. To assist the men the oblong sieves and the granulating bag are sometimes suspended by rattans from the rafters of the shed.

The roasting takes place in a row of iron pans, each about $2\frac{1}{2}$ feet in diameter, which are built into a platform of masonry about 15 feet long and 4 feet in breadth, covered with flat tiles. The pans rest in an inclined position, partly against the back of the platform, which rises about a foot above the level, and partly on a small prop of brick-work on the right side, an offshoot from the wall. Into the top of this prop a plate is sunk in which a cloth saturated with water is kept. Behind each pan is an open furnace mouth, and a man constantly attends to the fires, keeping them supplied with a few billets of hakan wood, and regulating them with a two-pronged iron fork, so as to maintain a moderate heat. The pan being gently rubbed with the cloth, a man who sits in front of it on a low stool on the platform pours into it a quantity of granular sago. This he slowly stirs for a short time with a wooden implement, called weah, having a sharp curved edge. More sago is poured in until it amounts to about two chupahs, when as it hardens he uses the weah more freely. After about three minutes' roasting it is removed to a table and passed through a round sieve, similar to that before described. The grains that adhere to each other are thrown aside, and those that pass through form a smoking heap, which is allowed to lie undisturbed for about twelve hours. The grains are about the same size as they were before roasting, and some retain wholly or partially their white and mealy appearance, but the greater part have become translucent and glutinous, and all have acquired a certain degree of toughness, although still soft. The final process is another roasting, which renders them hard and tough, and greatly reduces their size. The pearl sago thus prepared and fit for exportation, is put away in large open tins ready to be transferred to boxes or bags when sold.

The imports of sago flour from Labuan, Borneo, Celebes, and Sumatra, &c., into Singapore, were, in

	Cwts.
1868	314,546
1869	282,855
1870	367,255

The exports from Singapore have been, in piculs:

Year.	Sago Flour.	Pearl Sago.
	piculs.	piculs.
1865	67,782	59,112
1866	74,587	67,239
1867	235,864	..
1868	218,008	71,131
1869	173,820	107,245
1870	154,489	133,680

The imports of sago have steadily increased in England since the abolition of the duty which was formerly levied.

In 1830 the import and consumption of sago in the United Kingdom was only 3,000 cwt.; in 1841 it was 52,000 cwt.; in 1850, 90,000 cwt.; in 1860, 179,825 cwt.; in 1870, 280,047 cwt., of the value of 218,400*l.*; in 1875, 360,357 cwt. of sago and sago flour, of the value of 273,913*l.*

The following figures give the imports of sago into the United Kingdom from the Straits Settlements alone:

	Cwts.		Cwts.
1862	165,635	1869	268,978
1863	123,870	1870	268,666
1864	111,423	1871	227,766
1865	106,409	1872	288,862
1866	151,788	1873	279,766
1867	142,844	1874	300,299
1868	241,860	1875	350,064

The chief uses of sago are for feeding stock, making starch, and by the cocoa manufacturers for grinding up and giving thickness to their product when consumed.

The Bastard Sago (*Caryota urens*) is a native of the mountainous regions of India, especially in the Coromandel and Malabar coasts, and in Travancore, Mysore, and Ceylon. It is one of the largest and most charming of this beautiful tribe, having a straight trunk from 40 to 60 feet high. Sugar and toddy wine are both prepared from the sap of this palm, which is cultivated by the people for those uses. The best trees will yield 100 pints of sap in twenty-four hours; and it is on account of this productiveness that it is so much valued. The sugar and wine are obtained much in the same way as from the juice of other palms.

Sago is prepared from the pith, and is either made into bread or boiled as a thick gruel. According to Dr. Roxburgh, "the pith or farinaceous part of the trunk of old trees is said to be equal to the best sago . . . . I have reason to believe this substance to be highly nutritious. I have eaten the gruel, and think it fully as palatable as that made from the sago we get from the Malay countries."* This sago is found to be an efficient substitute for the staple food of the countries where it is produced, during periods of famine.

A fibre is prepared from the leaves of this palm, which is used for fishing lines and bowstrings. Commercially, it is known as kittool fibre and Indian gut in the English market. It is strong and durable; though it will resist the action of water for a long time, it is yet apt to snap if suddenly bent or knotted. It is now used in brush making. During late years the trade in this staple in England has been small for want of stock; the price in London in Jan. 1877 was for good, 11*d.* to 1*s.* 1*d.* per lb.; ordinary, 8½*d.* to 9½*d.*; common, 5*d.* to 7*d.* In Ceylon the split trunks are used as rafters, and are found very hard and durable. The fibre of the leaf-stalks is made into ropes, and used for tying wild elephants. The woolly substance found at the bottom of the leaves is employed occasionally for caulking ships. According to Buchanan, the trunks of this palm

* Roxburgh's 'Flora Indica,' vol. iii. p. 626.

are the favourite food of elephants. The fruit, which is about the size of a plum, has a thin yellow rind, very acrid, and if applied to the tongue will produce a burning sensation. Hence the specific name of the tree. The seeds are used by Mahomedans as beads.

Another misnamed sago palm is the *Cycas revoluta*, Willd., a native of Japan. It is in that empire grown in plantations around the houses. The seeds are eaten, and an inferior kind of sago made from the central stem, whence it has received the name of sago palm, although the true sago, as we have seen, is the product of the *Sagus Rumphii* palm.

Sago is easily obtained from the interior part or trunks of these trees. The process consists in pounding the spongy or cellular texture of the stem—sometimes erroneously called the pith—and washing it with water, which is strained, to separate the ligneous fibres from the fecula. Sago is grained by moistening the flour and passing it through a sieve into a shallow iron pot that is suspended over a fire, by which means it assumes a globular form. In consequence of being half baked during the process of granulation, it may be kept a long time without undergoing a chemical change.

According to Dr. Hamilton, a kind of sago flour is prepared from the nuts of *Cycas circinnalis*, which is much used by the poorer classes of natives and forest tribes of Malabar and Cochin. The nuts are dried in the sun for about a month, pounded in a mortar, and the kernel made into flour.

The Carnauba Palm.—This Brazilian palm (the *Copernicia cerifera*, Mart.) is but little known beyond the locality where it grows, but its many useful products demand for it a more extended notice. It is most extensively found in the province of Ceara, although it is met with in several others of the northern districts of Brazil, either isolated or aggregated in immense forests. The stem (stipe), completely round and straight, attains the height of 48 feet, and a thickness ranging between one foot and one foot and a half in circumference. The upper part of the stem contains a medullary substance (parenchyma), which gives forth the leaves. The terminal bud (palmetto, or cabbage palm) furnishes a delicate and substantial food. In springing from the head of the stem, the leaves, to the number of six or eight, cross each other perpendicularly, united together by a mastic or coating which holds them firmly together. The petioles remain separate, but the leaves re-unite at the top and form a round fringed body. The interior of the young groups of leaves is clear yellow. At this stage of their development the leaves transude a dry pulverulent ash-coloured substance, which covers their interior surface and exhales a particular but agreeable odour. This substance is a vegetable wax; it is detached from the leaves by the least shock when they begin to open, but when the fan is expanded, the simple movement produced by the wind is sufficient to cause this powdery substance to disappear. The carnauba palm delights in dry localities, or, at least, ground which remains dry the greater part of the year; and yet it will stand perfectly the prolonged inundations of water, provided that they do not cover completely the whole lower part of the trunk. At Ceara and the surrounding country, where it never rains for six months in the year, that is in the season called spring by the natives, the carnauba pushes forth its most vigorous strength when the season is dry and destitute of water. At the time of the greatest aridity and desolation, corresponding with the winter of the temperate zones, forests of carnaubas flourish, blossom, and ripen their fruit. This singular plant is so proof to heat that it can support without injury the action of fire, for the flames which may destroy the useless parts, only make it grow more vigorously subsequently. In the times of the greatest drought the people give themselves up with ardour to the collection of the products from the carnauba, which in those times yield new and increased resources. The most important of these products is the wax. Early in the century Manuel Antonio di Macedo discovered at Ceara the carnauba wax. But although he pointed out the means of obtaining the wax, no persons appear to have occupied themselves about it. It would seem that the discovery dates before 1810, for it was in this year, and after the description of the botanist Arruda, that it commenced to be known, and to produce a certain impression of novelty. The Brazilian authorities were not slow to give to it the importance it merited.

The greater part of the wax obtained is used in Brazil, where it is employed in its raw state for lighting. In making it into candles, a small quantity of tallow is added. No one is seriously occupied in the scientific improvement of this product, which might become an article of considerable commercial importance. Meanwhile, a few makers of candles from carnauba wax at Ceara have recourse to certain processes by which they obtain a slightly improved product, but in general the candles made of it in Brazil are of a very inferior quality. They are most used for household purposes, especially for lighting kitchens. In fact, these candles produce the cheapest light that can be obtained. In comparing their illuminating power, the advantage is chiefly in the extraordinary duration of these candles, as the price is not higher than that of those made with other materials. Candles made with carnauba wax in the crude state give off in burning a perfume which is not disagreeable. As the discovery of this wax only dates from the early part of the century, it received little attention till after 1846, resulting from the great drought of the previous year.

The following gives the exports from the port of Ceara:

Year.	Quantity.	Official Value.
	lbs.	£
1846	52,416	694
1856	83,808	2,075
1860	136,192	3,371

From the port of Aracati there was also shipped in 1858, 1,124,320 lbs., valued at 38,055*l*. From special information it appears that the minimum export from these two ports in 1862 was 1,440,000 lbs., and the quantity consumed in the province of Ceara being estimated at 1,120,000 lbs., it follows that the total quantity of carnauba obtained in 1862 was over 2,560,000 lbs., of the official value of nearly 100,000*l.* I may observe that of all the provinces of Brazil where the carnauba palm grows, that of Ceara alone gives any attention to the collection, and even there only the districts of Aracati and Ceara make of it an important industry. I cannot but think the official statistics given above are far below the reality, for the province of Ceara has more than half a million inhabitants, and these employ carnauba wax alone for lighting. There is also a very active commerce carried on with the adjoining provinces in carnauba candles, transactions which do not come under the control of the customs; and as the churches are exclusively lighted with them, these facts should be taken into account in the consumption. The commerce in this wax has increased considerably since 1862; in 1863 the official entries of exports through the custom-house of Ceara, and its outport, Aracati, were upwards of 2,000,000 lbs. of this wax. Supposing the local consumption to have increased in the same proportion, this brings up the production of carnauba wax to over 4,000,000 lbs. Taking these figures for basis we may try to discover the number of trees required to furnish that quantity of wax. The harvest of leaves is made during six consecutive months, by cutting twice a month, making thus twelve cuttings in the year. Each tree gives on the average eight leaves at each cutting, which forms an annual yield of ninety-six leaves per tree. From an interesting notice by M. C. F. de Lima, a distinguished agriculturist of Ceara, I learn that five hundred leaves on good land yield 32 lbs. of wax, but it takes twelve hundred leaves on poor land to yield the same quantity. Taking the mean of these two quantities of leaves, we find that it requires eight hundred and fifty leaves to obtain 16 kilogrammes, or 32 lbs. of wax. As each tree furnishes on the average ninety-six leaves a year, to ascertain the annual product of each tree, I take the following proportions (calculating in kilogrammes of 2 lbs.): $850 : 16 :: 96 : x$. The result for ninety-six leaves, or for one tree, is 1·807 kilogramme. To ascertain the number of palms necessary for the production of 2,000,000 kilogrammes (or 4,000,000 lbs.) of wax, the yield of 1863, it suffices to establish the following proportion: 1 kilo. $807 : 1 :: 2{,}000{,}000 : x$. We find the result to be 1,106,799 trees. This number scarcely represents one-fifth part of the carnauba palms distributed over the various provinces of Brazil. This palm thus produces an annual revenue of about 1*s.* 6*d.* per tree, which is the more important, as the tree requires no outlay for culture, and suffers nothing from droughts, heavy rains, or fires. The vegetable wax, which covers in a light powder the leaves of the carnauba, is scattered through the atmosphere, borne by the winds, when it is not collected by the hand of man.

In Ceara, where the collection of the wax is carried on, they have commenced to appreciate its value, and to look to its future importance. A law of the province specially protects the carnauba, by imposing a fine of 2*s.* 6*d.* on anyone who destroys a tree without the permission of the proprietor. In the province of Rio Janeiro they have commenced planting the carnauba palm, which has succeeded well. This is a useful attempt, because, besides its commercial yield, it contributes to render wholesome the locality where it grows. The collection of the wax is a very simple affair. When the leaves comprising the network which crowns the head of the palm, separate in the form of a fan, they are cut, taking care to leave the sheath in the centre, which forms the network of the new shoot. To effect this, a sickle, or gardener's knife, is attached to a long handle of bamboo. A native, well up to his work, can with this cut thousands of leaves in a day. As the cutting continues for six months, one would suppose that the tree would soon be deprived of its fans, but this is not the case, for the vegetation is so rapid that the young shoots follow immediately the removal of the leaves, and the rest of six months given to the carnauba is sufficient to repair the damage from the pruning to which it has been submitted. The leaves are dried on the spot, extended in rows, the exterior on the ground, so that the wax may not escape by the opening of the angles of the fan. In about four days they are collected or heaped up, and a cloth sufficiently large is spread on the ground, around which two or three females place themselves, and taking the leaves beat them with a stick, so that the powder which is to become the vegetable wax falls on the cloth. In order that the powder may be more easily detached, a man splits the leaves into strips by means of a stiletto. To obtain the wax, this powder is immediately melted in clay or iron pots, a few drops of water being added. The melted wax is run into moulds of earth, by which it is transformed into cakes, of about 4 lbs.; these, on cooling, however, break into small pieces, owing to the brittle property of the wax. After the removal of their coating the leaves are burnt, in default of any other convenient means of utilizing them. But independent of the wax which they furnish, the leaves might be applied to economic purposes. From time immemorial the aborigines of Ceara have prepared from the leaves a fibre which they twist into twine more or less fine, which is used for a number of purposes, such as for hammocks, cordage, fishing lines, &c. This industry has made much progress since the conquest of Brazil by the Portuguese, but it still remains in the hands of the semi-civilized natives. The leaves are reduced into fibre without any previous maceration, by first cutting them into strips, and then passing them over a rough card, consisting of points of iron fixed into a piece of wood. The aborigines make theirs of the teeth or bones of fish. I have no precise data upon which to form an estimate of the value of the fibre thus employed, but it is in such general use in the province that it must be considerable. The inhabitants of this country, with but rare exceptions, sleep in hammocks, and the cords by which these are attached to posts or trees are usually made of carnauba fibre. It would be possible to form an approximate estimate of the yards of cord employed for this purpose if it were all made of this fibre. However, I may, without much error, take the consumption of cords employed for this purpose at one million. If we calculate them at six yards, we arrive at an annual consumption of six millions of yards, supposing that the cords last but one year. Besides this special use, the cordage is employed for a great number of other uses: for securing the loads which are carried on the backs of beasts of burden; for lashing the bales of agricultural produce for export; for dragging in imported merchandise; for halters and ties for animals; for nets, and a variety of other purposes. We may certainly set down carnauba cordage at one-third of the whole used in the province. The ropes of this palm fibre, strong and handsome, have not yet entered into foreign commerce. The young leaves have also another and very general use in the province, and in many of the seaports of Brazil. A great number of articles are made of straw in Europe for which the fibre of this palm is usually substituted in Brazil. Thus, they make of it, and sell at very moderate prices, hats, mats, baskets, brooms, mattresses, &c. These are all in frequent and common use, and are carried by sea along the coast, as well as the leaves for making them. Thus, in the year 1857, there were shipped from the ports of Ceara and Aracati 30,625 mats, and about half a million leaves of carnauba, officially valued at 1500*l.* Another frequent use for these leaves is to make a kind of cushion for the back of beasts of burden, to prevent the load injuring the animal. The dry leaves are also employed for thatching cottages. In Ceara and the adjoining provinces, one-third of the houses are covered with these leaves, which are remarkable for their lightness, elegance, and durability, and form an impermeable thatch.

As evidence of the wasteful destruction of the leaves by burning, the following estimate may be given. A dry leaf, with the pedicle removed, weighs 134 grammes. The wax powder removed from a leaf is on the average 6·75 grammes. The number of leaves burnt in 1863, calculated on the yield of 2,000,000 kilogrammes, gives 296,444,446. The weight of leaves at 134 grammes each would be 39,723,555 kilogrammes. The immense quantity of textile material thus lost might be easily utilized for cordage, straw, &c. It only involves the cost of collection, which may be set down at less than 2*d.* per cwt. on the spot. The locality where it could be had in most abundance is the town of Limoeiro, about 10 or 12 miles from the port of Aracati, for the carriage road between the two is bordered by carnauba palms. An attentive examination of this fibre, and its abundance, suggests its utility as a paper-making substance. The scarcity of rags is becoming greater daily, therefore any raw material that can supply their place is a boon to the paper trade.

The wood of the carnauba is very useful. Not only is it generally employed as a carpentry wood, but it is esteemed for joiners' and cabinet work. It is very hard, of a yellowish red, traversed with black veins, is susceptible of a fine polish, and occasionally offers black shades of a handsome effect. For general carpenters' work not exposed to the inclemency of the seasons the wood answers admirably, for in such positions it is indestructible. It has nothing to fear from gnawing animals if it is felled at maturity. But if exposed to the weather its duration is precarious, and it decays in from ten to fifteen years. To make amends for this, it is most durable in salt water, and is much esteemed for piles, palisades, &c., from its great resistance. There have been removed from old marine constructions, abandoned more than a century, piles of this wood in a thorough state of preservation. The carnauba would also be suitable for yards of vessels, as it is perfectly cylindrical, of an equal thickness throughout its length, and very elastic. M. Manoel Dias, of Aracati, thus speaks of the carnauba in the Catalogue of Products shown at the National Exhibition, Rio Janeiro, in 1861: "This wonderful palm is the tree of special utility. Man can with this plant alone construct his house, furnish, and light it. He can obtain from it wherewithal to nourish, clothe, and heal him. He can extract from it fecula, sugar, and spirit. Moreover, it furnishes good food for cattle and the denizens of the poultry yard. No other plant has been supplied by nature with so many useful properties as the carnauba, which is in the vegetable kingdom what iron is in the mineral kingdom. The products of this palm can be applied to more than forty diverse uses, and it may be added that the number of its various applications is by no means exhausted."

The Betelnut Palm.—This palm, the *Areca Catechu*, is generally admitted to be the most graceful and elegant of the Eastern palms. It is extensively distributed over India, but is cultivated chiefly on the Malabar coast, in the north of Bengal, and the lower slopes of the mountains of Nepal; the south-west coast of Ceylon, Siam, Cochin China, Pinang, and Sumatra. Unlike the cocoa palm, it will thrive in high regions and at a distance from the sea.

From Ceylon the export seems to be on the increase; for whilst in former years, 60,000 to 70,000 cwts. was the average, in 1873 the shipments reached 146,484 cwts., valued at 85,300*l.*, and in 1874 129,826 cwts., valued at 108,730*l.*

This palm begins to bear fruit after five years, and continues productive for twenty-five years. It flowers in April and May, and the nuts are ripe in October. The nuts most esteemed are those gathered before they are quite ripe.

An extensive commerce is carried on in the East in the fruit of this palm, which forms a main ingredient in the Eastern masticatory. Blume tells us, that the Asiatic nations would rather forego meat and drink than their favourite betelnuts, whole shiploads of which are annually exported from different quarters. One hundred millions of people use the betelnut. There are said to be twenty different species of *Areca*, but probably many of these are only varieties. This palm often grows 50 feet high, with a diameter of less than two feet; it has no branches. The fruit, a drupe, about the size of a pullet's egg, does not fall from the tree even when ripe; it has a yellowish shell; thin, with arched veins, cohering with the pulp all round.

It is stated, that a fruitful palm will produce, on an average, 850 nuts annually, but the mean may be taken at 300 nuts. The average production in a plantation is about 10,000 lbs. of nuts per acre.

A cargo of betelnuts generates so much heat, that the crew cannot sleep between decks. A good tooth-powder is made from the nuts. When turned they are used for bracelets. In the Cossyah or Khasia country, the natives measure distances by the number of mouths of betelnuts chewed on the road.

In the island of Yap, Western Pacific, the betelnut tree is cultivated with the greatest care. It is a beautiful slender palm, and grows amongst the cocoanut trees, which it resembles in appearance. The nuts are pulled before they are ripe, and are chewed with the usual condiments, lime and aromatic leaves, by both sexes. They are called Addaca in Travancore. In the Bombay market three kinds are met with; white, from Shevurdhun, which are three times the value of those from other countries; red, which are half the value of the best white; and nuts in the husk, sold by the thousand. The crushed nut is generally used with the leaf of the betel-pepper (*Piper Betle*), and chunam or shell-lime. Prepared slices of boiled betelnut, called Callyareka, are sold in Cochin at about 6*d.* a pound.

The mastication of the betel is considered very wholesome by those who are in the habit of using it. Mr. Crawfurd thinks that, like tea, coffee, and tobacco, the areca nut stimulates the nervous system, and hence its general use. It may be so, but the black hue it imparts to the teeth (although it is said to be an excellent preserver of them), together with the blackened lips and mouth, give anything but an agreeable appearance.

Betelnuts contain a large quantity of tannin, which has caused them to be employed in some parts of India for dyeing cotton cloths. The exact country of the betelnut is unknown, but is supposed to be the Sunda Islands; the tree, from time immemorial, has been extensively cultivated in all parts of the East Indies, so that we are unable to trace it back to the spot whence it originally may be supposed to have come. It grows freely in all the eastern islands, from Sumatra to the Philippines, and seems to have as many distinct names as there are languages. Thus in Malay and Chinese it is called *Pin-lang* or *Pinang* (giving its name to the island in the Straits); in Sumatra, *Jambi;* in Bali, *Banda;* in Bugis, *Rapo;* and in Tagala and Bisaya, *Bongo;* in Achin, *Penu;* in Sanscrit, *Goorvaka;* in Bengalee, *Gooa;* in Arabic, *Fofal;* in Persian and Hindustani, *Soopara;* and in Telugu, *Poka Chettu.* Judging by this, the probability is that the tree is indigenous in each country. In the fresh or green state, the betelnut is an object of general domestic consumption; and in the dry state, of large exportation to China and India. Fifteen tons of these nuts were shipped from Singapore in 1858, to the single port of Ningpo. The shipments from the Straits Settlements in 1867 were 3,820,457 cwt., valued at 120,626*l.* From Pinang the exports in 1870 were 166,111 piculs. The most productive countries in this article are Ceylon, and the northern and southern coasts of Sumatra, towards its western extremity. At Billiton, in the Eastern Archipelago, there were in 1874 65,223 Areca palms.

At Travancore, where the betelnut is a staple product, a quarter of a century ago, there were ten and a quarter million of trees growing, which, at the average yield, would produce about 63,000 tons of nuts. From the Madras Presidency there was shipped to Bombay in 1872–73 43,958 cwt., besides about two millions of the nuts unhusked. In Pinang there are half a million, or more, betel palms, producing upwards of 3000 tons. The Pedir coast of Sumatra produces annually about 4700 tons, of which half is exported. The Chinese receive from thence 3000 tons, besides as much more from Cochin China. When there is not an immediate demand for the nuts they are stored in the husk, but insects attack them freely. Of the nuts produced in Travancore, 300 tons of prepared nuts are annually sent to Tinnevelly and other parts of the peninsula, and about 3,000,000, ripe nuts, in the husk, to Bombay and other places by sea. The local modes of preparing the nut for use in Travancore are as follows:—Those used by families of rank are collected while the fruit is tender, and the husk, or outer pod, is removed; the kernel, a round fleshy mass, is boiled in water. In the first boiling of the nut, when properly done, the water becomes red, thick, and starch-like, and this is afterwards evaporated into a substance like gambier or catechu. The boiled nuts being now removed, sliced, and dried, the catechu-like substance is rubbed on them, and when dried again in the sun they become of a shining black colour, and are ready for use. Whole nuts without being sliced are also prepared in the same way for use. Ripe nuts, as well as young nuts in the raw state, are used by all classes of people, and ripe nuts which have been steeped or kept in water, are also used by the higher classes.

At Pedir, Acheen, and other parts of the East, betelnuts are sold by the loxa or laxar, which weighs about 168 lbs., and consists of 10,000 nuts, with from 10 to 25 per cent. added, according to the bargain previously made, to make up for nuts which may be worm-eaten or otherwise damaged.

The nut is conical, but varies, in some having an elevated apex and small base, in others a large base, and a very slightly elevated apex. The nuts are gathered in July and August, though not fully ripe till October. The quality of the nuts does not at all depend upon their size, but upon their natural appearance when cut, indicating the quantity of astringent matter contained in them. If the white or medullary portion which intersects the red or astringent part be small, has assumed a bluish tinge, and the astringent part itself be red, the nut is considered of good quality; but when the medullary portion is in larger quantity, the nut is considered more mature, does not possess so much astringency, and is therefore not so much esteemed.

The areca nut fibre is worthy of notice because of its capability of being turned to many useful purposes, especially as it has a soft and cotton-like feel, and is capable of being spun into twine. Moreover, immense quantities of the husks are now thrown away, and should this fibre be found capable of being made into paper, or turned to other useful purposes, of which no doubt is entertained, it may be collected in large quantities, and at little cost.

The Nagar division of Mysore, in consequence of its hill tracts and moist climate, offers peculiar facilities for the cultivation of this palm. So we find almost every hut sheltered by a shady grove of these trees, whose slender forms sway with the breeze, and whose fringy tops, whilst murmuring amid the mountain solitude, cast a fragrance around from their aromatic blossoms.

The land most congenial to its growth seems to be a level cut on the slope of a hill, or some sheltered valley rich in vegetable deposit. That it is a tree requiring manuring like the plantain is obvious, from the trees requiring trenching and manuring round annually to ensure a good crop of nuts.

The ripe nuts are gathered, and, after being peeled on a sharp knife fixed on a board, are cut in two, and dried in the sun. Another process is slicing the nut and parboiling it.

The Mysore nut is considered superior to all others, and forms four-fifths of the consumption in Madras.

The nut imported from Ceylon and the western coast is not so much appreciated, and commands a much lower price in the market.

The land devoted to the areca and cocoanut palms in Mysore amounts to 48,000 acres, of which the bulk (43,000 acres) is under areca trees. The quantity of betelnuts exported in 1869 was 5069 tons, valued at 300,486*l.*

In the northern coasts of Acheen, especially Pedir, much attention is given to the Areca palm, and large quantities of betelnuts are sent to Penang and the Coromandel coast. The total production is estimated at upwards of 700,000 piculs yearly. In 1874 114,843 piculs were shipped to Pinang.

The following table gives the exports of Areca nuts from Ceylon for a series of years:

Year.	Quantity,	Value.	Year.	Quantity.	Value.
	cwts.	£		cwts.	£
1850	66,254	42,907	1863	68,406	51,304
1851	78,030	54,806	1864	54,326	40,715
1852	71,794	52,230	1865	62,616	46,962
1853	59,396	46,433	1866	94,540	74,980
1854	46,209	32,175	1867	99,159	74,369
1855	47,399	42,191	1868	93,731	70,298
1856	66,429	50,183	1869	67,759	50,822
1857	47,594	45,438	1870	76,558	65,501
1858	69,088	51,816	1871	66,543	62,594
1859	49,972	11,111	1872	71,715	64,966
1860	75,996	56,997	1873	146,484	85,300
1861	69,558	52,168	1874	129,826	108,730
1862	55,372	41,529			

In Europe there is little demand for betelnuts. Small quantities are occasionally received. They are grated and given to horses as a preventive of diarrhœa, and burnt into charcoal for tooth-powder, and sometimes they are turned into small fancy articles, such as rosaries, bracelets, etc.

The leaf of the Betel Pepper (*Piper Betle*) is inseparable from the use of the betelnut, the slices of which are wrapped in a leaf of that plant, over which a small quantity of chunam or lime is spread, to which a fine pink colour is given by mixing a little turmeric.

The shrub is cultivated all over India in most districts. In 1870 there were 16,000 acres covered with it in Madras. It is planted in rows, requires a moist situation and a rather rich soil.

The plant has been found wild in Java, which is probably its native country, and is extensively cultivated in the Malay countries. In Bengal it is grown within a fenced enclosure, covered on all sides and on the top by reeds. Its use is considered in the East to be conducive to health. It acts as a powerful stimulant to the salivatory glands and digestive organs, and has been found to be an excellent preservative against scurvy in long sea voyages.*

* 'The Indigenous Drugs of India.

The betel pepper is cultivated at Zanzibar, where the use of the betelnut prevails as it does in the Comoro Islands and at Bombay; but the custom is not in vogue in Arabia. The betel palm is also grown on the island of Zanzibar.

The Date Palm (*Phœnix dactylifera*, Lin.) flourishes in all the vast regions of the tropic of Cancer, from the Atlantic Ocean to the valley of the Indus, between 12° and 57° N. lat. Throughout this immense space, it is, with the bamboo in Eastern Asia and the cocoanut in the equatorial regions, the most precious gift of nature to man, for it contributes to all his most essential wants, food, clothing, lodging, cooking utensils, &c.

The date is the special tree of the Saharan regions. Its constitution, temperament, and habits particularly suit it to the African climate, which is especially characterized by the deficiency of rain and the digressions of temperature. Its fruit is the source of sustenance for the nomad or sedentary people scattered over its immense countries. It is the most common tree in all the valley of the Nile, and is found in greatly increasing numbers from the village of Ibrim in Lower Nubia to the Mediterranean. The dates of Upper Egypt and the Oasis are the most delicate. They are not left to ripen on the tree. After being gathered and exposed several days to the sun they get ripe, and are then a very fine and sweet fruit. The date palm has from two or six to twelve or fourteen spadices. When these are too numerous, it becomes requisite to remove some in order that the tree may not be weakened or thrown down by the weight of the bunches, and the fruit being too numerous would not be of such good quality. Four hundredweight of dates have been gathered from one tree in Egypt.

Although the countries where the date flourishes best are characterized by an absence of rain, it will not fruit without its roots are well watered. Hence there is a native proverb that the date must have its head in the fire and its roots in the water, proving the necessity of frequent irrigation.

The date palm, cultivated and attended to from time immemorial, has produced in the hands of the natives as many varieties as our most carefully cultivated fruit trees. There are reckoned not less than ninety varieties of dates in the Ziban. Dr. Edward Vogel, who paid considerable attention to this subject, writing from Murzuk, in Feddan, gives a list of thirty-seven kinds, with full descriptions and figures, in 'Bonplandia.' * The largest (and what appears to be the best) is 21½ lines long and 10 in diameter; the smallest 7½ by 5. The Arabs enumerate thirty distinct varieties. The different dates are of almost every colour except pure white and black. There are not, as is the case with our apples and pears, early and late sorts, but all arrive at maturity pretty much about the same period (restricted to within a fortnight), which falls in Fezzan about the latter part of August, in other parts one or more months later. Besides those destined for home consumption in the country, dates of a superior quality are gathered, and, after being prepared with great care, fetch a

* Vol. ii. p. 74.

higher price in the markets of Europe. Several Parisian merchants within the last few years have given importance to this trade, by proceeding each year to the seat of production in Algeria, and preparing on the spot, by special modes, large quantities of dates, for France, which replace with advantage those formerly procured from Tunis and Egypt. The region of Ziban, to the south of the province of Constantine, is the part of Algeria where the culture of the date occupies the largest surface, is carried on with the greatest care, and where the fruit is of the best quality. This region includes nineteen oases, of which Biskra is the principal. Laghouat, in the province of Alger, is another centre of production. Algeria might take a considerable part in this commerce by direct communication with England, or through Marseilles, of the dates of Laghouat and of Constantine, a large part of which are sent from Tunis.

The principal production of Touggort, Soub, and the oasis in French territory, is the date, and there are about 124,300 palms subject to taxation, but the total number is nearly double that. Each tree yields about 4*s.* return yearly to its owner. Estimating the average yield per tree at 100 lbs., there would be a total product of 62,150 cwt. per annum. There are two qualities of dates produced, the *Deglet nour*, the best, which sells at 30 francs the cwt., and the *Ghars*, or ordinary, at 20 francs.

In Goleah, in the Great Desert, there are about 16,000 date palms, of which 14,000 are in full bearing.

The best trees are those produced from slipped plants. Those raised from seeds are much longer in arriving at maturity, and are generally poor. When the slip, taken from the foot of the stem of an adult tree, is first planted, it must be watered daily for six weeks, and every other day for the next six weeks; after which the trees are watered once a week in summer, and every month in winter.

The nut does not commence to germinate under six months or a year after planting, and the growth is very slow in the first two years. In a favourable situation it will begin to fruit at six years, and lasts to seventy years or more.

The tree commences to yield fruit about five or six years after planting: but it is not till after twenty or twenty-five years that it comes into full bearing, and then it will endure for about one hundred and fifty years. A date tree in full bearing will produce eight or ten bunches, each containing 12 to 20 lbs. of fruit, which, at an average of 144 lbs. of dates per tree, is at the rate of 14,400 lbs. per hectare ($2\frac{1}{2}$ acres).*

Although there are so many varieties of the date differing in size, form, and quality of the fruit, they may chiefly be divided by colour into three classes, red, yellow, and whitish.

The dates, after having been gathered, are dried in the sun, and, when quite hard, sometimes buried in the sand. They may thus be preserved about two years; but generally after eighteen months they are attacked by worms, and in the beginning of the third year nothing remains of them save the stones. As an every-day food, dates are

* Hardy, "On the Culture of the Date in Algeria," 'Bulletin of the Society of Acclimatisation,' Paris, vol. v. p. 63.

considered very heating, in consequence of which they are not much used on journeys, as causing great thirst. The most relishing and wholesome way to eat them is when made into a paste mixed with barley. Each year the lowest ring of leaves falls off, so that the age of a palm may be roughly calculated by the notches on the stem. It will bear for at least two hundred years, but after a century, its fruit begins to decline, and it is generally then cut down for building purposes. Each proprietor has a right to two hours' water in the day from the stream which passes by his grounds, and this right is always specified in the title-deed by which he holds his garden. Before the dates are ripe, each family is bound to set apart one tree, all the fruit of which is consecrated to the service of the Mosque and the use of the poor. From the juice of the tree is made a fermented wine or liquor called *laguni*, of which the Arabs are very fond. In its fresh state it has an insipid taste like new beer. It is produced in Egypt by simply making an incision in the top of the tree, reaching the centre. A tube is fitted, through which the sap flows into a bamboo-joint vessel. The palm thus yields about ten quarts every morning. The Egyptians bleed the tree every two months, sometimes every day, to prevent the healing of the wound. The operation will kill the tree if continued too long, but cautiously practised for a few days, will often invigorate a sickly or ill-bearing palm. The cabbage, or heart of the date tree, is also eaten, and the taste approaches that of a sweet potato, but it is never cut unless the tree has accidentally fallen.

The bunches of fruit are suspended by peduncles as thick as a man's fist. The yellow dates are the smallest, and the black generally the largest, but there is a larger variety of the yellow date. The fruit does not all ripen at once, but each date matures separately, and, falling, makes way for another to ripen.

In this dried state they form the principal food of the Arabs, and are esteemed by many other nations. The crushed dates, which arrive in Europe in mass, are the inferior and damaged sorts.

At the time of the collection of the ripe fruit, receptacles, walled with masonry, something in the form of large oil jars, are prepared in the yards of the houses to hold the dates; these will contain from 2000 lbs. to 6000 lbs. Men tread the dates down, adding from time to time a little water to soften them. An opening is left at the bottom to allow the syrupy fluid to be collected. This is eaten with butter. In the winter this mass of date paste or cake, is commenced upon, and it is so solid that an antelope horn, or some other hard tool, has to be used to dig it out.*

The date palm is found growing in Central Africa according to Dr. Baikie, as far south as Lukoja.

Its various useful products are very numerous. The petiole, or leaf-stalk, is employed for fences, and other supports. The tow from the leaves is spun, used for stuffing saddles, and serves as tinder. The fibre it yields is of use as a textile material; of it are made ropes for wells and cordage for vessels, as it is not impaired by sea water.

* "The Commerce in Dates in the Souf," 'Explorateur.' Paris, vol. i. p. 319.

The fibre is obtained from the terminal shoot of the tree, and also from the leaves. The peduncle which bears the fruit yields a very strong thread, of a silvery white, resembling that of the agave, which is used in the baths as a friction rubber. From the split leaves of the palm, or with its folicles, mats and baskets are made, as well as chairs or seats, at a very low price. The trunk is employed as posts by carpenters; the wood is compact, and easily cut into thin planks, which take a fine polish. It may, indeed, be called the pine wood of the desert, for it is the only long and straight timber to be met with in the regions where it flourishes. From the unripe fruit spirit and vinegar, and syrup or molasses, can be made. The crushed kernels or seeds of the fruit are given as food to domestic animals, being greedily eaten by camels, goats, sheep, horses, and dogs.

In Egypt there are 4,000,000 female date palms grown, and the annual production of dates there is estimated at 15,000,000 cwt. annually, but they are nearly all locally consumed; only from 300 to 700 tons being exported yearly from Alexandria. In Egypt about thirty distinct varieties are enumerated. Those best known are a stoneless kind, the dates of Assouan, Siout, Edfou, of the oasis near Esneh, Helwa, Minieh, and Menchiek. The dates of Upper Egypt and the oasis are the most delicate.

The fine yellow dates of Rosetta and Burlos are preserved, and much sought after in Europe, and might become the object of an important commerce. In preserving them the epidermis is removed, and the two ends cut off; the stone is taken out by means of a small piece of wood, and the fruit thus preserved is boiled in water to soften and separate an astringent principle; they are then placed in a bucket to drain, after which they are put in a glazed pot. There is then added some hot concentrated sugar, in which they are left for six hours. At the end of that time the syrup, having lost its consistency by reason of its mixture with the water contained in the dates, is put on the fire and concentrated as before. Some more dates are then added, in which parched almonds have been placed, or some pistachios instead of the stones, in order to keep them from getting out of shape. It is then boiled again, until the syrup becomes more solid, and afterwards put into earthenware pots. When cool a little pulverised sugar, impregnated with essence of lemon, is added to flavour it.

The principal revenue in Tunis is derived from their excellent dates, which are exported in large quantities. According to a recent enumeration there were 886,554 date trees in the Djerid, one of the most important provinces of the Regency, which are taxed by the government. As the young trees are not included, and there are grounds for believing the calculations made to be incorrect, it is presumed that the total number does not fall much short of 2,000,000, which produce 300,000 cwts. of dates, valued in the locality at 487,000*l.* The ordinary kind of dates are made into a paste or cake, which forms the staple food of the Bedouin Arabs in the Sahara. It is highly nutritious. The dates are sometimes eaten fried in butter, or simply with fresh butter uncooked. In former times the chief market for dates was Touzer, to which the merchants from Ethiopia resorted with slaves, whom they exchanged for a very few hundredweights of dates, but this traffic has now ceased. There were exported from Tunis in 1873 dates valued at 13,036*l.*; in 1874, 7,535*l.* From Tunis in 1871, 37,000 cwt. of dates were shipped direct, but owing to the heavy export duty levied upon them, a good many are smuggled over the Algerian frontier. The duty is from two to ten piastres per cwt. according to quality, those of Degla paying the highest rate. From Morocco about 4000 cwt. are sent to the London market.

Bagdad sends away 3000 to 4000 tons of dates yearly. The date groves of Bussorah are of great extent and value, forming an almost unbroken line of from one to three miles in depth along both banks of the Euphrates and Shat-el-Arab, from Medinhab to the sea—that is, for more than 140 miles—and yield annually from 40,000 to 60,000 tons of dates in a good season. In 1869 the produce was but 25,000 tons; in 1870 rather less. Owing to a succession of cold north-westerly winds, which prevailed during the spring and early summer, while the date palms were still in flower, much of the fruit failed to arrive at maturity, and the crop gathered in the autumn was both poor and bad. In ordinary years about 33,000 tons are produced in the Turkish portion of this district, and 26,000 tons in that under Montefik rule. About half the above may be roughly stated as consumed in Bussorah and in the interior, and the other half exported to the Persian Gulf ports, India, and England.

The kinds most esteemed are hullowee, zehedi, and khudtherawee; the other varieties, of which there are no less than 36, are known in commerce by the common name of sayr. The quantity of each kind produced in 1873, and their range of price per ton, according to the report of the British consul, was as follows:—

	Quantity.	Price.
	tons.	£ s. d.
Hullowee	6,404	15 16 0
Khudtherawee	2,377	10 13 0
Zehedi	1,937	13 15 0
Braemi	412	10 12 0
Sayr	24,625	8 9 10

The dried dates are pulverised, and this meal is carried with them by the Arabs on journeys. By allowing the dates to ferment in water, a vinous beverage is obtained, which is also much esteemed. When the fruit has been left to ripen thoroughly on the tree, and has attained a fine red colour, it is too soft to be dried, and hence is made by pressure into a solid cake or mass called "adjoue," and with us "date-cake." A great quantity of this is sent from Bussorah to India. The Arabs of Sinai make a date-cake into which they put almonds, and then wrap it in skins. These bales of date-cake are sold in Cairo during the winter. In travelling, dates soaked in water form a mild and refreshing drink.

The consumption of dates is not large in the United Kingdom, but of late years we have no official returns, as the Board of Trade does not consider dates and various other minor fruits worthy of record. In 1860 only 11,300 cwt. were received. The imports in later years were :—

Year.	Quantity.	Value.
	cwts.	£
1867	33,443	35,393
1868	35,112	35,223
1869	18,775	32,957
1870	93,873	70,611

The Spiny Date (*Phœnix spinosus*, Thonning) is met with in the delta of Nun and Brass, West Africa, and in some parts of Central Africa, generally with the oil palms. The leaves are extensively employed in Núpe and Zarcya for making fine mats. This palm extends from tropical Africa to the Cape Colony, where it is indigenous. Dr. Kirk found the green bunches, if immersed in water for half a day, suddenly to assume a scarlet hue, and then the astringent pulp to become edible and sweet.

The Wine or Bamboo Palm (*Raphia vinifera*, Beauv.; *Sagus vinifera*, Poiret; *Metroxylon vinifera*, Spr.).—This West African palm is constant along mouths and in deltas of rivers; also, according to Dr. Baikie, inland, in moist places in Ibo, Benín, Yoruba, Dahomi, &c., and still farther from the sea, in Korórofa, Adamawa, Bautsi, Yúriya, Gbári, Núpe, Kambari (as far as near to Yaúri), Bórgú, Gurma, and along the road to Gonja. The greatest known distance from the sea is the town of Kuno, and more than 400 miles from the sea.

The dried pinnæ of the leaves used for making ropes, pretty bags and mats, dyed hats, and for tying thatch. Long midrib of leaves, often upwards of 30 feet in length, used in construction of roofs of houses, for poling canoes, for making seats, couches, &c. The soft inside part of this used for making a large kind of mat used in travelling, and called by Hánsa and Núpe "Mémme." Sap used as a kind of palm wine, termed Bourdon, and much relished by the drunken savages of the coast. Fruit occasionally eaten (the mesocarp), but bitter, and in a few places, as in Kúpa, oil is made from it. The fibre of the midrib is also woven with cotton into a kind of cloth in Benín and Yóruba.

The Doum Palm of Upper Egypt (*Hyphene Thebaica*, Mart.; *H. crinita*, Gaert.), grows away from the sea. The fruit of this is much larger than that of the date palm, and is equally nutritious. The pulp of the fruit is brown and mealy, and has both the taste and colour of gingerbread; hence one of its common names is the gingerbread tree. The spongy, internal portion of the fruit of this palm forms an important article of food, and when mixed with an infusion of dates, it constitutes a cooling drink, much prescribed by the Arabs in febrile affections as cooling and demulcent.

The kernel is turned into beads for rosaries, and little perfume cakes are made of it at Kuno. The leaves are used for mats and the best kind of hats in parts of Central Africa. Dr. Baikie states that the most southern station for it is Lukoja.

The Dwarf Palm (*Chamærops humilis*), in Arab called Doum, is widely spread over the Algerian Tell, and particularly the departments of Alger and Oran. Its presence is a sure indication of good soil, in consequence of the depths of its roots, which form at 3 feet or more below the surface, an inextricable mass, the removal of which renders the clearance of these palms from the soil for cultivation a serious and expensive affair. The dry portion of the alluvial plain of the littoral is that where they most abound, for they would perish in a wet or swampy ground. The value of the leaves has now caused the plant to be encouraged rather than destroyed in localities distant from towns where land is not very valuable.

Northern Africa generally is covered and infested with this shrub, which multiplies rapidly, and was long the pest and grievance of the colonists, who were obliged to grub it up. But now it has become a useful aid to industry, and, instead of being considered a barren and worthless plant, it has become a source of profit and commerce. Properly prepared, the leaves furnish a fibre which, dyed black, twisted, and curled, furnishes a vegetable hair, that can be employed like horsehair, as a stuffing material in upholstery, or in matting. It possesses two advantages over the animal fibre which have led to its extensive employment, viz. those of being exempt from insect destruction, and 75 per cent. cheaper than horsehair. The leaves are now sold on the spot for about two to two and a-half francs the cwt., and a man can cut say 400 lbs. a day. It is generally the Arabs and Spaniards who apply themselves to this work. The first idea of using the leaves of this indigenous plant of Algeria as a substitute for horsehair in upholstery is due to a M. Averseng, who took out a patent for it in 1847. This manufacturer had great difficulty at first in carrying it into execution, but the necessity for cheap articles, which increases daily, greatly aided him, and established the reputation of this substance. If it has not all the good qualities of horsehair, it does not want for suppleness and elasticity, and, mixed with it, greatly reduces the cost of stuffing in beds and furniture. The form in which the raw material is bought for working is after the leaves have been combed or stripped. This is a very simple operation, which requires but cheap tools, and can be carried on by women and children. A good operator on the handful of leaves can prepare 90 lbs. to 100 lbs. of dry fibre, which, at the current price of 12 francs the cwt., gives a return of 5½ to 6 francs per day, with the mere aid of a child eight or ten years old, to cut off the leaf-stalks and gather the leaves into handfuls. Many native families find their means of existence in this occupation. The men cut and gather the leaves, and the women and children comb and prepare them into fibre. This is a new example of union of the two races in labour, and a hopeful instance of their permanent fusion in the future. The combing or preparing the palm leaves is also a great resource for the French colonists in the period of rest between the harvest and the first labours of autumn. The fibrous thread, when dry, is handed over to the manufacturer. The hair, called light or green, is twisted and curled in its raw state, and packed. For black the fibre is first dyed, by being passed successively through baths of sulphate of iron and logwood. It is then twisted, and the cord again dyed. The firm of Averseng, of Alger, at their works El. Affroun, works up annually 3,500,000 kilogrammes of dry fibre, representing about double that quantity of palm leaves, the average yield of fibre being about 50 per cent. The price of the undyed fibre is 21 or 22 francs the cwt., of good black dyed, 29 or 30 francs, and of superior, 35 to 38 francs. In the department of Oran, Messrs. Giraud Brothers, in their large enclosed works at Eckmuhl, covering a space of 5 acres, prepare daily 60 bales of 2 cwt. each. The combing is effected by means of drums with needles and knives, worked by a 12-horse power steam engine, at a speed of 300 revolutions per minute.

They also heat their dye vats by steam, which is much more economical than the application of direct heat. Another Algerian firm, J. and J. Mathieu, whose factory is at Arbra du Dgendel, in the plains of Cheliff, by a particular process, prepare a black and brilliant crin vegetal without smell or dust, of which they turn out 1000 cwt. a month at 30 francs the cwt., the undyed being sold at 20 francs. This fibre, like the esparto, is also twisted into ropes and cables. It has long been used as a paper-material in conjunction with esparto and rags. The 'Akbar,' a newspaper of Algiers, is printed on paper of this kind, and quantities have been imported from time to time for use at Lloyd's paper mills at Bow. It is not, however, held in much estimation for paper-making, as there is a good deal of waste from the tough leaf-stalks, and it requires a considerable quantity of chemicals to bleach it. In 1857 the export of leaves of the dwarf palm from Algeria was to the value of 24,000 francs, crin vegetal, 763,000 francs. The shipments of crin vegetal, which were only 19,000 lbs. in 1845, reached 316.000 lbs. in 1853, were doubled two years later, quadrupled in the space of four years, and in 1860 amounted to nearly 2,500,000 lbs. In 1865 they had reached treble that amount. 44,000 cwts. of crin vegetal was shipped from Algeria in 1868, and the value of the fibre prepared in that year in the colony is stated to have been about 90,000*l.*

The following figures show the exports (always progressive) of later years, in kilogrammes, besides a small quantity of rough leaves:

Year.	Crin Vegetal.	Leaves.
1869	4,835,630	14,085
1870	3,851,282	65,436
1871	4,252,789	1,171,737
1872	9,011,919	199,100

The quantity of this vegetable hair sent to foreign countries in 1872 was 2,394,000 kilogrammes. The shipments, which were formerly limited to France, are now extending rapidly, demands having sprung up in various countries, especially in England.

The first shipments of rough palm leaves for paper-making were made about 1852, and the following have been the exports since:

	Kilos.		Kilos.
1852	55,820	1857	24,460
1853	15,187	1858	17,482
1854	207,336	1859	131,685
1855	294,160	1860	26,159
1856	502,805	1861	91,723

In 1871 it reached the largest quantity, 1,171,737 kilogrammes; since then it has dropped again.

There is an extensive trade carried on in other palm leaves, such as the Palmetto of the Americans (*Sabal Palmetto*, Lodd.), the *Thrinax argentea*, furnishes a sinnet, or chip, which is woven into hats, and there is a large import of palm leaves for plaiting, into China, but these scarcely deserve special detailed enumeration; suffice it to say, that there was imported into the port of Shanghai, in 1871, 4,755,117 piculs of untrimmed palm leaves, and 231,091 trimmed palm leaves for making fans.

The *Attalea* genus of palms are nearly all natives of Brazil; one or two species yield the valuable brush fibre known as Piassaba, and a species common to British Honduras (*A. Cohune*, Mart.), was recommended to notice some years ago, from the fact of its nuts yielding a good, useful, white oil.

SECTION III.

THE TROPICAL CEREALS AND STARCH-PRODUCING PLANTS.

INDIAN CORN.

The importance and value of Indian Corn (*Zea Mays*) in tropical and semitropical countries, are too well known to need illustration. On every part of the globe where the hand of civilization has broken the turf, this beautiful grain receives a large share of attention. In the western continent it is raised from Canada to Patagonia and the islands of the South Seas, through almost every variety of climate and people, and over an extent, from north to south, of more than 7000 miles. It was introduced into Africa by the Portuguese in the sixteenth century, and is cultivated more or less from the Mediterranean Sea and the Libyan Desert to the Cape of Good Hope. In Java and the Asiatic isles it forms an important product. In Central Asia it is known and valued, as well as in Australia and the islands of the Indian Ocean. In Europe it is extensively produced in Hungary, Lombardy, France, and Spain, and we might almost say from the Ural chain to the Atlantic. No grain could secure such favours from all parts of the world except from its intrinsic value. No other cereal, in fact, except rice, is so extensively cultivated.

Its flexibility of organization makes it very easy of adaptation to climate and soil. Though it prefers moist and rich soils, with strong heats, there are varieties of it which can be raised in tropical climates, at a height of more than 9000 feet above the level of the sea. The warmest regions of the torrid zone produce maize in abundance, where three crops can be taken in a season, while the short summers of Canada have a variety adapted to them. This cannot be said of rice, which requires great heat, and cannot endure a climate of high latitude.

Indian corn ripens at a time when most other grains have been harvested; it therefore furnishes employment, when there would naturally be but little else to do. But what gives to Indian corn its great importance is the actual amount of nutritive matter which it contains. It is said to be third in this respect, wheat and rice containing a somewhat greater amount, though many place maize second only to wheat.

No plant is more beautiful, and none so well suited to the varieties of climate; for, anywhere between the 43rd degree of north latitude and a corresponding parallel south, it may be grown in the greatest perfection. Its ease of hybridization has produced innumerable varieties, suited to every kind of soil and every degree of temperature, from the time-enduring hard corn of Canada, to the Stowells' evergreen for boiling in the unripe state. We have it suited to summers, varying from three to six months; thus we find it in the north requiring but half the time for its growth that is requisite in the south, and still in each locality are kinds appropriate to the different lengths of summers.

United States.—We may say of the Indian corn crop of America what Mr. Webster said of the turnip crop of England, that "its failure for three successive years would nearly bankrupt the nation."

Fortunately, however, by the recent improvements in agriculture, they are enabled, in the growth of this crop, almost to defy drought, and to render every variety of soil suitable for the production of maximum quantities. It is the food of both man and animals; and even its stalks, by proper treatment, have been rendered equal in value to the whole labour and expense of raising the crop. To it America is indebted for her fine beef, her plentiful supply of pork, and also as an article of human food. It is the plant of the country; and the olive branch might with propriety be taken from the claw of the national emblem, and the Indian corn plant substituted in its place. In proof of the American origin of this plant, it may be stated that it is still found growing in a wild state from the Rocky Mountains to the humid forests of Paraguay, where, instead of having each grain naked, as is always the case after long cultivation, it is completely covered with glumes, or husks. Columbus found the natives of Hispaniola cultivating it in extensive fields, and those of other places visited by him were also in possession of it. The first Englishmen by whom it was cultivated, were they who settled in Virginia in 1760.

In England all cereals used as food for man are called "corn;" but those who first landed in America from that country found a new cereal, also used as food by the aborigines. They added it to their catalogue of corn with the prefix of Indian. As it had been for ages the main dependence of the Indians, so it has since become the real staff of life to thirty millions who now occupy their places, while it is gradually making its way to favour among other millions in Europe. The pioneers give no accounts of the Indians having many varieties of corn. They seem to have been content with what they had. The higher civilization of the whites quickly seized on the new cereal, recognized its value as food for man and beast, improved its culture, multiplied its varieties, made its increase a hundredfold, and, by the invention of machines for shelling it rapidly, and grinding it cheaply, raised it to the position of a staple so important, that if the whole wheat crop of America were suddenly annihilated, the maize crop alone would supply the people plenteously with food. It already equals the wheat crop of the whole world. The latter can be profitably cultivated only within certain latitudes, but Indian corn grows luxuriantly in all. The border States of the tropics refuse to yield wheat. Louisiana and Florida produce but 10,000 bushels annually, but nearly 9,750,000 bushels of corn.

The annual average wheat crop of the world is about 760,000,000 bushels, of which nearly 290,000,000 may be credited to the United States. In 1875–76 her Indian corn crop averaged 1,300,000,000 bushels, thus exceeding the wheat crop of the whole earth.

It is a remarkable fact in connection with this subject that, although the experience of the people of the entire American continent bears uniform testimony in favour of the palatableness, the healthfulness, and the economy of Indian corn, it is but little known to the people of those portions of Europe to whom cheap food is the great desideratum. The famine of 1847 brought it prominently into notice here, and once having tasted it, even after imperfect cooking, it has secured a thorough foothold. European chemists have discovered that while Indian corn contains 77 per cent. of nutritive matter, wheat contains 95. When a bushel of wheat is worth 95 cents, one of Indian corn is worth 77 cents, nutriment alone considered; yet when corn has stood at $1 per bushel, wheat has stood at $2 50 c.; thus, in buying wheat, we obtain, for any given amount of money, a little less than half the nutriment we obtain when buying Indian corn. Why this disparity in price? It must be mainly sought for in supply and demand. Wheat is relished by a greater portion of the human family; it may be kept sweet more readily in any of its stages of manufacture, whether stationary, or during transportation by sea or land; hence its superior commercial value. Then, all the world is familiar with it as an article of food, while not a tenth of its population ever heard of Indian corn. Wheat needs no introduction among any people, while maize has required thorough judicious and persistent effort by European Governments to induce even famishing communities to consume it.

It is well known that residents in American cities are small consumers of Indian corn, in comparison with those who live in rural districts. This is because the former do not so well understand the art of cooking it in the numerous forms of which it is susceptible. No wonder that European nations, to whom the grain and meal are novelties, should be more ignorant of their value, and should therefore refuse to consume them. But since 1855 the Prussian Government has left no means untried to ascertain the best mode of preparing corn bread. As corn meal, even when the dough is nicely risen, always falls when placed in the oven, producing an unsatisfactory bread, a multitude of experiments were tried with mixtures of potato flour, wheat, rye, and other substances. Rye flour was found to be the best. But most of these experiments were, unfortunately, made with meal which had soured before reaching Berlin. Finding it to be coarsely ground, the operators caused it to be ground very fine, not knowing that no kind of grain is spoiled by fine grinding except Indian corn. In spite of these discouragements, Germany is annually consuming larger quantities, as her people are better acquainted with the article. In England and Ireland it has become permanently domesticated. Its introduction has been slow, but nothing seems more certain than that a few years hence will witness an enormous

European demand, not the result of famine, but of popular appreciation of this cheap and wholesome staple.

The prejudice existing against the use of maize as an article of human food, among certain classes of people, is surprising, and this prejudice is based on ignorance. It is seldom found in Irish or English kitchens, although millions of bushels are exported to England every year. The people there are strangers to those New England luxuries, corn bread and puddings, and we suppose it will be a long time before they will know anything of them.

Indian corn is one of the most important and healthful articles of human food that a beneficent Providence has bestowed upon man; and to its high nutritive value is due in a large degree the strength and vigour of the race of men who laid the foundations of the great American republic. It was much more largely used fifty or one hundred years ago than now, as fine wheat flour, for some not well-founded reason, has usurped its place in bread-making. In the several forms, however, of hulled corn, popped corn, hominy samp, corn starch, maizena, &c., vast quantities are consumed by all classes of people in America.

Meal from Indian corn contains more than four times as much oleaginous matter as wheat flour, more starch, and nearly as much nitrogenous material; consequently in all cold climates it is admirably adapted to sustain the system by furnishing heat-forming compounds. The oil gives warmth, the nitrogenous principle gives muscular strength. The combination of alimentary compounds in Indian corn renders it alone the mixed diet capable of sustaining man under the most extraordinary circumstances. It holds the elementary principles which constitute the basis of organic life. In this particular it is more remarkable than any other vegetable production known to man. There is a large number of dishes of which corn meal forms the basis, which are exceedingly palatable. What, for instance, is more delicious than cold corn-pudding, cut in slices and fried in sweet butter or lard? Hot corn-cakes, when properly and skilfully made, are almost universally regarded as a luxury, and Boston brown bread is famous everywhere in the country. The reason why corn meal is not more largely used at the present time is that it is quite difficult to obtain it of dealers or grocers in a perfectly pure and sweet state. Millers grind the corn as it comes from the West, mixed with portions of the cob and saturated with dust and dirt, and this is sold for kitchen as well as for stable use. Much of the western corn is damaged in transportation, and this is ground up with that which is sound. If good, sweet, northern corn is properly ground in an old-fashioned stone mill, after being winnowed to free it from dust, a meal will result of a rich golden colour, and no dish can be prepared from it which will not be palatable and most nutritious.

Maize flour, even of the finest quality, cannot be baked alone into bread. It ferments like other flour, but the dough falls in the oven, and gives a compact, soap-like loaf, which could not be eaten daily. A certain quantity of some other substance must be mixed with it to make a good bread—a third part of wheat, rye, or potato fecula is sufficient for this purpose.

In the process of kiln drying, to preserve maize for transport, it is subjected to a degree of heat not greater than 212° Fahr. sufficiently long to destroy its germinating power; but not long enough to parch or cook it so as to impair its substance or nutritive properties. Kiln drying, however, injures the flavour of corn of all kinds.

An American paper well remarks: "The great difference in the consumption of this staple agricultural product in America and Europe is to be ascribed to the ignorance of the people abroad of the mode of preparing it for use in the form of bread. During the famine in Ireland immense quantities of Indian meal were exported to that island, to be made up into bread; but necessitous and starving as the people were, they could not be induced to eat it except when mixed with rye or wheat. Some one or more experts were sent over, commissioned to instruct the natives in the mystery of making corn-bread, but they were as ignorant of the art as the Irish themselves. The fact is, the people in the Northern States, and even in our large cities in the South, are not skilled in making bread from corn; they can make an article which is called by that name, and prepared as it is with milk, eggs and other condiments, it is very nice as a delicacy; but it is not the veritable article, and no more resembling it in form, substance, and taste than it does pound-cake. In fact the corn bread, so called, as we find it on the table of our city friends, more resembles cake than the healthful, substantial and nourishing poue of the country. We have never yet seen a professed cook who could make good corn bread. We very much doubt if any but a plantation negro can make the genuine article. We are very certain that a lady housekeeper cannot make it—she would be sure to make it too nice for every-day habitual food. We are very confident that if the simple art of making corn bread were generally understood, its consumption would be indefinitely increased."

The uses of oil in Indian corn are manifold. It is obviously to protect the grain from rapid decomposition in the soil, from long-continued wet, and to retain a portion of food until needed by the young plant, as the oil is uniformly the last portion of the grain taken up. It serves to keep meal from souring readily, as flint-corn meal will keep sweet for years, even when put up in large quantities, while the Tuscorara meal will sour in a short time. There is from six to twelve per cent. of oil in corn, that of southern growth containing less than northern. The colours of Indian corn depend on that of the epidermis, or hull, of the oil—the latter, when yellow, showing its colour through a transparent epidermis. In white varieties the oil is translucent and colourless, and the epidermis being also free from colour, the meal is white. The golden Sioux, a twelve rowed variety, is coloured by the oil. Red and blue owe their lively hues to the colours of the epidermis, and not to the oil. On inspecting very thin slices of corn under the microscope, the epidermis is found to be made up of hexagonal cells, much larger than those of the glutinous and oily parts of the grain. The starch globules are distinctly seen in the starchy part; a drop of diluted tincture of iodine brings out their forms and character with beautifnl distinctness. The phosphates are probably in the state of a fine powder, while the ammonia is, in combination with the organic matters, forming a kind of *amidon* in the mucilage around the germ.

The ingredients concentrated by nature in a grain of corn are all essential to a highly nutritious food. The gluten and mucilage contain nitrogen, an element essential to the formation of fibrous tissue, muscle, nervous matter, and brain. The oil is nearly formed fat, easily convertible into animal oils by a slight change of composition. Starch is also convertible into fat, and into the carbonaceous substance of the body; and during its slow combustion in the circulation gives out a portion of the heat of animal bodies, while in its altered state it goes to form a part of the living frame. From the phosphates are derived the substance of bone, as well as the saline matters of brain, nerves, and other solid and fluid parts of the body. The salts of iron go to the blood, and there constitute an essential portion of it, enabling it, by successive alterations of its degree of oxidation during the circulation through lungs, arteries, extreme vessels, and veins, to transport oxygen to every part of the body. Indian corn therefore contains all the elements required for the perfect development and support of the bodies of animals.

Dr. Salisbury has furnished the analysis of five leading varieties of Indian corn:—1. Golden Sioux, bright-yellow, twelve-rowed, frequently having fourteen rows. 2. Large eight-rowed yellow. 3. Small eight-rowed. 4. White flint. 5. Ohio Dent, one of the largest varieties.

Constituents.	1	2	3	4	5
Starch	36·06	40·85	30·29	49·22	40·34
Gluten	5·00	4·62	5·69	5·40	7·69
Oil	3·44	3·88	3·90	3·71	4·68
Albumen	4·42	2·64	6·00	3·32	3·40
Casein	1·92	1·32	2·20	0·75	0·50
Dextrine	1·30	5·40	4·61	1·90	3·00
Fibre	18·50	21·36	26·80	11·96	18·01
Sugar and extract	7·25	10·00	5·20	9·55	8·30
Water	15·02	10·00	13·40	14·00	14·00

The male flower is the plume at the top of the stem, which blossoms like wheat, and evolves an immense quantity of pollen, which, wafted about by the wind, fertilizes the female portion of the plant (the ears or future cobs) which spring forth from the junction of a leaf with the stalk. These are at first a mere tassel of delicate threads; there is one of these to every incipient grain of corn; they receive the pollen of the tassel and are fertilized at once. If any thread is injured or broken, the grain belonging to it is lost; if all are fertilized, the ear is beautifully regular and complete. Where purity of kind is required, only one variety must be sown.

Maize may be divided into two kinds, table maize and farm maize. Only the white Georgian maize is used by the Americans for table purposes, all the yellow varieties for flour and cattle food. Besides being useful for human food, Indian corn meal is excellent for fattening stock, milch cows, sheep, and poultry. It is much used in dry summers in the States as green forage, the stems being then very sweet and agreeable to cattle. Where much Indian corn is grown in America, the husks of the ears are saved, and used for stuffing mattresses, bolsters, &c., and it is a material always clean, sweet, and elastic. Paper is also made of a good quality for wrapping. The dry stems and leaves also make fair fodder for cattle.

The limits fixed by many agriculturists for the culture of this cereal are very incorrect, as there is such an immense number of varieties. Parmentier rightly signalizes this cereal as created for the whole world, and as suiting itself to all climates. There is a short-stalked maize, which suffers little from the action of the wind, and can be planted in the north of France in double rows like the maize of Auxonne and Burgundy. It has been found that 35 to 40 hectolitres can be obtained per hectare, weighing from 76 to 80 kilogrammes per hectolitre.

It is, however, in America that its value has been demonstrated. There a couple of million farmers are engaged in the raising of maize; some lands producing 20 bushels to the acre, and others 150, swelling the aggregate crop of the nation to vast proportions, the corn crop amounting to several hundred million dollars in value. The grain produced is sufficient to feed not only the population of the United States, but half that of Europe in addition, for a year. It possesses another value, which, under present circumstances, is an important one. The sheathing leaf is the best adapted for paper of any material yet tried. It was used in the manufacture of paper in Italy last century, but the manufacture declined from obvious causes. Some years ago the process was again taken up in Austria and in Switzerland. The paper made from it was reported to be much better than that from rags, being stronger and more tenacious, and very little size being requisite. It has none of the brittleness peculiar to ordinary straw paper. Maize paper appears to be the most unexceptionable of all the papers not made from rags. Not only is it remarkably tough, but it is devoid of the silicious matter which proves so embarrassing in ordinary straw paper, causing great brittleness when folding, and rapidly destroying the face of printers' type. There are large manufactories of the maize stalk in Austria; the 'Algemaine Zeitung' is said to be exclusively printed on it. The extreme toughness of the paper makes it particularly eligible for bank-note paper, and for the purpose of envelopes. The colour is somewhat yellowish, but it is easily bleached.

Indian corn or maize is the staple and peculiar food crop of the United States, although it is also grown in many other countries; but there it is harvested by hundreds of millions of bushels per annum. Whenever Europe is short of food, America stands ready to supply the deficiency with the excess of her corn crop, the superabundance of which she is obliged at present to fatten swine and live stock on, or to convert into whisky.

All the endeavours used by Cobbett and others since his time have failed to make maize a popular grain, or its meal much relished in Europe, and yet a number of excellent food products, as has been stated, may be obtained from it.

The soil best adapted to the crop is a sandy alluvial; next to this, a gravelly or slaty loam. Stiff clay is very objectionable. The most approved manner of cultivation is as follows: Manure a clover-lay with long unrotten manure, at the rate of twenty-five cubic yards to the acre; plough the same under not less than seven inches deep, either in the autumn or spring. If the lay is old and stiff, plough it early in autumn, if not, in the spring. Before planting, harrow and pulverize the soil as much as possible. Then mark out with a light plough, or an implement used to mark four rows at a time, in squares of 3 feet. Drop in four to six grains at each crossing, covering with the hand hoe lightly, not more than 2 inches deep. The drill barrow (Emery's) is coming much into favour for planting large crops. It is a great labour-saving machine; it marks the rows, drops the seed at any required distance, and covers it in by once passing over the land. Drawn by a single horse, it will plant from ten to twelve acres per day. Soon after the plant appears above ground, a top-dressing of gypsum, ashes, or lime, or a compost of all of these, is usually applied, an ordinary handful to each hill. Soon after the leaf begins to expand, the cultivator, or horse hoe, is run between the rows, and the soil loosened and pulverized as much as possible, followed by the hand hoe, that the surface may be made clean of weeds and grass. After the plant is four or five inches high go through again with the cultivator, and follow with the hand hoe; clean the crop, and thin it to not more than four stalks in each hill; if in drills, the rows should be 3 feet apart, and the plants 1 foot apart in the row. The crop requires close attention, and if the soil becomes stiff and hard, some implement to loosen it should be used again; but usually two thorough workings are sufficient. After the grain becomes glazed, the stalks are cut close to the ground, and set up in small stouts or shocks, to cure. In the course of thirty days the corn is fit to husk and house; and the stalks, which may be stacked or housed, make a great deal of excellent winter fodder for cattle. All the different varieties are cultivated in the same manner. The yellow and white are the only varieties that are grown to much extent. The yellow generally makes the best crop, and will usually mature in about one hundred days after planting. The time preferred for planting in the State of New York is from the 15th to the 25th of May.

The varieties of corn are numerous, and are continually increasing by improvement, and the introduction of seed from one section to another. It would be almost impossible to enumerate the many varieties now cultivated, or to give the reasons why one is preferred above the others. With proper cultivation in an ordinary season, the crop should not be less than 60 bushels to the acre; 100 bushels is not an uncommon yield. The New York State Agricultural Society require a yield of 80 bushels to the acre, to be entitled to a premium.

Here are the names of seventeen varieties grown there:

No. 1. Dutton corn.	No. 10. Red pop.
2. Eight-rowed yellow.	11. Blue pop.
3. Sweet corn.	12. White pop.
4. Eight-rowed white.	13. Yellow pop.
5. Red blaze.	14. Mixed pop.
6. Sixteen-rowed Dutton.	15. Eight-rowed yellow.
7. Twelve-rowed red.	16. Ohio flint.
8. Sixteen-rowed red.	17. Rocky Mountain corn.
9. Early Canada.	

Two hundred varieties of Indian corn were shown at the London Exhibition of 1862, from the Modena Royal Botanical Gardens, collected by the late Professor Giovanni Brignoli, and thirty-five varieties by Professor Parlatore of Turin.

Common preference, as well as chemical analysis, proves that the round northern yellow variety contains the most nutriment, and is in all respects best adapted for the consumption of people living in high latitudes. The white variety, by its resemblance to wheaten flour when manufactured, meets with a ready sale where the difference is not known, or where appearance is alone consulted. There are a great number of varieties of corn in cultivation, and these have become considerably intermingled. The principal ones, which may be distinguished by the number of rows or grains on the cob, and the colour, shape, or size of the kernels, may be classified and described as follows:

1. *Yellow Corn.*—Golden Sioux, or northern flint corn, having a large cob with twelve rows of moderate-sized grains; very oily. This is regarded as one of the best varieties for fattening animals, or for human food. By skilful tillage, 130 bushels have been raised to the acre, weighing 9216 lbs. in the ear; when dry, 75 lbs. of ear gave a bushel of corn shelled.

2. *King Philip*, or the eight-rowed yellow corn. Its ears, which contain only eight rows, are longer than those of the Golden Sioux, and it will yield about the same quantity of oil. It is a hardy plant which belongs to a high latitude; grows to about nine feet in height; stalks small; ears from ten to fourteen inches in length.

3. *Canada Corn*, or eighteen-rowed yellow corn, which is smaller, earlier, and more solid than any of the preceding, contains more oil than any other variety, except the rice corn and the pop corn. It is exceedingly valuable for fattening poultry, swine, &c., and is grown by many in gardens for early boiling.

4. *Dutton Corn.*—The cob sometimes grows to a length of fourteen or fifteen inches, but the grain is so compact on it, that two bushels of small ears have yielded five pecks of shelled corn, weighing 62 lbs. to the bushel. With proper management, an acre of ground will yield one hundred to one hundred and twenty bushels to the acre. As it is very oily, gives a good yield, and ripens early, it has always been a favourite variety for culture in the North.

5. *Southern Big Yellow Corn.*—The cob of this corn is thick and long, the grain much wider than it is deep, and the rows unite with

each other. The grain contains less oil and more starch than the northern flint kinds; yet its outward texture is somewhat flinty, solid, and firm. It comes to maturity rather later, affords an abundant yield, and is much used for fattening animals.

6. *Southern Small Yellow Corn.*—The grains of this variety are about the size and shape of those of the Tuscarora corn, but differ from them in containing an abundance of transparent colourless oil, which may be easily seen through the clear pellucid hulls. The farinaceous parts of the grains are white, and as the quantity of oil which they contain is large, the flour or meal is more substantial as an article of food, and less liable to ferment and become sour.

7. *Southern Little White Flint Corn.*—The kernels of this variety are smaller than those of the preceding, and much resemble them in shape, but they are more firm and solid, contain more oil, and consequently are of greater value for feeding poultry and swine, and for human food.

8. *Dutton White Flint Corn.*—A variety, not differing materially from the yellow Dutton corn, except in the colour of the oil.

9. *Early Canadian White Flint Corn.*—Cultivated principally for early boiling and roasting while green.

10. *Tuscarora Corn.*—The ears contain from twelve to sixteen rows of grain, which are nearly as deep as they are broad, of a dead whitish colour on the extreme end, and entirely composed within of pure white dextrine, except the germs. As it contains neither gluten nor oil, it may be profitably employed in the manufacture of starch. It is much softer and better food for horses than the flinty kind, and if used before it becomes sour, may be converted into excellent bread. It is also an excellent variety for boiling when green, or in the milky state.

11. *Fine White Flint Corn.*—The ears of this variety contain twelve rows of rather white, roundish, thick grains which are filled with a snowy white flour composed principally of starch, but contains neither gluten nor oil. As it possesses similar properties with the preceding variety, it may be profitably used for the same purpose. It is also an excellent variety for boiling, when green.

12. *Virginia White Seed Corn.*—The ears of this corn, which are not very long (nor is the cob so long as those of the big white or yellow flint), contain from twenty-four to thirty-six rows of very long narrow grains. These at their extreme ends are almost flat, and grow so closely together from the cob to the surface, that they produce a greater yield than any other variety in proportion to the size of the ears. They contain more starch, and less gluten and oil than those of the flint kinds, and from their softness serve as better food for horses, but are less nourishing to poultry and swine. This variety ripens later, though it is more productive than any other kind.

13. *Early Sweet Corn.*—There are two kinds of this corn; one with the cob red, and the other white. The ears are short, and usually contain eight rows, the grains of which, when mature, are of a higher colour, and become shrivelled, appearing as if they were unripe. It contains a very large proportion of the phosphates, and a considerable quantity of sugar and gum, though but little starch. It is extensively

cultivated for culinary purposes, and is delicious food when boiled green.

14. *Rice Corn.*—A small variety, with small conical ears, the kernel terminating in sharp points which give them the appearance of burrs; the kernels in size and shape something like rice. It contains more oil and less starch than any other kind, and when ground, its meal cannot be made into bread alone, but is dry like sand. From its oily nature and peculiar size this corn is well adapted for feeding poultry.

15. *Pearl Corn*, commonly called pop corn, from the fact of its being used for popping or parching. The ears of this variety are small, the grains are sound, of various shades of colour, the white of a pearly appearance; and contains with the rice corn more oil and less starch than any other variety.

16. *Chinese Tree Corn.*—This is a pure white variety, a very handsome ear, about ten inches long, has ten rows, grain very closely set, long and wedge-shaped, well filled out to the end of the cob, some of the grains slightly indented. One peculiarity of this corn is, the ears grow on the buds of the branches, hence its name *tree corn.* It is said to yield from one-third to one-fourth more than the common varieties; when ground into meal it is handsomer and better flavoured than the common varieties of white corn. There are generally two ears on a stalk, and often three.

There are many other varieties, but the foregoing list embraces pretty nearly all those worthy of cultivation.

In New Mexico the colours of the grain are numerous—blue, yellow, white, and even jet black. Blue seems to be the predominant colour, and is esteemed by the natives as the richest of all, being almost universally used by them in making the *tortilla*, or corn cake. This is the only shape in which they prepare Indian corn for the table.

The culture which will answer for the small farmers of the Atlantic seaboard would be impracticable in the immense corn fields of the far West; for the amount of labour which may be judiciously and profitably applied in the former would be impossible in the latter, and hence it will be necessary to state the methods applicable to different districts. Land at $200 dollars per acre and at $5 per acre cannot generally be manured alike, even although their constituents and requirements may be the same; for the cheaper lands are so far from the manufacturing districts that in some cases the necessary fertilisers to be used as manure for the soil cannot be obtained, and the scarcity and high price of labour give rise to the necessity for the use of implements by horsepower in place of any other mode of culture, and that too of the simplest and most expeditious kind. The roots of the Indian corn plant, in soil prepared to admit of their full ramification, will average in length 5½ feet, and hence the necessity of deep and subsoil ploughing for this crop must be evident to all. When the constituents of this plant are considered, it will be evident that its inorganic requirements, obtained principally in many places from the subsoil, render deep disintegration necessary. It will also be evident that soils habitually wet cannot be profitably employed in the growth of corn without thorough drainage; for until surplus water ceases to occupy the spaces between the particles of earth, atmospheric air cannot enter. Nor can the pulverulent condition of the soil result from this disturbance by the plough during the growth of this crop, if partially immersed in water, for the surplus water, acting as a lubricator to the particles, causes them to settle in so compact a form that the corn roots cannot travel freely in search of their proper aliment. The different modes of culture adopted should always embrace such manipulations as will give the greatest amount of disturbance to the soil with the least amount of abrasion to the roots of corn, hence the original preparation of the soil before planting should be such as to secure the most mellow condition, and to the greatest depth. This will be perfect security against drought; for wherever air can circulate among particles of soil colder than itself it will deposit moisture; therefore, corn grown on subsoiled land free from excess of water never suffers from drought. The after cultivation during the growth of the crop should be such as to render the surface at all times penetrable to the atmosphere and free from parasitic growth.

Planting Corn.—The seed may be prepared by any of the usual steeps which are known to protect from the ravages of insects, &c., during its early growth, and to stimulate its early germination until ready to throw forth its roots. Among these may be named dilute sulphate of ammonia, saltpetre very dilute, cubical nitre, &c.

Preparation of the Soil.—After thorough preparation of the soil by deep and subsoil ploughing, and the addition of such amendments as analysis may prove to be necessary, the corn should be planted at slight depths in hills 4 feet apart in every direction, which will admit of more thorough cultivation in both directions than if planted in rows. I cannot but suggest that in the final preparation of the soil before planting, it would be well to run the subsoil plough at a full depth in striking out the rows; this having been done in both directions will leave the intersections visible for the planting of the corn. From the peculiarity of this plough the soil will be left in a much more divided condition than if turned over by the surface plough alone. In these intersections the corn may be planted. When 3 inches high the lifting subsoil plough, which will affect the soil at the surface for 2 feet each side of this line of travel, should be run in one direction, half-way between the rows of hills, thus disintegrating the soil in the centre to full depth, disturbing it at the surface to the very plants, gradually lessening as it approaches them, so that none of the young roots are abraded by its action. It will now be seen that immediately under the corn is a deep disintegration, readily accessible to the roots, while the space between the hills is thoroughly pulverized and deepened as it recedes from the hills, so that the roots will not be inclined to travel surface ways. At the proper time for a second ploughing the lifting subsoil plough may be run in the opposing direction half-way between the rows, thus rendering the soil pulverulent to a great depth at a later stage of the growth. The after cultivation may be conducted by the universal cultivator, set the whole width of 4 feet, or so near it as not to disturb the plants, and to such depth as will keep the entire surface free from weeds, and open for the admission of the atmosphere. The running of this cultivator, once in each direction, will be found to be more efficient than the ordinary use of the hoe, and at the same time securing flat cultivation. At the first application of the cultivator, or lifting plough, stimulating manures may be used to each hill with safety, and we have known many instances where 100 bushels of shelled corn per acre have been produced by the application of two ounces of improved superphosphate of lime to each hill, at the first hoeing or first cultivation. The result seems to be larger when stimulants are thus applied than when placed in the soil before planting. Indeed, when guano, or any other stimulating manure is used, it should be at the first disturbance of the soil after the corn is above ground, rather than before the planting of the seed. Some growers prefer to plant the corn in hills as already named, running a universal cultivator, with the two rear share teeth reversed, between the rows, when the corn is three inches high. This throws a light furrow from each row, in which special manures may be applied. A small subsoil plough should then be run with the flat side toward the corn, the wing of the plough removed so that the lifting action of the nose only will be applied to the soil. This should be repeated on each side of the row, so as to disturb the soil to a depth of ten inches before the corn roots are sufficiently grown to be abraded, and this loosening will thoroughly mix the manure with the soil. The rear teeth of the cultivator may then be reversed and run again between the rows so as to replace this narrow furrow, leaving the soil flat. In place of a second hoeing, at the usual time, the horse hoe may be run in the opposite direction, clearing the ground of weeds, and leaving the soil clean and pulverulent. The large western corn growers require more simple methods, and less labour, and for their use we can only recommend that after planting the corn by the machine drill, the cultivator or horse hoe, capable of disturbing the whole distance between the rows, should be used, instead of the ordinary common hoe, and if this be properly conducted the economy of such practice will be evident. Special manures may be applied in advance of the use of this instrument when necessary. In some cases it may be found profitable to use the lifting subsoil plough in the centre line between the rows, during the early growth of the corn, in place of the cultivator, as this will leave the soil in better condition for after crops by its more thorough disturbance.

From the official statistics we find the following have been the maize crops of the United States at the several periods of the decennial Census:

	Bushels.		Bushels.
1840	377,531,875	1860	838,792,742
1850	592,071,104	1870	760,944,544

From the report of the United States Agricultural Department, it would appear that the production of maize in 1874 was 850,148,500 bushels. The largest producing States were: Illinois, 133,579,000; Iowa, 115,720,000; Ohio, 88,422,000; Indiana, 74,624,000; Kentucky, 48,514,000; Missouri, 46,049,000; Pennsylvania, 35,821,000; and Tennessee, 32,000,000 bushels. In the State of Illinois there were nearly 8,000,000 acres under culture with Indian corn. The exports from the United States were in

	Bushels.		Bushels.
1871	9,826,309	1874	34,434,606
1872	34,491,650	1875	28,858,420
1873	38,541,930		

The prices at which No. 2 quality sold in the Chicago market (whence 45,381,153 bushels were shipped in 1876) were as follows, per bushel, in cents:

Year.	Highest.	Lowest.	Average.
1873	29	53¾	37
1874	53	86	65
1875	46	76¾	63¾
1876	38⅝	49	44⅝

The corn growing of the States is immense. Maize is now successfully cultivated in nearly every part of a tract of country that extends 1000 miles from north to south, and even more than that from east to west.

According to the latest returns there would seem to be about 37 million acres under culture with maize.

The following were the produce of the States of the Mississippi Basin in 1872:

	Bushels.
Michigan	16,987,000
Indiana	85,541,000
Illinois	217,628,000
Wisconsin	21,180,000
Minnesota	7,987,000
Iowa	101,189,000
Missouri	97,002,000
Kansas	29,631,000
Total	577,145,000

The State of Kansas, which has only recently entered the field as a grower, had in 1875 1,932,860 acres under maize, and produced 80,798,769 bushels.

The progressive imports of maize into the United Kingdom are shown below:

	Cwts.		Cwts.
1840	99,703	1860	7,936,123
1845	241,667	1865	7,096,033
1850	5,473,161	1870	16,756,783
1855	5,208,570	1875	20,438,480

In 1876 we imported the large quantity of 39,958,226 cwt., besides 7706 cwt. of maize meal and maizena, for which we paid nearly 12,750,000*l.*

Indian corn is largely used as food, both for man and animals, in all parts of the United States. In the Southern States it forms the largest portion of the food of the inhabitants. It is the principal grain used in all parts of the Union, for fattening cattle, swine, sheep, and poultry. It is used for those purposes, not only on account of its cheapness of production, but for its intrinsic nutritive properties.

In Brazil maize is largely cultivated, especially in the southern provinces, where, in the shape of bread, meal, and farina, it constitutes a wholesome and nutritious food. It comes to market in a variety of forms. As a rule, maize yields there an average of 150 for one; it is not rare, however, to meet with soils which give from 250 to 300, and on the island of Fernando de Noronka 400 for one have frequently been harvested. In the province of Parana thirty-six varieties of maize are grown.

The Australian colonies are greatly dependent upon the farmers of New South Wales for their supply of maize. Upwards of one million bushels are grown. The yield is about 38 bushels per acre.

In the year 1874–5 there were 1523 acres under culture with maize in Victoria, and the produce was 24,263 bushels. In the following year there were 2346 acres, and the produce was 37,177 bushels.

There are several varieties of maize grown in Australia, known by the names of Richmond River, Mackey, Queensland, Hogan, &c. The Richmond River variety is a dwarf kind, the stalk short, and the cobs small.

The Mackey has large cobs, the grain is also large, but flat and square shaped. The stalk is bulky, and stands 9 or 10 feet high. This is a good variety, well worth general cultivation. The Hogan variety is small sized and inferior to the preceding.

In Bankoora and other highland districts of Bengal maize seems to constitute one of the chief articles of food during a considerable part of the year. It is more used in Behar than any part of Bengal, being ordinarily roasted when green, and eaten with salt.

Maize is now widely distributed not only over India proper, but in Burmah, and is universally used for human food. Baden Powell observes, in his 'Punjaub Products,' that "maize grows everywhere throughout the hills, and appears to flourish well in a temperate as in a tropical climate. At 7000 feet or more it is the favourite crop of the people, and for six months of the year forms their common staple of food. Although superseded in the valleys by rice, there is always a little plot of maize around the cottage of the peasantry, which is reserved for themselves, while the rice is disposed of to wealthier classes. To the uplands maize is an admirably suited crop. It is very hardy, requires little rain, and is rapidly matured. In sixty days from the day of sowing, the cobs are fit to cut, but the grain will not keep. Weevils attack it in preference to any other grain, and it is a popular saying that the life of maize is only a year long."

From experiments made at the Madras farm on Queensland maize Mr. Robertson has proved that this grain can be profitably cultivated in Southern India. He gives the following instructions for its cultivation there:

"The seed is best sown on drills about 3 feet apart, with intervals of 10 or 12 inches between the seed. It may be planted 2 inches deep, at the rate of 30 lbs. per acre.

"Maize should always be well manured; from 15 to 20 tons per acre may profitably be employed. Sheep and cattle dung may be applied, decayed leaves, ashes, brick-yard dust, tank mud, which has been thoroughly exposed; wild indigo, madder leaves, &c., may also be beneficially used. No crop pays better for a thorough manuring. The better the land is ploughed and worked the more satisfactory will be the results.

"To prevent crows, squirrels, &c., destroying the seed tar it before sowing. Take one and a-half pints of hot water, and add to it one-twelfth of a pint of tar, mix together, and after cooling pour the solution over the seed. After dusting sand, ashes, or sawdust to prevent the seeds adhering together, the grain is ready for sowing. Keep down the weeds during growth, and cultivate between the rows, with hand-hoes and ploughs.

"On good soils 2000 lbs. of grain may be grown per acre without extraordinary management. One average-sized Queensland cob yielded more grain than twelve of the cobs of maize usually grown in the Vellore districts. Queensland maize is only a four month crop, and may be harvested in time to allow of a crop of grain (pulse) being grown before the commencement of the hot season.

"The cobs should be well matured before being gathered. If the weather during the harvesting of the crop be favourable, the skins are best kept on the cobs until the seed is perfectly hardened and glazed. The average cost of production may be estimated at 25 rupees, while the gross return will vary according to the quality of the soil from 50 to 60 rupees per acre. The profit may vary from 25 to 30 rupees per acre, according to the quality of the soil. The better the cultivation the larger the profits. Maize can be sold at 50 rupees (5*l.*) per ton, and leave a handsome profit to the cultivator. The large quantity of straw or stalk, &c., yielded by maize renders it a crop particularly valuable in a country like India.

"Maize can be profitably cultivated on a soil so poor as one containing 90 per cent. of sand; but the better the soil, the better will be the crop."

The late Judge Buel, of Albany, was a great advocate for the growth of maize. He used to say that it was as indispensable to a Yankee as the potato to an Irishman, or the oat to a Scotchman; that there was no crop more beneficial to the farmer than Indian corn; that it was the meat, meadow, and manure crop of the farm; that it was convertible into human food in more forms than any other grain, and that its value in fattening domestic animals was not exceeded by any other product of the farm. The uses of Indian corn are very numerous; when very young we are told "the small young stalks of thickly-sown crops are cut over by the Mexicans as an article for the dessert, and almost everyone relishes green corn in its season. Then there are various preparations of the grain, such as johnnycake, hominy, mush, samp, succatash, pop corn, &c.; and now it is largely used as a substitute for arrowroot, known in Britain as "Oswego flour," and "corn starch." The use of the Indian corn plant for soiling cattle has long been known and recommended; also for winter fodder, when pasturage and meadow threatened to fail.

It is now employed largely for this purpose, and no plant answers better, or gives more feed to the acre when properly manured and managed. Corn was at one time greatly recommended for making sugar, and many experiments were tried with it in the United States, but it evidently did not prove profitable, as for many years we have heard nothing of corn-stalk sugar. This by the way was no new use for this plant, as Prescott, in his History of the Conquest of Mexico, after noticing several of the most important articles of their industry, says that the great staple of the country, as indeed of the American continent, was maize or Indian corn, which grew freely along the valleys, and up the steep sides of the Cordilleras to the high level of the tableland. The Aztecs were as curious in its preparation, and as well instructed in its manifold uses as the most expert New England housewife. Its gigantic stalks, in these equinoctial regions, afford a saccharine matter not found to the same extent in northern latitudes, and supplied the natives with *sugar* little inferior to the cane itself; which was not introduced among them till after the conquest in 1519. Indian corn is also largely used for distilling all over North America, and in South America it appears to have been made into *Chica* or maize beer at a very remote period—it was a common drink of the Indians long before the Spanish conquest. It was commonly made in a similar manner to ordinary beer. The liquor is said to be of a dark yellow colour, with an agreeable slightly bitter acid taste; it is in universal demand on the west coast of South America, and is consumed in vast quantities by the Mountain Indians; scarcely a single hut in the interior is without its jar of this favourite liquor. Besides the use made of Indian corn as food and drink for man in its various preparations, it is largely used for feeding cattle and stock of all kind. In the Western States, cattle and pigs are turned into the corn fields and there fatten for the market, thus saving all harvesting. With us it is used for feeding pigs, either whole or ground into meal, and also for feeding cattle when fattening during winter. It is excellent for feeding to milk cows during winter and spring, and is sometimes fed to horses; indeed all kinds of stock on a farm—horses, cattle, sheep, pigs, and poultry—will readily eat and seem fond of Indian corn. We hear of corn being sometimes used for fuel in the West, where wood and coal are scarce and dear and corn is cheap. In Illinois and other parts they use the corn cobs chiefly for summer fuel; when kept dry they burn well, and are no bad substitute at that season for wood or coal. There are many varieties of Indian corn known, of which the most prominent are those distinguished by colour, as white, red or brown, and yellow; those that have different numbers of rows on the ear, as the eight, ten, twelve, to twenty-four rowed kinds; those that differ in taste, as the sweet and common kinds; and those that have some peculiarities in their kernels, as the horse tooth, gourd seed, rice corn, &c., &c. There is no doubt that this plant can be much improved by selection and cultivation, and that varieties may be multiplied to almost any extent by judicious selection of kinds, and crossing by careful impregnation. Almost every corn grower has his favourite kind; but scarcely any kind will thrive better than the common eight-rowed yellow corn. Though corn is a tropical or sub-tropical plant, yet it is capable of being acclimated in almost any region up to nearly the 50th degree of latitude on the American continent, and is adapted in some of its varieties to almost any part of the country. Being a short-lived annual it will succeed wherever the heat of summer is intense and of sufficient duration, whatever may be the cold of winter. The corn crop must have been of immense benefit to the early settlers of this country. It succeeds well on new-cleared land; it requires little cultivation there; it gives a large increase for the seed planted; it requires a short season to mature, and could be used for food before it came to maturity. It is no wonder that this was a favourite crop; even yet there is said to be more land devoted to the production of Indian corn in the United States than to any other grain.

In Italy it is an important part of the cereal crop, and the produce has been given at 45,000,000 bushels. How largely it enters into the agricultural economy of the country may be seen from the fact that in certain parts, the province of Turin for instance, the labourer is allowed to share the produce of the Indian corn with his master. In other parts of Lombardy, besides a money payment for wages, he receives a proportion also, which when mixed with rye and millet flour is made into a coarse bread. Amongst the better paid a "polenta" of corn meal is principally eaten: this, mixed with vegetables, and flavoured with a little bacon, is a favourite dish.

In the south of Europe and on the banks of the Danube the cultivation has been attended with considerable success; in Hungary, in particular, the crops of maize are large and profitable, some 3,500,000 acres yielding 66,000,000 bushels.

We have no details of the acreage under maize in the Austrian empire, but in Baron Czoernig's 'Statistical Handbook' (Vienna 1861) the production is returned at 43,076,000 metzen ($1\frac{3}{4}$ bushels), which is nearly equal to the wheat produced.

In Greece, where it shares attention with wheat, barley, and rice, the production amounts to about three million bushels. In localities where the land can be irrigated and the soil is particularly good, maize is planted after the barley has been cut in the month of May. The principal food of the peasantry consists of a coarse brown bread, called "keramedopita," made of a mixture of barley and corn flour, or "bobota," being a bread made of maize.

In Portugal Indian corn is the staple cultivation of the northern part, and the produce amounts to about fifteen million bushels. The proportion that it bears to that of all other corn crops throughout the country is one-half in respect to quantity and value, and one-third in respect to the portion of the cultivated area devoted to cereals. The universal bread food is "broa," a strong, wholesome, and not impalatable mixture of maize and rye. To the use of this bread food is ascribed the well-being of the Portuguese peasant.

In France the production is stated to be 30,000,000 bushels, and the grain is grown and used chiefly for poultry, which, in the subdivided condition of the soil, is one of the mainstays of the peasant farmer, as in England, so far, one of its chief uses is for feeding pheasants, who thrive very fast upon it.

In 1872 there were 698,091 hectares under maize and millet, which was somewhat under the quantity in previous years, for in 1870 there were 1,653,000 acres under Indian corn. The produce in 1872 was 11,635,832 hectolitres.

In Algeria much attention is not given to the culture of maize, as it requires good land and irrigation. It is sown in March and April, according to the season. The forty days' variety is harvested in June; the larger kinds in July and August. The mean produce on irrigated land is 18 to 20 cwt. per hectare; on dry land it is not a third of this.

There were in 1870 about 19,000 hectares under culture, which produced 210,405 hectolitres. In 1874 there were under culture about 47,000 hectares, chiefly by the natives, as only 5000 were cultivated by Europeans.

Maize Starch.—A large quantity of Indian corn is employed in America and this country in making starch, or what is known as corn flour, and maizena. In this manufacture the maize is softened in a solution of carbonate of soda and crushed in mills, on which water is poured. The milky liquid which flows is diluted with water, and conveyed over a large sieve, on an inclined surface, the fibres, &c., being left on the sieve. The starch is deposited on the inclined plane, while the fatty and nitrogenous substances pass off with the liquid into the vat. The starch is collected, washed, and dried. The residues remaining on the sieve are employed for feeding stock and in paper making, the oil or fat in soap making.

There is a small sweet variety grown in Demerara, called cariaca, which ripens its grain in less than two months from the time of sowing. It is in every respect more diminutive than the ordinary Indian corn, being very slender in its stalk, and with the leaves and ears also small in comparison with the ordinary kinds. The flavour of the cariaca is very fine roasted in the milk, that is, before the grain is fully ripe, when it is very soft and juicy. Indeed it is usually prepared in this way, and seldom permitted to arrive at maturity. You see the negroes munching the grain off the roasted cob. The natives sometimes crush and bake it, and it makes a nutritious, juicy sort of bread, which they call "cachapo."

RICE.

One of the most extensively diffused and useful of the grain crops, and supporting the greatest number of the human race, is rice. It occupies, in fact, the same place in most intertropical regions that wheat does in the warmer parts of Europe, and oats and rye in those more to the north. It is raised in immense quantities in India, China, Java, and most Eastern countries; in parts of the West Indies, Central America, and the United States, and in some of the southern countries of Europe. The chief food of perhaps one-third of the human race, it affords the advantages attending wheat, maize, and other grains, while it is susceptible of cultivation on land too low and moist for the production of other useful plants.

The rice from the Southern States of America is decidedly the best brought into commerce, being much sweeter, larger, and better coloured than that from Asia, where its cultivation is not so well managed. It is necessary to except Bengal rice, which now nearly equals that grown in the Carolinas. South Carolina produces the best American rice, and Patna the best East Indian variety. Excellent rice is also grown in the Spanish provinces of Andalusia, Valencia, and Catalonia, as well as in the marshes of Upper Italy, especially Lombardy and Venice, and in the plains of Milan, Mantua, Verona, Parma, and Modena, along the river Po.

Our imports of cleaned rice in 1875 (besides 16,601 quarters in the husk) were derived from the following sources:

	Cwts.
Holland	51,369
France	11,191
Siam	110,216
Bombay and Scinde	32,486
Madras	182,265
Bengal and Burmah	6,251,319
Other countries	81,048
Total	6,719,894

The Carolinas and Louisiana now produce annually about 420,000 cwts. of rice; the Brazilian comes into commerce from Rio Janeiro, and the Egyptian from the Delta of the Nile, viâ Damietta and Rosetta.

The following table shows the imports into the United Kingdom, of rice cleaned, and in the husk, or uncleaned, at decennial periods.

Year.	Cleaned.	Paddy.
	cwts.	qrs.
1840	443,918	42,119
1850	785,451	37,150
1860	1,535,575	516
1870	4,077,468	98,178
1875	6,719,894	16,601

In 1876 the imports of cleaned rice were 6,485,987 cwts.

It will be seen how enormously the trade has increased. About half the quantity received is re-exported to the Continent, &c.

Loureiro enumerates the following species: *Oryza communissima, glutinosa, montana, mutica* and *praecox*, all of China; other authors consider them only varieties of *O. sativa.* Then we have *O. latifolia*, Desv. of the Carolinas and St. Domingo; *O. minuta*, Presl. of Luzon; *O. Nepalensis*, G. Don; *O. perennis*, Moench, and *O. platyphylla*, of New Granada.

The varieties of rice are very numerous in the different countries where it is cultivated. The natives of India and China distinguish them a good deal by the size, shape, and colour of the grain. There are white and red rice, small and large-grained. The chief commercial classifications, however, in the East are, table rice, cargo rice and white rice.

Although there are such innumerable varieties cultivated, practically they resolve themselves, agriculturally, into two kinds—the upland or mountain rice, and the lowland or aquatic rice.

Java rice is inferior to that of Bengal, or Carolina. This is not attributable to any real inferiority in the grain, but chiefly to the careless mode in which it is prepared for the market. In husking the grain it is much broken; and from carelessness in drying, it is very subject to decay, from imbibing moisture and the attacks of insects. Unhusked rice or paddy may be kept sound for many years; indeed for table use, rice a year old is usually preferred by judges. Of all the cereals it is the most compact, seldom weighing less than 65 lbs. to the bushel.

Rice does not contain half as much gluten as wheat, but has one-fourth more starch in its composition, hence the preference given to it by our starch makers, both from its cheapness and larger yield.

Professor Johnston found the proportions of water in rice to be as follows:

Madras	13·5
Bengal	13·1
Patna	13·1
Carolina	13·0

Mr. Dugald Campbell, in a series of analyses, published in my 'Technologist,'* on the amount of starch in rice, found in four samples of pinky Madras rice an average of 13·57 per cent. of water, and the proportions of starch in four qualities were:

First quality	76·6
Second "	73·0
Third "	70·2
Fourth "	69·1
Average of the four specimens	72·2

The following are given by Dr. Watson as the composition of the several varieties of rice named:

	Pegu.	Bombay.	Broach.	Bareilly.	Pulut Maulmein.
Moisture	13·50	13·00	13·10	12·80	12·90
Nitrogenous matter	7·41	7·44	7·12	8·24	7·24
Starchy matter	78·10	77·63	78·70	77·80	78·56
Fatty or oily matter	0·40	0·70	0·49	0·64	0·60
Mineral constituents (ash)	0·59	1·23	0·66	0·52	0·70
Total	100·00	100·00	100·00	100·00	100·00

In Europe, America, and Africa the cultivation of rice is comparatively insignificant. It is in the intertropical countries of Asia that rice is of the very first importance. Over the seaboards of the peninsulas of India and China, in Japan, and some of the eastern islands, it holds undisputed sovereignty.

* Vol. i. p. 191.

Italy.—To the Moors has been attributed the introduction of rice into Spain, and subsequently to Italy. From the Venetian provinces it extended rapidly through the marshy tracts so common in that region. The great swamps of Verona and Mantua, useless for other species of culture, afforded a profitable field for rice; in them it was early established, and has always continued to be of great importance. Its progress to the eastward was slow, and it was not until the middle of the sixteenth century that the rice cultivation of the Milanese became of sufficient extent to attract public attention to its sanitary relations. Its development thus kept pace with the progress of that great system of irrigation canals which had been perfected at this time.

In Piedmont and Lombardy rice cultivation is divided into two classes—permanent, locally termed *risage da zappa*, from the use of the spade in its tillage; and temporary, *risage da vicenda*, which forms a part of the rotation of crops in the irrigated districts. The permanent rice cultivation is restricted exclusively to low marshy localities unsuited for any other culture, and is of great value, being the only crop which soils so wet are capable of affording when introduced into the rotation. This extends over nine years, generally in the following order: 1st year, wheat with grass seeds; 2nd, 3rd, and 4th, meadows; 5th, 6th, and 7th, rice; 8th and 9th, Indian corn, or other crops, varying from year to year.

A clayey impervious soil, with a small proportion of sand near the surface, is found to be the best for rice. As the plant passes its existence in water, the details of the culture are directed to securing this condition. The means employed are much the same in Italy as in India. The surface of rice land is made as nearly as possible horizontal, and where variations of level occur, a series of terraces is formed, each of which is carefully levelled. Compartments are then marked out, of which the dimensions are extremely variable, and each is surrounded by earthen walls or banks about two feet high. Connection is established between the compartments at high and low levels, so that the water entering the first passes into the others, and thus maintains a very gentle movement which keeps the supply always fresh. When the divisions are duly formed, the rice-ground is ploughed and carefully weeded in spring.

If the soil be too wet for the use of the plough, as in marshy localities, it is broken up by the spade, a tedious and unhealthy process. After the ground has been thus prepared, water is admitted for the purpose of verifying the levels, and of consolidating the partition-walls of the different divisions. It is necessary to remove all trees from the immediate vicinity, as shade is very hurtful to the crop.

The period of sowing extends from the beginning of March to the beginning of May. The new rice-lands are sown first: those which have been established for one or more years at a later period, as the soil is benefited by exposure for some time to the heat of the sun. Rice in the husk, locally termed *risone*, is employed as seed in the proportion of from three to four bushels per acre, according to the nature of the soil. It is sown by hand, and as the land is literally in the state of mud, it is very laborious and unhealthy work for the cultivators. It is usual to soak the rice-seed in water for twenty-four hours previously, with the double object of quickening its vegetation, and preventing its floating on the surface of the water, as without this precaution it occasionally does.

Twelve or fifteen days after the sowing, the young plants rise above the surface of the soil, and as they increase in height, the sheet of water is gradually increased with them, so that merely their tops show above it. The fields are kept in this flooded state until the plant flowers, which, according to the time of sowing, takes place between the middle of July and the middle of August. About this time the flooding of the crop is replaced by regular but abundant irrigation, at intervals of a few days. When the head becomes well formed, the grain of good size and the colour changes from deep to lighter yellowish green, all use of water is discontinued, the land is drained as dry as practicable, and in ten or fifteen days afterwards the crop is ready for cutting. The rice harvest in the north of Italy ranges, according to circumstances, from the middle of September to the beginning of October; and the crop is cut with the scythe when large compartments are used, and with the reaping-hook in the smaller ones. The grain is made into small sheaves about 25 lbs. or 30 lbs. in weight, and with a constant length of 18 inches. When the plants are longer than this, they are cut higher, and the stubble is afterwards ploughed in as manure.

The thrashing is effected after the Oriental fashion, by the treading of bullocks or horses; and the grain is subsequently dried for some days by exposure to the sun. It is then stored, and during the winter, when water is cheap and abundant, it is cleared of the husks in the rice mills attached to the farms, which are worked by water-power. Throughout Northern Italy the meadow and rice lands may be said almost to divide between them that vast volume of water which is every year poured over the face of the country.

Italy exported the following quantity of rice:

	Kilos.		Kilos.
1862	26,666,820	1871	84,350,000
1866	52,466,222	1872	75,372,000
1867	86,340,069	1873	66,421,000
1870	86,681,044	1875	72,769,000

India.—At least three-fourths of the rice that forms the export trade of the world is exported from British India. Bengal rice finds its way wherever coolies emigrate, and no other rice seems able to compete with it in the market.

The rice exported from Calcutta is divided broadly into three qualities: table rice, ballam, and moonghy; of these table rice is of course the best quality. Ballam is mostly Backergunge and Eastern Bengal rice; the name may be supposed to be derived from the Chittagong boats of peculiar construction in which the rice is carried, called ballam boats. The moonghy is common or inferior rice. To the United Kingdom the exports in the largest proportion are of table rice; and similarly to Bombay and Australia, where it is intended in the first instance as food for Europeans; the rice exported from Calcutta is table rice. To the Mauritius, however, the exports are ballam and moonghy, being in the proportion of 150 tons of ballam and 75 of moonghy to 15 tons of table rice, and the same to Bombay and the West Indies. To the Straits, to Java, to the Maldives and Laccadives, to Ceylon, to Madras and the Coromandel Coast, and to the Gulfs the export is almost entirely of ballam rice.

First among the Indian cereals, of course comes paddy. There are over 1400 different specimens of it in the Calcutta Museum. Probably there does not elsewhere exist an equally extensive and valuable collection of this cereal. Of paddy, or the rice grain, there are in Bengal three well recognised classes—the *Aus*, the *Amun*, and the *Boro*. They may be shortly distinguished as follows:

The aus is sown between the middle of March and the middle of April, and is cut in August and September. It does not grow in water; is coarse, and is not largely produced. The amun is sown between the middle of May and the end of June. It requires showers of rain even in its early days, but the young plants should be strong before the regular rains set in. It is cut in November and December, and constitutes the staple crop of the country. The boro is sown in January and February, or somewhat earlier; is planted out in low marshy places, and is cut in April and May.

The number of varieties of paddy in the three different classes together is something enormous, when compared with anything of the kind to which we are accustomed in England. Ten or a dozen names each would probably cover all the different sorts of wheat and barley with which the practical English farmer is brought in contact. But there are already in the Calcutta Museum as many as 1104 names of paddys, and though very many of these are merely local synonyms, a large number unquestionably correspond to intrinsic and seasonal distinctions.

The obvious differences in the grain itself are indeed very remarkable. In colour the specimens range from a bright golden hue, through almost every gradation of tint, to black. And in regard to size they vary from the dimension of a large mustard seed to those of a cantaloup melon seed. Some two hundred or three hundred of the samples of paddy in the museum have been tested by weighing; and of these the smallest furnished 203¼ paddy grains to the half drachm, the largest 54¼ grains.

The husked rice, or rice proper in the understanding of English people, exhibits, necessarily, differences of size corresponding with those of its parent grain. It also varies in tint from a pure white colour to a dull red. The proportionate out-turn of rice to the unhusked paddy from which it arises depends both upon the sort of grain and the process of husking pursued; probably also upon other elements. Dr. Buchanan Hamilton says it amounts to a little more than one half;* and a writer in the 'Statistical Reporter' gives the proportion of "rice" to "paddy" at from half to two-thirds.

It has not yet been ascertained what are the external conditions of season, situation, and culture, which give the different sorts their respective economic values; and investigation on these points forms

* Vol. ii. p. 824.

part of the work which is yet reserved to be accomplished in Calcutta.

It is impossible to give anything like an approximate estimate of the land under culture, and the annual production of the great rice-growing countries of the East. But a few incidental facts may be stated. In 1870, there were 4,000,000 acres devoted to rice in the Madras Presidency.

The following are extracts from an interesting note on the cultivation of rice, by Lieutenant Ottley, Assistant to the Chief Engineer, Irrigation Branch, Bengal:

The rice continent of the world is Asia, and in Asia, British India is pre-eminent as the territory where rice cultivation most prospers.

American rice, from the careful cultivation to which it has been subjected, has acquired a quality far finer than that of any other rice. Persistent efforts have been made by the Indian Government to introduce the Carolina varieties into India, but hitherto with only moderate success. On this point Sir George Campbell, in his 'Administration Report for 1872–73,' writes thus: "For Carolina rice cultivation an artificial supply of water is necessary, and instructions have now been issued that the seed should be sown on our canals, and duly irrigated. Carolina rice is much more highly priced in the market than ordinary rice, and it may be that with command of water we shall be able to realise from the cultivation of Carolina rice much that is now sunk on canals."

The following figures may be useful as showing the immense importance of rice cultivation. Rice is the principal article of diet over Bengal proper, and among Bengalees is often the only food eaten; pulses, fish, vegetables, oil, salt, spices, and other condiments are only added to give the rice a relish. It is generally admitted that the consumption varies from two-thirds to three-fourths of a seer (about 2 lbs.) per head per diem. The population of Bengal and Orissa amounts to 44,913,305 souls; this number therefore at two-thirds of a seer per diem, or six maunds per head per annum, require nearly 270,000,000 maunds of rice. In Behar, rice is still the principal food crop, though among the poorer classes, and especially in the district of Sarun, maize and barley are in a great degree the food of the people. . . . The population of Behar is 19,736,101 souls, and allowing 3 maunds of rice per head per annum, we require nearly 60,000,000 maunds of rice. Bengal and Behar together, therefore, consume about 330,000,000 maunds of rice yearly, or say 12,250,000 tons; add to this an export of 500,000 tons, and 2,000,000 tons for seed grain and waste, and the total requirements amount to nearly 15,000,000 tons of rice per annum, or say 574,000,000 maunds of paddy. An article in the 'Indian Economist,' taking the consumption at three-fourths of a seer per head per diem, and allowing that amount for Behar, as well as Bengal and Orissa, arrived at a total requirement of nearly 20,000,000 tons of rice, or say 765,000,000 maunds of paddy. Both these calculations exclude the reserves which must be stored, and deal only with the actual yearly hand-to-mouth consumption. Taking the lower of the two estimates, the area yearly under rice probably amounts to from 30,000,000 to 40,000,000 acres, or say from 60,000 to 80,000 square miles; unfortunately, there is no reliable information obtainable on this point in any district, so that it is difficult to arrive at even an approximation as to the area under rice cultivation.

Rice being the staple food crop of Bengal and Burmah, it is important to ascertain as nearly as may be the average out-turn per acre. The conclusions which I draw from a very careful study of a mass of statistics on this subject are as follows :—

1st. That *very good land in very exceptional years* will give an out-turn of 48 maunds per acre, and in such exceptional places as Hidgellee even as much as 54 maunds.

2nd. That the out-turn of the *same land in an ordinary good year* may range from 36 to 40 maunds per acre.

3rd. That the out-turn of *ordinarily fair low land in a really good year* may range from 30 to 36 maunds.

4th. That this *same land on an average of say ten years* will give a yearly out-turn of from 18 to 24 maunds.

5th. That *poor or high sandy land* will give in a *good* year 18 maunds.

6th. That the *same land on an average of say ten years* will give a yearly out-turn of 12 or 13 maunds.

7th. That the *average out-turn for a number of years of all classes of land* will be about 15 maunds per acre.

These conclusions have reference only to crops depending on the rainfall or irrigated from sources the supply of which is not assured, and it appears to me that a never-failing supply of canal water would eliminate the unfavourable years, and would thus raise the average yearly out-turn of the irrigated crops from 15 maunds to between 24 and 30, according as the lower or higher estimate of a favourable out-turn is accepted.

Doubts having been frequently expressed as to the value of, or necessity for, irrigation for rice crops, a great number of experiments to ascertain the out-turn of irrigated and unirrigated crops were carried out in 1873 by Mr. Apjohn in the Midnapore district. The results may be here briefly stated thus. The unirrigated lands gave an out-turn of about one-fifth of a bumper crop, lands irrigated in October and November gave nearly half a bumper crop, and lands irrigated from June and July gave six-sevenths of a bumper crop. The crops irrigated from the beginning of the season exceeded in value the altogether unirrigated ones by rupees 16 per acre, the value being obtained from the selling price of the paddy and straw on the ground.

Now, inasmuch as the year (1873) in which these experiments were made was one of deficient rainfall, the comparison is decidedly favourable to the canals and unfavourable to the unirrigated crops, and this proportion of out-turn, viz., $4\frac{1}{2}$ to 1, cannot, and will not hold in ordinary years.

This much, however, may be safely inferred—*firstly*, that in bad seasons the canal-irrigated crop will be say $4\frac{1}{2}$ times better than the unirrigated one; and *secondly*, that in ordinary years the canal-irrigated crop will compare with the unirrigated one as 6 to 5 at least. This increase may not appear great when merely one acre is considered, but becomes of vital importance when the area of cultivation is reckoned in hundreds of thousands of acres.

In India generally, it has been said, rice is produced in every variety of soil, at every altitude, and in every latitude. On an average estimate the yield of one acre of rice in the fertile soil of Eastern Bengal has been taken to be about 27 maunds of paddy, or 2,214 lbs. Rather less than 2 maunds or about 160 lbs. would be the amount of seed required in those provinces for sowing an acre; and the produce may, therefore, be estimated at thirteen or fourteen-fold. This is rather an over-estimate for ordinary Bengal produce. Twenty maunds of paddy or say 12 maunds of rice per acre is really a very good average out-turn, and a yield of seven-fold is an average beyond which few cultivators on an ordinary soil venture to calculate. In the North-West Provinces the average yield of rice is reported to be little over 10 or 12 maunds of paddy per acre, or from 500 lbs. to 800 lbs. of cleaned rice. In the Punjaub the out-turn is estimated at 550 lbs.; in Oudh at 649 lbs., in the Central Provinces at 207 lbs., and in Mysore at 1577 lbs. of rice per acre. It is presumed that these calculations are in cleaned rice, as it is impossible to suppose that there can be so small a yield as this of paddy or rice unhusked. The Mysore estimate, however, is apparently in paddy. In Mr. Dalzell's 'Memoir on the Famine of 1866,' it is asserted that the Revenue Settlement Department of Madras, after inquiries and experiments, extending over ten years, had estimated that an acre of unirrigated land in the Madras Presidency produces on the average a yield of about 5 cwts. or 560 lbs., and that an acre of irrigated land produces 10 cwts. or 1120 lbs. of cleaned rice. The yield of paddy is said to be double the yield of cleaned rice. In Sindh the out-turn of an acre is estimated at from 900 to 1200 lbs. of paddy.

In British Burmah it is reported that one acre will produce from fifty to one hundred baskets, or 2700 to 5400 lbs. of paddy, according to the class of land. On the best land somewhat less than one basket (54 lbs.) of paddy will plant an acre, while on inferior land it takes more. The yield of paddy in British Burmah is, therefore, from fifty to a hundred-fold. The average on the Tenasserim coast is said to be only twenty-fold. In Siam, Cochin-China, and Java it is a common practice to exact two crops of rice yearly from the same soil, one in April and one in October, and an English acre in Java so cultivated has been found to yield an annual produce of 560 lbs. of cleaned rice. In the same island an acre of good land yielding annually one green crop and a crop of rice was found to produce 941 lbs. of clean grained rice or about 1250 lbs. of paddy.

It would not be difficult to re-produce many other calculations that have been made of the out-turn per acre and of the remunerative quality of rice cultivation. To do so, however, would be of little use, as the calculations are mere estimates, and are often evidently very inaccurate.*

Rice is the favourite food-grain of the people of Asia; but, except in Arracan, and a few other districts, in which it constitutes the chief and almost only article cultivated, its use is confined to the richer classes throughout the country.

Rice is used for food for man, beast, and bird; for the manufacture

* Mr. H. J. S. Cotton in 'Calcutta Review,' 1874.

of starch, the distillation of spirits, &c. Its varieties are as numerous as its uses. There are in Bengal three distinct crops: the first, grown on somewhat high ground, is the early crop, sown for the most part in June, and reaped in August and September. The second is the main crop, sown in June and July, and cut from November to January. It requires a great deal of moisture, some varieties growing in several feet of water. The third is a dwarf crop, cultivated in the months of March, April, and May, on low-lying land, generally on the sides of marshes and pools, where irrigation is easy. The ratio of productiveness is said to be, in a good season, as 1 to 35.

The following figures show the rice exported from India, distinguishing husked and unhusked, chiefly to England, Ceylon, and Mauritius. Value of that exported about 5,000,000*l*. a year.

Year.	Husked.	Paddy.
	cwts.	cwts.
1871	15,792,022	295,791
1872	16,990,890	320,395
1873	22,973,797	320,159
1874	19,805,184	440,201
1875	16,940,642	452,296

The expansion of the export rice trade of Burmah is remarkable. The value of the exports is between two and a-half and three millions sterling, or more than one pound per head of the population. Now, rice mills are being built year by year at Akyab, Bassein, and Rangoon.

Rice constitutes the main staple of British Burmah, which province exported during 1875 nearly 61 per cent. of the total exports from India. These Indian exports and the value were in:

Year.	Rice and Paddy.	Value.
	cwts	£
1869	15,377,071	4,283,965
1870	10,614,644	3,087,615
1871	16,087,813	4,203,850
1872	17,311,285	4,499,161
1873	23,293,956	5,761,030
1874	20,245,383	5,549,797
1875	17,392,938	4,765,334

The narrow strip of coast between the sea and the Aeng range, which we call Arracan, covers an area of about 16,250 square miles. It is generally fertile. The deep lagoons which intersect it in every direction afford ready means of communication, and it has a fine and convenient outlet for its produce in the magnificent harbour of Akyab. The production has been developed by the small independent owners of land, until the province now competes successfully with Bengal in the supply of rice to the continent, so that the exports, which in 1830 gave employment to but a few coasting vessels, now require one million tons of shipping.

The Burmese recognize nearly a hundred varieties of rice, but the principal distinctions between the different kinds are as follows:—hard grain, soft grain, and glutinous rice. The "Natsieng" is the hardest grain, and the rice which is accordingly principally exported to Europe. The "Meedo" is the chief of the soft grain varieties. It is much preferred by the Burmese to the hard-grained sorts, and it is certainly superior in taste when cooked; but the hard-grained rice is that purchased by the merchants for export, as it keeps better, and the soft-grained rice is too much broken by European machinery in cleaning. Latterly, on the continent, this last objection appears to have been overcome, and a greater demand is consequently springing up for the "Meedo" rice for the markets of foreign Europe. The "Koungnyeen," or hill rice, is called "glutinous" rice by Europeans, from the property it possesses when cooked of the grains all adhering in a thick glutinous mass. It is the chief article of food with the Karens, and other hill tribes, but is not much eaten by the inhabitants of the low swampy plains, where the common rice is grown.

The annexed table shows the exports of rice (excluding paddy) from Bengal to Indian and foreign ports for twelve years:

Year.	To Foreign Ports.	To Indian Ports.	Total.
1861–62	341,198	69,082	410,271
1862–63	407,793	74,264	482,057
1863–64	388,814	187,253	576,067
1864–65	403,432	291,909	695,341
1865–66	255,167	81,045	336,211
1866–67	160,357	62,302	222,659
1867–68	268,892	83,574	352,466
1868–69	254,244	132,369	386,613
1869–70	190,093	182,962	373,055
1870–71	244,916	185,442	430,358
1871–72	252,812	179,052	431,864
1872–73	355,054	156,206	511,260

The following were the several countries to which cleaned rice was sent from British India in 1872-73:

	Cwts.
United Kingdom	11,944,640
France	10,144
Germany	111,831
Mediterranean ports	382,667
Other countries in Europe	200,627
North and South America	128,919
West Indies	591,773
Mauritius	2,435,035
Bourbon	148,236
Other countries in Africa	140,244
Arabian and Persian Gulfs	1,162,620
Ceylon	3,049,052
Total	20,305,787

In Cochin-China there were in 1874 700,000 acres under culture with rice. In 1867 3,200,000 piculs of rice were exported.

Rice, although regarded by us more as a cheap luxury than a necessary article of food, forms the chief subsistence of the Hindoos, Chinese, Japanese, and other eastern nations. The Burmese and Siamese are the greatest consumers of this grain. A Malay labourer requires 56 lbs. monthly, but a Burmese or Siamese 64 lbs. The South Carolina people do not consume much rice themselves: they raise it principally to supply the foreign demand; the swamps of that State, both those which are occasioned by the periodical visit of the tides, and those which are caused by the inland flooding of the rivers, being well suited to its production. The mountain rice of India is grown without irrigation, at elevations of 3000 to 6000 feet above the level of the sea; the dampness of the summer months compensating for the want of artificial moisture. Rice, which comes to us in the husk, is called by its Indian name "Paddy." Before it can be used for food, the husk must be removed: this is done in India amongst the poorer people by merely rubbing the grain between flat stones, and winnowing or blowing the husks away.

Siam.—In 1870 2,563,302 piculs were exported, equal to 3,204,000 cwts. The export in 1875 was 3,904,800 piculs of cleaned rice and 21,578 piculs of paddy, valued together at 1,215,042*l.* This was nearly all sent to Hong Kong and Singapore for China.

This export of rice was in excess of all previous years by about 1,000,000 piculs. There is, however, no reason to believe that this arises from new land being brought into cultivation, but simply that the season was a good one and the demand for rice in China was constant throughout the year. Burmah and Cochin-China having the advantage of telegraphic communication with the rest of the world, and their trade being on a more regular footing, the rice from those countries is all taken away as soon as it is ready. In Siam the export though far less on the whole than in either of those countries, continues throughout the year.

There is little reason to believe that Siam will produce, at least for some time to come, more rice than she does at present. Nothing is done to encourage the cultivators, and a system of advances made by officials on the crops is growing up, which eventually takes all profit out of their hands.

China.—Rice culture extends over all the provinces of China, which combine abundance of water with the mild temperature necessary for this grain. The provinces of the south yield two harvests annually. There are many varieties, as white and red rice, large and small grain, the upland or dry rice, and the glutinous rice. The mountain rice (*Oryza montana*, Lour.), distinguished by its long grains and epidermis, would seem to be a distinct species.

The following is the plan generally adopted in China: When the rains of June begin to fall, the ground is covered with water to the depth of an inch or two, and ploughed. The humus is then reduced to a sort of fluid pulp by harrowing. After this preparation the water is let off, and the seed sown broadcast, and a roller is passed over the ground to embed the seed. The land then remains dry for a week. When the rice begins to spring up a small quantity of water is given, but not enough to cover the young plant, which would kill it. The quantity is increased as the plant grows. Forty or fifty days after the sowing the transplanting begins. Land is prepared and laid out with trenches surrounding it to hold water. It is then trenched and harrowed, and the planting out proceeded with. For eight days, however hot it may be, the plants are not watered, but when the leaves begin to develop the soil is covered with a small quantity of water, which is increased as the plant grows.

It is calculated that the aquatic rice only yields a return of 25 for one, but that it might yield up to 80. The upland or mountain rice is, however, said to be more profitable, for it is not unusual to obtain 100 to 120 for one. This abundance is explained by the habit which rice has to tiller, and a single grass will often produce many stems crowned with numerous spikes of grain.

Formosa.—The chief agricultural crop in this island is rice, grown in irrigated, or rather inundated fields. Much labour and skill must have been bestowed upon the levelling of the fields and the provision of the supply of water, which is conducted by artificial channels from elevated springs, or from the upper courses of streams. The rice fields of the plain of Bangka, ten or twelve miles inland, are chiefly supplied by a stream which is conducted from a higher part of the Tamsuy River, and is carried across another stream at Kiang-beh, by a wooden aqueduct of 100 yards or more in length. Two harvests in each year are obtained from the irrigated fields. In November or December, after the removal of the autumn crop, the fields are ploughed up. The fields remain vacant for about four months, save that about the end of January seed is grown in nursery patches sheltered from the north-east. In February or March, the fields are in course of preparation for planting. Besides the plough, two kinds of harrows are used, namely (1) the "blade-harrow" (locally called "Kiva-pay") a wooden-frame, holding beneath it two sets of metallic blades, which make parallel cuts through the clods or mud as the implement is drawn along by a buffalo, the driver standing on the frame; (2) the "hand harrow" (or "Chew-pay"), of iron, with a long row of spikes. This seems to complete the stirring of the ground. In the latter part of March, or the early and middle part of April, the fields, now in a state of soft mud, are planted out with the young rice plants. In taking up the strong plants from the nursery patches, a sort of flat spatula is passed underneath, so as to take off a very thin slice of earth with the plants upon it.

In the immediate neighbourhood of Tamsuy, about a fortnight before the harvest, the rice is laid down, four adjacent rows being folded together, and so laid that the ears of each cross-row shall rest upon the cross-row in front of it. It does not appear that this practice is followed in the more sheltered inland country. In July the crop is reaped. The grain is thrashed out immediately in the fields. There is a tub, within which is placed obliquely a set of wooden bars. The operator takes by the lower end a handful of rice stalks, and gives it a few smart blows upon the bars, detaching the grain, which is received in the tub. A curtain, supported by bamboo sticks, keeps the grain from flying overboard. The tub is dragged forward as the progress of the work requires. The ground is then speedily got ready for the planting out of the second crop, the young plants of which are already growing upon nursery patches. In preparing the fields for the second crop, the implement chiefly used in the locality is the "lah-tak." This is a wooden roller, four or five feet long, and twelve or fifteen inches in diameter, very deeply-grooved longitudinally, so that its rectum would be a seven-pointed star, and mounted in a wooden frame, in which the driver stands. The lah-tak is drawn by a buffalo, over or through the wet land, the rollers revolving and stirring the soft surface by the action of its grooves and ridges. The second crop is planted out in the latter part of July or early part of August, and is reaped in or about the first week of November. This completes one year. In some cases the second crop is planted before the reaping of the first crop, the young plants being placed among those of the first crop. The planting out of the first crop in the spring, and the harvesting of the second crop in late autumn, are liable to interference from the chill blasts and driving rain of the north-east monsoon. The frequent prevalence of wet weather in winter is a well-known peculiarity of this region. In summer there is sometimes an unfavourable continuance of dry weather. In the plain of Banjka, and in the regions to the south, the seasons are somewhat earlier, and there seems to be some difference in the mode of procedure. The dry ground rice, grown without irrigation, locally called "e-neap," or "i-liap," may be seen occasionally inland, and it is said to be cultivated by the wild aborigines of the mountains. It appears to be very fine rice, but to yield only one crop a year, and not to succeed well if the weather be dry. There are flour-mills worked by the overshot water-wheel. The wind-mill, which might be very useful in China, seems to be unknown to the Chinese, as it was to the ancient civilized nations of the west.

A simple contrivance, called the "water-hammer" or "water-pestle," is used for the pounding, to clean away the integument of the rice. The pestle is fixed like a hammer-head in the end of a beam which moves on an axis. The other end of the beam holds a bowl or shallow bucket, into which falls a small stream of water. When the bucket is full, its weight and the impulse of the falling stream send it downward, raising the pestle; but in sinking it pours out its contents and passes out of the course of the stream. The pestle then falls, bringing the bucket under the stream again, and so the process repeats itself.

Japan.—The surface of the paddy fields in Japan is estimated at 1,587,757 hectares; the annual yield is said to amount to 50,512,000 hectolitres, of a total value of 6,500,000*l.* sterling, the average produce being about 3181 litres per hectare.

The young rice plants are set out in the paddy fields in regular rows of bunches towards the end of May or the beginning of June, having been previously raised in some different place. The harvest takes place in September or October.

Rice wine, or sake, as it is locally called, forms the principal and almost the only alcoholic beverage of Japan. It is made exclusively of rice. In preparing the ferment the rice is washed, steamed during several hours, and spread out on mats to lower the temperature; afterwards it is kept in a warm room for several days, where it is mixed with a certain quantity of rice covered with fungi; these latter spread rapidly over the whole surface of the rice. The fermenting wort is made of fresh rice, also steamed, and mixed with water and a certain percentage of ferment in small tubs. A large cool is filled with these mixtures, and kept for about eight days at a certain temperature, which is maintained by introducing a vessel filled with hot water into it. The wort first gets a sour taste, whereupon the temperature is lowered; at a later period the taste becomes bitter, and the wort is cooled so as to stop further fermentation. In January the real brewing begins. Again fresh rice is steamed, washed with a considerable percentage of both the ferment and the wort, mixed with a sufficient quantity of water. The whole is then transferred into big vats, frequently stirred, and left for about twenty days, at the expiration of which period it usually acquires a vinous taste. The mash is now placed in bags and pressed, and the liquid runs out into casks, where it settles, whence it is tapped when quite clear. The clear liquid is then heated up to a certain point and kept in large butts. This sake is generally drank hot at meals. The residues and the spoiled sake are distilled, and the alcoholic liquid used for making the "mi-rin" or sweet liquor. The total production of sake in 1874 was estimated at 6,501,083 hectolitres, that of certain inferior kinds of sake at 127,446 hectolitres, that of brandy at 60,577 hectolitres, that of sweet alcohol liquors at 56,712 hectolitres.

Java.—There are three principal varieties of rice reckoned here: *Oryza glutinosa*, or Ketan; *Oryza sativa*, or paddy; and sawa (*Oryza montana*), with a variety called Paddy Girek. This last sort falls from the stem immediately after being cut. Besides these principal kinds, there are more than one hundred varieties, some of which are cultivated in upland grounds, but the greater part in irrigated lands.

The mean temperature varies very little in Java in the various regions, even at different elevations. Rice grows as well at heights 3500 feet above the level of the sea, where at six in the morning before sunrise the thermometer only marks 10° Réaum., while in the day it will ascend to 20°. The stalks are, however, less heavy, and the grain ripens quicker than in the interior, where it will not ripen under eight months.

The yield cannot well be fixed, for this depends upon the kind of rice and the nature of the soil. A return of 80 to 100 for one is considered very good, although this is sometimes exceeded.

The time of sowing and transplanting varies, depending upon the nature of the rains, as the sowing commences in the wet season.

The culture of rice is the principal occupation of the people, as it is not only the chief source of their food, but there is a surplus for export.

In 1873 the culture of rice in the island occupied 6,250,000 acres, and the produce was 52,244,230 piculs, without reckoning the culture in the environs of Batavia and the provinces which are partially in the hands of the native princes. The table rice is called Beras. The glutinous rice is employed for making pastry; the red rice is given to poultry and horses; the black rice is more remarkable for its colour than for its quality. In Java as in Sumatra there are two different climates, one in the lower regions, which are tropical, and those of the higher plains and mountains, which resemble the climate of Southern Europe.

In 1863, 126,537,000 lbs. of rice were exported from Java; in 1870 310,722 piculs.

Borneo.—Both the soil and climate are here very favourable to the growth of rice, but little more is grown at present than would appear to suffice for home consumption. It is raised in almost every part of the country. Its price is from 80 dollars to 97 dollars the koyan of 5220 lbs.

In the *Philippines* the hill rice is sown in May, and cut in October; whilst that of the plains is planted generally in July or August, and gathered in December and January. Rice forms the staple article of food for the inhabitants. Its price varies, according to locality.

One quinon (or about 7 acres of land) in the province of Bulacan is said to produce on the average 250 to 300 cavans (96 lbs. each) of paddy. Were the system of irrigation understood and generally practised, the cultivation of rice might be considerably augmented.

Africa.—The cultivation of rice undoubtedly dates from the oldest periods of which we have any historical record. "Cast thy bread upon the waters: for thou shalt find it after many days," * evidently applies to rice, which in Egypt is always sown whilst the waters of the Nile still cover the land, the retreating floods leaving a rich deposit of thick alluvial silt, in which the rice vegetates luxuriantly.

The chief rice grounds of Egypt are in the Delta, and the choicest in the environs of Damietta. The beating and husking are effected with American machines. The commerce in rice centres almost exclusively at Alexandria, Damietta, and Rosetta.

Rice is cultivated abundantly by the negro tribes of East Africa to the Monomoisy inclusive, bearing everywhere its Malay name of "padi." Cademosta met with rice on the Gambia. And Lopes (A.D. 1588) speaks of "a grain brought to Congo not long since from the river Nilus, and called 'luco;'" in which word we readily recognise the Egyptian name of rice. It is also grown on the west coast of Africa, and in the islands of Ceylon, Réunion, Mauritius, and Madagascar. From Madagascar we received upwards of 10,000 cwts. in 1875.

Brazil.—Vast plains and even slopes of hills favour throughout this empire the culture of rice, which sometimes grows to three feet in height, and produces more grain than the fertile lands of India. Maranham rice rivals that of Carolina, and on the marshes and banks of the rivers of Mato Grosso, or those of the San Francisco and others, it grows and yields excellent crops without labour.

Wallace, in his 'Travels on the Amazon,' thus describes the process by which the rice is freed from its husk at Para. The grain first passes between two mill-stones, not cut, as for grinding flour, but worked flat, and by this the outer husk is rubbed off. It is then conveyed between two boards of similar size and shape to the stones, set all over with stiff iron wires about $\frac{3}{8}$ of an inch long, so close

* Ecclesiastes, xi. 1.

together that a grain of rice can just be pushed in between them. The two samples very nearly touch another, so that the rice is forced through the spaces of the wires, which rub off the rest of the husk and polish the grain. A quantity, however, is broken by this operation, so it is next shaken through sifters of different degrees of fineness, which separate the dust from the broken rice. The whole rice is then fanned to blow off the remaining dust, and finally passes between rubbers covered with sheep skin with the wool on, which clean it thoroughly, and render it fit for the market. The Para rice is remarkably fine, being equal in quality to that of Carolina, but, owing to the carelessness with which it is cultivated, it seldom shows so good a sample. No care is taken in choosing seed or in preparing the ground, and in harvesting a portion is cut green because there are not hands enough to get it in quickly when it is ripe, and rice is a grain which rapidly falls out of the ear and is wasted. It is therefore seldom cultivated on a large scale, the greater portion being the produce of Indians and small landholders who bring it to the mills to sell.

United States.—Rice was first introduced into Virginia in the year 1547. In 1698 about 60 tons were shipped from Charleston to England. In 1718 its cultivation was commenced in Louisiana by the "Company of the West." The rapid development of its cultivation will be seen from the fact that in 1724 South Carolina exported 18,000 barrels; in 1740, 90,110 barrels; and in 1760, 100,000 barrels. Since that time the swamps of South Carolina have proved well suited for the production of rice; and not only has the cultivation been effected with trifling labour, but the grain produced possesses a remarkably fine quality, being decidedly larger and handsomer than that of the countries whence the seed was originally derived. The following table shows the exports of domestic rice before and since the civil war:

	Lbs.		Lbs.
1810	84,452,263	1850	77,467,909
1820	56,226,103	1865	1,666,442
1830	74,920,431	1866	2,212,901
1840	65,339,731	1870	2,133,014
1846	92,866,561	1871	455,842

As will be seen from the above figures, the exportation since the war instead of increasing is decreasing. The re-exports of foreign in 1869 amounted to 8,868,664 lbs., in 1870 to 15,212,833 lbs., and in 1871 to 10,215,940 lbs.

In 1840 the rice crop of the United States amounted to 80,841,422 lbs., that of 1850 to 215,312,710 lbs., and that of 1860 to 187,140,173 lbs. The production of 1870 was but 73,600,000 lbs. Evidently this industry has not recovered from the effects of the war as has the cotton crop. The rice plantations of the Southern States were not so universally abandoned during the war as were the cotton plantations; therefore this can hardly be urged as the cause of the languishing condition of rice production, while the cotton crop has not only fully recovered, but exceeds the production of the last year before the war by 500,000 bales. The true cause must be looked for in the 80 per cent. duty. While foreign pays such an exorbitant duty, it cannot decline for any length of time beyond a certain limit. In 1860 the exports amounted to over 81,600,000 lbs.; in 1871, under a duty of 80 per cent., to 445,000 lbs. The countries south of the United States, viz., Cuba, Porto Rico, and the West Indian Islands, Mexico, Venezuela, and other Central and South American countries, are the largest consumers of rice in the world, with the exception of China. These countries, instead of seeking their supplies from the United States, now draw them mostly from England, and all because the rice cannot be cleaned and dressed in the United States. The duty on raw rice drives it to Liverpool to be cleansed, and from there it is exported in direct competition with American exporters, who obtain their supplies for export from the same port, as Government, while refunding the 2½ per cent. duty on cleaned rice, does not refund the additional 10 per cent. levied on rice imported from places other than the countries of production.

In 1869 the crop of South Carolina, as returned by the census authorities, was 32,304,825 lbs.; of Georgia, 22,277,380 lbs.; of North Carolina, 2,059,281 lbs. Production had nearly ceased in 1865.

In Georgia, two-thirds of the rice is grown in Chatham and Camden counties; half in the vicinity of Savannah. In South Carolina, nearly half of the crop is grown in Georgetown. The following figures show how small a district yielded the rice in the palmy days of 1859:

South Carolina.	Lbs.	Georgia.	Lbs.
Georgetown	55,805,385	Chatham	25,934,160
Colleston	22,838,984	Camden	10,330,068
Charlestown	18,899,512	McIntosh	6,421,100
Beaufort	18,790,918	Glynn	4,842,755
Total	116,334,799	Total	47,528,083
Twenty-four other counties	2,765,729	Eighty-eight other counties	4,979,569
Total	119,100,528	Total	52,507,652

The rice crop has been steadily increasing in quantity in South Carolina, but decreasing in price:

Year.	Crop, Tierces of 640 lbs.	Lbs.	Value per lb.
			cents.
1866	4,119	2,677,350	13
1867	21,031	13,670,150	11
1868	25,114	16,324,100	9
1869	36,445	23,689,250	8½

The value of the crop of 1869 was 309,782*l.*; 5367 tierces were locally consumed, and the rest exported. 18,000 bushels of rough rice were shipped from Wilmington in 1868.

I append a tabular statement of the yield in tierces for five years:

Year.	North Carolina.	South Carolina.	Georgia.	Total.
	tierces.	tierces.	tierces.	tierces.
1871	500	42,842	11,250	54,592
1872	600	47,240	19,874	67,714
1873	750	43,067	23,702	67,519
1874	600*	47,268	21,671	69,539
1875*	..	50,000	23,000	73,000

* Estimated.

A larger area of territory is each year being brought into cultivation, and great improvement made every season in the quality of the crop. Considering the impoverished condition of that section, and the many disadvantageous surroundings, the advance of the five years is remarkable. The following is the milled product of the three rice-growing States, viz., Georgia, and North and South Carolina, since the war:

	Lbs.		Lbs.
1866	7,500,000	1869	36,087,600
1867	14,602,200	1870	40,641,000
1868	18,477,000	1871	41,000,000

The rice crop of Louisiana is an industry of increasing importance, and particularly so from the fact that its cultivation exacts the investment of but a limited amount of capital. When fields are once divided by ditches, and a substantial culvert and sluice gate, to admit the water from the river, are constructed, every preparation for commencing the cultivation of this product has been made. The entire cost for preparing the land and for seed is estimated at 3½ dollars per acre. Its cultivation and shocking amount to 13 dollars more, and the expenditure 6 dollars, for threshing and handling, sums up 22 dollars for twelve barrels of rough rice, which can be produced on one acre. Milling, freight, package, insurance, drayage, and commission will amount to 3 dollars 40 cents more, making a total expenditure of 36 dollars 40 cents for 1200 lbs. of clean rice worth 84 dollars. It will be seen that a net profit of 47 dollars 60 cents per acre is thus given, making allowance for the wages of labourers and every other expense. Heretofore 100 acres has been considered the task of three men, which would pay each 1588 dollars 33 cents for six months' work, or salaries that at the present time would be pronounced enormous were the talent and muscular force invested considered. Really, however, their profits would be much greater. Ploughing for rice entails scarcely any labour, the earth being turned up but for a few inches, and by performing their own work fully 3000 dollars could be saved. The same is true of cultivation, the occasional flooding of the land being the chief requisite. Only during the harvest season is a large force required, and the adoption of the newly-invented labour-saving machines would materially reduce the estimated cost. A time was when that part of South Carolina flooded by the tide of Ashley and Cooper rivers was believed to be the only spot of ground in America where rice could be profitably cultivated. It was also believed the African was the only human being who could thrive in the miasma the plenteous use of tide-water generated. Both theories have been disproved. Louisiana rice is now largely cultivated by white labourers.

In Louisiana the growth is in quite as encouraging a condition as on the coast. Previous to the war its product was exceedingly limited, all being absorbed by the local trade. Inferior in colour, with indifferent milling facilities, the quality rated far below that raised on the coast or even most foreign kinds. The past few years have been attended with serious disasters, inflicting great damage and curtailing the yield, which under favourable circumstances would have been much larger. In 1870 the early fall of the Mississippi prevented proper irrigation: in 1871 considerable injury resulted from the Bonnet Carre Crevasse. The increase is, however, noteworthy, as the statistics of annual growth in that section since the war proves:—

	Lbs.		Lbs.
1866	4,502,080	1869	12,750,320
1867	4,765,860	1870	13,476,320
1868	9,089,740	1871	18,000,000

Great advances have also been made by planting selected seed, and adding to this improved milling advantages, the general standard is raised very materially. Viewing the whole field and taking the increase of cultivation in the past five years as a basis of calculation, the future is assuring, giving every evidence of its speedy reinstatement as one of the great national products of America.

A pamphlet, published locally by Mr. Bouchereau, remarks:—"Should the cultivation of rice continue to increase in Louisiana as it has been doing since the war, we shall soon equal South Carolina in the production of this valuable cereal, the rapid increase in its cultivation here proving to be highly profitable.

"Many large plantations are now cultivated with rice which formerly produced quantities of sugar. Before the war rice was only grown in a small portion of the parish of Plaquemines, and but in small patches. Now it is largely cultivated in several parishes, and there are still vast quantities of marsh lands which could be advantageously devoted to it, wherever the proper irrigation can be applied at the proper time.

"The average yield of rice to the acre in Louisiana is fifteen barrels of rough rice, although on the Star plantation, in the parish of Plaquemines, nineteen barrels were gathered to the acre last year, which is equal to eight and a half barrels of clean, merchantable rice."

But the extension of rice culture in Louisiana is a triumphant refutation of the baseless assertion that the business cannot prosper under the most favourable present circumstances. The census exhibits it as follows: 1849, 4,425,349 pounds; 1859, 6,331,257 pounds; 1869, 15,854,012 pounds. The record of M. Bouchereau, by plantations, accounts for a total crop in 1869 of 100,748 barrels of 200 pounds each, or 20,149,600 pounds. The crop of 1870 was not a successful one. In 1859 Plaquemines parish yielded 4,635,500 pounds of the crop of 6,331,257 pounds, or about two-thirds of the total product of the State; in 1869 the same parish produced 6,247,400 pounds, and yet it was less than a third of the crop of the State, and returns were made from fourteen other parishes.

These facts show the culture of rice is rapidly extending in Louisiana, and may be extended to nearly every parish in the State; it is slowly but surely overcoming its serious hindrances on the marshes of the Atlantic coast; it has been mainly carried on by negroes on their own account, as a business in which they have had a lifetime training.

In referring to the recapitulation of the crops for 1872-73 we find the following particulars:

Parishes.	Steam-power Rice Mills.	Horse-power Rice Mills.	Crop.
			barrels.
St. James	..	..	435
St. John the Baptist ..	1	..	1,250
St. Charles	1	2	5,402
Jefferson	..	..	308
Orleans	1	..	12
St. Bernard	..	..	117
Plaquemines	5	..	30,254
Lafourche	1	13	11,741
Terrebonne	..	4	1,224
Vermillion	..	..	884
Lafayette	..	..	579
Total	9	19	52,206

The following is the official return of American rice production at three decennial periods:—

States.	1850	1860.	1870.
	lbs.	lbs.	lbs.
Alabama	2,312,252	493,465	222,945
Arkansas	63,179	16,831	73,021
California	..	2,140	..
Florida	1,075,090	223,704	401,687
Georgia	38,950,691	52,507,652	22,277,380
Kentucky	5,688	..	..
Louisiana	4,425,349	6,331,257	15,854,012
Mississippi	2,719,856	809,082	374,627
Missouri	700	9,767	..
North Carolina	5,465,868	7,593,976	2,059,281
South Carolina	159,930,613	119,100,528	32,304,825
Tennessee	258,854	40,372	3,399
Texas	88,203	26,031	63,844
Virginia	17,154	8,225	..
Michigan	..	716	..
Minnesota	..	3,286	..
Total	215,313,497	187,167,032	73,635,001

The appended statement of exports and imports of rice has been furnished by Edward Young, Chief of Statistics in the Treasury Department:—

Years.	Domestic Exports.			
	Tierces.*	Barrels.†	Lbs	Value.
				dollars.
1850	127,069	..	76,241,400	2,631,557
1851	105,590	..	63,354,000	2,170,927
1852	119,733	..	71,839,800	2,471,029
1853	67,707	..	40,624,200	1,667,658
1854	105,121	..	63,072,600	2,634,127
1855	52,520	19,744	39,421,600	1,717,953
1856	58,668	81,038	67,616,000	2,390,233
1857	64,332	74,309	68,322,800	2,290,400
1858	64,015	49,283	58,122,200	1,870,578
1859	81,820	69,946	75,070,400	2,207,148
1860	84,163	77,837	81,632,600	2,567,399
1861	39,162	50,038	43,512,400	1,382,178
1862	2,146	7,335	4,221,600	156,899
1863	494	3,496	1,694,800	83,404
1864	..	5,442	2,176,800	84,217
1865	..	2,458	983,200	65,105
1866	..	..	2,212,901	136,993
1867	..	..	1,394,007	100,338
1868	..	..	3,079,043	170,357
1869	..	..	2,232,833	145,934
1870	..	..	2,133,014	127,655

Years.	Foreign Exports.		Imports.	
	Lbs.	Value.	Lbs.	Value.
		dollars.		dollars.
1861	348,900	10,856	148,550	3,610
1862	2,339,146	103,738	56,961,317	1,589,109
1863	7,844,068	392,134	61,196,740	1,760,077
1864	7,637,635	452,722	99,691,447	1,911,330
1865	8,290,318	559,465	60,407,756	1,474,393
1866	8,656,060	337,016	76,209,397	2,379,857
1867	4,676,082	180,043	44,782,223	1,219,387
1868	11,908,953	403,941	59,140,707	1,636,492
1869	8,868,664	284,632	54,065,191	1,325,234
1870	15,212,833	454,316	43,123,939	1,007,612

* Estimated at 600 lbs. each. † Estimated at 400 lbs. each.

Export of rice from the United States:

1770	150,529 brls.	1840	101,617 tierces.
1800	112,056 tierces.	1850	105,590 „
1810	131,341 „	1860	136,054 „
1820	88,221 „	1870	3,555 „
1830	116,517 „		

The largest export was 175,019 tierces in 1827.

Upland rice is an important crop not only for home use, but pays well for its cultivation, and should be more generally looked after than it is. It will pay to grow it as a green crop, for it bears two cuttings a year below 32° north latitude, and makes a hay which sheep, horses and cattle prefer to the best grass product known. The fact that a rice-huller has been invented that will cost little more than a coffee mill, and enable the good woman of the house to grind out a meal of rice with as much ease as she would grind her mess of coffee, and always have rice, or rice batter cakes or rice pudding on the table, will make it a greater inducement than ever for every family to plant a patch of rice. Sandy land, level and fertilized, is best for upland rice. Land that will yield 25 or 30 bushels of corn per acre will produce 50 bushels of rough grain, that will, when hulled, leave 25 bushels of clean rice, say 1,200 pounds, that, at 5*d.* a pound, would be worth 24*l.*, and the straw is worth one-third more.

The following shows the land under culture with rice in some of the principal producing countries as far as can be ascertained with any precision :—

	Acres.		Acres.
Madras	4,000,000	Java	5,500,000
Bengal	35,000,000	Menado	75,000
Cochin-China ..	700,000	Egypt	40,060
Ceylon	494,592	Portugal	9,880
Pondicherry and other French possessions in India	20,600	Austria	1,398

THE MILLETS, OR SMALL-SEEDED FOOD-GRAINS.

The word millet has a widely extended signification, and embraces the edible seeds of various grasses, very dissimilar in habit and appearance. In popular parlance the term is applied to almost all the small-seeded edible grains. In many countries different millets form large and important food-crops, and in some years considerable quantities have been imported into the United Kingdom. In 1870, besides Dhurra, we received 74,635 cwts. of millet, valued at 19,864*l.*

Thus in 1853 we received 158,159 cwts. of millet, in 1857 230,451 cwts. of millet, and 147,187 cwts. of Dari or Dhurra, (*S. vulgare*); in 1870 74,635 cwts. of millet, valued at 19,864*l.*, and 70,735 cwts. of Dhurra, valued at 19,491*l.*

In England the millets are very seldom eaten as food, and yet among the great variety of seed in this extensive group of plants (of which we as yet know comparatively little in an economic point of view) many form articles of large consumption in parts of Europe, Asia, Africa, and the West Indies. They pass under a variety of names in different localities; in northern Africa the large-seeded species is known as Dhurra, and this occasionally reaches Mark Lane to be ground and mixed with flour. In the West India Islands it is known as Guinea corn, in India as Jowarrie, in Southern Africa as Kaffir corn, in the United States as broom corn, and so on.

Of these small food-grains Roxburgh remarks: "It is probable that through the whole of southern Asia as many of the inhabitants live on the various kinds of dry or small grain as upon rice, and they are reckoned fully as wholesome as that is."

Dr. Forbes Watson, in his treatise 'On the Composition and Relative Value of the Food Grains of India,' also states that the millets in India occupy a position second to none in the country, and form the staple food of a larger number of the population than perhaps all the other cereals put together.

A third part of the inhabitants of the globe feed upon the different millets, especially those of Africa, the greater part of Turkey, Persia, and India. In Japan about 35,000,000 bushels of various kinds of millet are raised annually. Millet forms the principal sustenance of the people of Bokhara. The grain there yields so abundant a harvest that there is a large quantity for export. The seeds of millet are excellent for food both for domestic animals and man. The grain mixed with that of wheat gives an excellent bread, though a little heavy; but generally it is boiled with milk, like maize meal; it swells considerably in water. Millet fattens poultry in a very short time. The stalks serve for heating ovens or for cooking food in countries where fuel is scarce. The panicles of some, after the separation of the grain, form excellent brooms; the sale of these brooms in Italy, in Spain, France, and North America, is so remunerative that they enter largely into the value of the profits of culture.

Millet is considered in Texas one of the very best for feeding horses, oxen, milch cows, and sheep during the winter months. The yield is very heavy; so productive has it been found that in many regions of the State it nearly supersedes the use of fodder.

The two genera *Andropogon* and *Sorghum* are closely allied. Some of the best authorities consider the difference so slight as to warrant their union into one. General Munro is now at work upon a monograph of the Millets, and before long we may have some clear and definite information respecting them.

The species are very imperfectly understood, and as yet badly described. Professor Parlatore, in a collection shown at the London Exhibition in 1862, enumerated the following species of Sorghum :—

Sorghum compactum.	*Sorghum saccharatum*, Moench.
,, *durra.*	,, *caffrarum*, Beauv.
,, *nigerricum.*	,, *cernuum* (*album*), Willd.
,, *nigrum* (*S. vulgare*).	,, *elongatum*, Beauv.
,, *vulgare* (three varieties).	,, *glycychilum.*

The specific limits of the various Sorghums are not well ascertained. They are, however, much cultivated in different parts of Africa, in the West Indies, and various districts of North America and India, and have been introduced into Australia.

The large Indian Millet or Guinea Corn (*Andropogon Sorghum*, Brotero; *Sorghum vulgare*, Persoon; *Holcus Sorghum*, Lin.), is grown in the warmer parts of Asia, and is very prolific; the grains can be converted into bread, porridge, and other preparations of food; it is the yellow cholum and jowarree of some districts of India. This is a beautiful grass, resembling in appearance Indian corn. It bears a small yellow seed, which when crushed makes a good auxiliary food for cattle or sheep. It grows on all kinds of cultivated soil, but best on those that are thoroughly cultivated and well manured. Indeed, few crops will pay better for high cultivation. This valuable plant has attracted a great deal of attention during the last few years, and has been highly recommended as a fodder crop. It is best suited for cultivation in countries where the temperature seldom falls below

60°. It will certainly grow in much colder climates, but scarcely pays expenses. This forms with rice the staple food of the Madras Presidency, with rice and bajree that of the Bombay Presidency, and with wheat that of the North-West Provinces, Oudh, the Punjaub, and Central Provinces.

This grain is universally cultivated, and is in fact in some parts the principal support of man and beast. It will grow upon most soils, but luxuriates in the black soil. There are several varieties, but principally one with red seeds and one with white. Some botanists recognize at least three species in cultivation, more or less extensively, in India—*S. vulgare*, Pers.; *S. cernuum*, Willd.; and *S. bicolor*, Moench; whilst others regard them as mere varieties of the one species, which is extensively grown over the world, and exhibits, like all largely cultivated plants, a great tendency to variation.

Dr. J. F. Watson gives the composition of this seed as follows:

Water	11·95
Nitrogenous substances	8·64
Dextrine	3·82
Sugar	1·46
Fat	3·90
Starch	70·23*

* With husks.

From an analysis of the half-grown plant raised in England, Dr. Voelcker found that it contained above $2\frac{1}{2}$ per cent. of flesh-forming matters, and about 11 per cent. of fat, or heat-producing matters. The composition was:

Water	85·17
Flesh-forming matters	2·55
Fat or heat-producing matters	11·14
Inorganic matters	1·14
Total	100·00

There was little or no sugar in the half-grown plant, but when three-quarters grown, there was as much as 5·85 per cent. of sugar in the lower part of the stem. We have no analysis of Indian grown plants; but it may be safely inferred, that if such a large amount of sugar was present in plants grown in a climate so ill suited for the production of sugar as England, a very much larger quantity would be found in plants grown in the tropics.

From experiments carried on in India with plants as fodder producers, the following were found to be the results:

	Weight of Fodder per Acre.	Days required to produce a Crop.
	lbs.	
Yellow Cholum, dry crop	10,000	90
„ wet „	12,000	60
Chinese cane (*Sorghum saccharatum*) dry crop	20,000	80
Cumboo, dry crop	15,000	75

Among the food-grains grown in the Madras Presidency, there were in 1870 devoted to

	Acres.
Cholum (*Sorghum vulgare*)	4,855,000
Raggy (*Eleusine corocana*)	1,611,000
Veragu (*Panicum miliaceum*)	1,605,000
Cumboo (*Penicillaria spicata*)	3,197,000
Corralu (*Panicum italicum*)	1,018,000
Millet of various kinds	614,000
Total	12,900,000

In Ceylon there are about 72,762 acres under these small grains.

Red Cholum. This is the *S.* (*Andropogon*) *Caffrarum*, Kunth, of the Australians; it is a variety of the white cholum, and is supposed to have been originally obtained from the south-eastern coast of Africa. In America it is by many considered a better sugar-producer than the Chinese species, and all agree that its sugar is much more easy to analyze.

S. cernuum, Willd., *Andropogon cernuus*, Roxb., of which the grain is white, forms the staff of life of the mountaineers beyond Bengal. It is much cultivated in India and other tropical countries.

Sorghum or Dhurra is produced in considerable quantities in middle and lower Egypt for making bread. Being 40 or 50 per cent. cheaper in price than wheat, it is more commonly the food of the fellah or peasant than any other grain. The late Prof. Johnston states that from his analysis Dhurra flour contains 11½ per cent. of gluten.

Schweinfurth tells us that a large yellow-grained variety of *S. vulgare* is known in the Khartoum markets as Soffra. The panicles are about nine inches long and four in diameter. In *Algeria* two species are grown, the *Sorghum scoparium*, Lin., with a red grain; and the *S. vulgare*, Lin., with white grain. It is sown in April, in good deep soil, when not irrigated, or in June, when water can be had. These plants are, however, remarkable for their resistance to drought and their power of vegetation.

The grain of the *S. vulgare* has a high food value both for man and animals. The Arabs merely cut all the panicles, and leave the green stalks standing, to feed their cattle. In 1870 there were 14,117 hectares under Sorghum in Algeria, which produced 237,516 hectolitres. In 1874 there was under Sorghum

	Hectares.
By natives	24,588
„ Europeans	5,102
Total	29,690

equivalent to about 74,000 English acres. The grain is known there under the names of bechna, dra, and durra.

The dari from Jaffa is considered the best in the Mediterranean, on account of its whiteness and hardness. It used to be a large article of export from thence to the United Kingdom for feeding and distilling purposes. The yield of 1862 was as much as 7225 qrs., on account of the latter rain having been abundant. Dari is used by the poorer classes there for making bread.

In *Natal* the species of Sorghum grown are known as Kaffir corn.

In 1870 the land under culture with it and the produce were as follows:

	Acres.	Muids.
By natives	45,047	172,077
„ Europeans	50	334

The muid is nearly three bushels. There were also forty-eight acres under other millets, which yielded 1091 cwts. of grain. In 1875 the land under millets was only 36,162 acres.

Sorghum (*Andropogon*) *saccharatum.* This plant can be advantageously utilized for preparing treacle. For this purpose the sap is expressed at the time of flowering and simply evaporated; the yield is from 100 to 300 gallons from the acre.

This sugar-producing millet has been already alluded to at p. 218.

Broom Corn or Millet (*Sorghum Dhurra*). Whether this is only a variety of *Sorghum vulgare*, the *Holcus Dhurra*, Forsk., or a distinct species, it is impossible to state. Its seed-panicle is, however, loose and spreading instead of close and compact, like the principal kinds of *Sorghum vulgare*. One species of Sorghum, described as *Sorghum Dhurra*, is grown in Italy, in the United States, Australia, and other countries, for its panicles as a brush-making fibre.

In 1876 there were ninety-six acres sown with it in Victoria, which yielded 2095 bushels of seed, and 338 cwts. of fibre. There are many thousand acres under culture with it in the United States. In 1875 there were in the State of Kansas 12,742 acres under broom corn, and 82,552 acres under other millets; the produce was 9,844,869 lbs. of broom corn and 218,252 tons of millet. The following is the mode of culture pursued in America.

The seed is sown with a seed-barrow or drill, as early in spring as the state of the ground will admit, in rows of 3½ feet apart. As soon as the corn is above ground it is hoed, and soon after thinned, so as to leave the stalks 2 or 3 inches apart. It is only hoed in the row, in order to get out the weeds that are close to the plants, the remaining space being left for the harrow and cultivator, which are run in frequently so as to keep down the weeds. The cultivation is finished by running a small, double mould-board plough, rather shallow, between the rows.

The broom corn is not left to ripen, as formerly, but is cut while it is quite green, and the seed not much past the milk. It was formerly the practice to lop down the tops of the corn, and let it hang some time, that the brush might become straightened in one direction. Now the tops are not lopped till the brush is ready to cut, which, as before stated, is while the corn is green. A set of hands goes forward and lops or bends the tops to one side, and another set follows immediately and cuts off the tops at the place at which they are bent, and a third set gather the cut tops into carts or waggons, which take them to the factory. Here they are first sorted over, and parcelled out into small bunches, each bunch being made up into brush fibre of equal length. The seed is then taken off by an apparatus, with teeth like a hatchel. The machine is worked by six horses, and cleans the brush very rapidly. It is then spread thin to dry, on racks put up in buildings designed for the purpose. In about a week, with ordinary weather, it becomes so dry that it will bear to be packed closely.

Carpet brooms, velvet brushes, and other kinds of brushes are made of the panicles.

Panicums.—*Panicum* is the richest in species among the grasses. Hitherto about three hundred well-defined species are known, chiefly tropical and sub-tropical. Many are good fodder plants, whilst the seeds of several furnish palatable and nutritious table food.

In Algeria the following are grown :—*P. glomeratum rubrum*, ordinary millet (*P. miliaceum*); the brown Pekin (*P. Pekinensis*); the Persian millet (*P. Persicum*); another with a large spike (*P. monostachyum*, H. B.); bristling millet (*P. echinatum*), *P. eriogonum;* and the Hungarian millet (*P. Germanicum* or *Italicum*).

Italian Millet (*Panicum Italicum ; Setaria Italica*).—This grain is cultivated in many parts of India, and delights in a light, elevated, tolerably dry soil. It is much prized by the native Indians of all descriptions, who make cakes of it, and also a kind of porridge; for the purposes of pastry it is little if at all inferior to wheat, and when boiled with milk forms a light and pleasant meal for invalids. The Brahmins hold it in high estimation, indeed more than any other grain. The seedtime for the first crop is June or July, and the harvest in September. A second crop may be had from the same ground between September and the end of January. This grain is commonly cultivated in the Himalayas, occasionally up to 6500 feet. There are three varieties of Italian millet.

Chena or Indian Millet ; Veragoo (*Panicum miliaceum*, Lin.).—This does not appear to be a crop worth much attention. The grain is very inferior, and fetches a low price in the bazaars of India, while it is a very slow grower, and occupies the land a long time. Still it is extensively cultivated in most parts of India. In the Deccan it is sown in June or July by hand, is sometimes transplanted ; requires weeding in August and September, and is reaped in November or December. Its grain is considered digestible and nutritious, and in some parts is mostly consumed unground.

It is grown in Sicily, where it is called milium, or little millet, and there are two varieties, white and red.

Shamay.—In Bengal *Panicum miliare*, Lam., is the species usually known as little millet. It would seem to be a native of India, and China, and is by no means extensively cultivated. In the Punjaub it is known as *kutki*.

Panicum colonum, Lin.; *Oplismenus colonus*, Beauv.—This small grain millet, which grows wild in parts of India in sufficient plenty, is collected in times of scarcity to be employed as food.

SAWA MILLET (*Oplismenus frumentaceus*, Kunth.; *Panicum frumentaceum*, Roxb.)—This plant is much less cultivated in India than *P. miliaceum.* It delights in a light, tolerably dryish soil; the same ground, according to Dr. Roxburgh, yields two crops, between the first of the rains in June and July and the end of January. The seed is wholesome and nourishing; it is an article of diet amongst the lower classes of the natives; and yields about fifty-fold in a good soil. The seed is light, and easy of digestion; it makes very palatable puddings, which children appear more partial to than those made of rice, to which grain, when boiled, it bears a striking resemblance, both in taste and appearance.

CUMBOO or SPIKED MILLET (*Penicillaria spicata*, Swartz; *Pennisetum typhoideum*, Rich.; *Holcus spicatus*, Lin.; *Panicum spicatum*, Roxb.).—Terminal cylindric spike erect, as thick as a man's thumb, from 6 to 9 inches long; seed obovate, pearl-coloured, smooth, with hilum.

This plant yields in India about 668 lbs. of seed, and 3 tons of straw per acre. In some localities the grain is called bajra or bajree, and with the usual adjuncts of a little milk, &c., forms the chief article of diet of a very large number.

Compared with rice, it is considerably more nutritious, containing about 10½ per cent. of gluten, and giving a proportion between the carbonaceous and nitrogenous compounds of from 7 to 7½ per cent. of the former to one of the latter; whereas the kind of rice most rich in gluten contains only about 8½ per cent. of that substance, and gives the proportion of a little more than 9 of the non-nitrogenous to the nitrogenous, thus involving the addition of a large quantity of some pulse or extra nitrogenous substance to maize,—the proportion between the flesh forming and heat and fat yielding constituents. It is this grain which is chiefly used for the Couscoussou of Northern Africa. It is known by the French as *Dekkelé*, and a report recently presented to the Agricultural Society of Bouches du Rhone recommends its culture in the Landes and Pyrenees. In certain districts it rises to the height of 9 or 10 feet. The seed may be planted in the close of April. In September or October the seed-spikes ripen; the stalks, chopped, may be fed to cattle. With the decorticated pith of the stalk a pleasant beer can be made by the addition of hops.

This grain is, from the shape of its seed-spikes, called candle millet. It is the "benitche" of the Arabs of Africa. The spiked millet is as common in Africa as in Asia, at a distance bearing some resemblance to our indigenous cat's-tail grass, or Timothy, in the form and size of its spikes. Many stems often proceed from the same root, and these are from 3 to 6 feet in height. The fruit-spike is dense, compact, and thicker than a man's thumb, from 6 to 9 inches in length in India, or twice as long as it grows in Africa. Except Sorghum this is the most commonly cultivated grain in India.

Roxburgh says that it is sown about the beginning of the rains, that is about the end of June or beginning of July, and is ripe in September. It is much cultivated in the higher lands on the coast of Coromandel. The soil it likes is one that is loose and rich; in such it yields upwards of a hundred-fold; the same ground will yield a second crop of this or some other sort of dry grain during October, November, December, and January.

The stalk is almost useless as fodder when dry, but cattle are sometimes fed with it when green. The seeds are rather heating, and are used in cold weather mostly as flour. In Africa a kind of beer is said to be made from the malted grain.

The per-centage composition of the grain is:

Water	11·80
Nitrogenous substances	10·13
Fat	4·63
Water	71·75

RAGGY, OR RAGGEE (*Eleusine corocana*).—This grain is of high importance to the poor of India, from its hardiness and from the abundant return it gives. It will grow on almost any soil, but the yield will be proportioned to the quality of the soil and to the attention bestowed on the cultivation. The seeds are usually ground into flour by the hand-mill, this being chiefly a bread-grain. In the south it is very largely cultivated, and extends north over the Punjaub plains to the Himalaya, where it is frequently found as far west as the Chenab up to 6000 and 7000 feet. This grain is the chief article of food amongst the labouring classes in Mysore and other parts of Southern India. It is usually stored in pits, and will keep good in them for many years. *Eleusine stricta* is said to be the most cultivated species of the two, as it is found to be the most productive.

KODA MILLET (*Paspalum scrobiculatum*, Lin.).—This is a common and cheap grain, grown to some extent in most parts of India. It delights in a dry and loose soil. The seed is an article of diet with the Hindoos, particularly with those who inhabit the mountains and most barren parts of the country, for it is in such districts it is chiefly cultivated, being an unprofitable crop, and not sown where others more beneficial will thrive.

Another undescribed species, believed to be *P. exale*, is grown in Sierra Leone, and other places on the West African coast, where it is known under the names of hungry rice and fundungi.

TEFF (*Poa Abyssinica*, Jacq.; *Eragrostis Abyssinica*, Link.).—There are several varieties of this millet; though the seed is small it is abundant, and much used by the natives of Soudan; it forms the bread-corn of Abyssinia.

STARCH-PRODUCING PLANTS.

Starch is the chemical and common name, in some instances, for the fecula or amylaceous matter washed out from different parts of several plants, such as the seeds, roots, and cellular tissue of the stems. It is one of the most abundantly diffused of all proximate vegetable principles.

Some kinds of starch are prepared for application in the arts, and by the laundress for stiffening linen; others are more powdery and are used for food, such as the arrowroots and corn flours; others again are granulated like the sagos and tapiocas.

The colour of starch is usually pure white. In some cases a tinge of blue can also be seen, as in some wheat starch, while the starch from the potato has a slightly yellowish cast. The fineness of the starch powder depends on the size of the individual grains, except where the grains are artificially agglomerated, as in sago and tapioca; the former is in small, round, white or brownish grains, while tapioca is in larger, irregular, white fragments. The individual starch grains vary much in size, though they are pretty constant in any given species. Oat, rice, and rye starches represent the smallest grains, while those of maize starch are much larger. The medium size is found in the grains of wheat and arrowroot starch. The largest grains are found in potato and Canna starch. In the last two the unaided eye can distinguish the largest individual grains, but in nearly all others they can be seen only under the microscope. The specific gravity is more than that of water, though it varies much with the state of dryness of the starch. Its average is given by Wiesner at 1·5. It, however, varies with the different species of starch. The grains contain considerable water—as high as 30 per cent. when fresh, reduced sometimes to 7 per cent. when air dry.

Under the microscope the starch grains present the form of minute grains of a form and structure characteristic for each species.

They are for the most part bounded by curved surfaces—spherical, elliptical, egg-shaped, bent-shaped, &c.—but sometimes they have flat surfaces as well. They usually contain a dark spot, line, or cross within, which is sometimes central, sometimes eccentric. This spot is called the nucleus, and is generally small and round in starch found in fresh tissues, slit or cross-shaped in grains which have been dried.*

Arrowroot.—The demand for colonial arrowroots has not progressed very rapidly, owing, probably, to the imitation potato starch, and the corn and rice flours or starches so largely sold.

In 1860 arrowroot to the value of 42,404*l.* was imported into the United Kingdom, in 1870 this had dropped to 33,063*l.*, but in 1875 recovered to 56,143*l.* In 1876 the imports into London were larger, amounting to 16,673 casks and 9102 boxes and tins.

* Professor Harrington, in 'American Journal of Pharmacy.'

The following have been the total imports of arrowroot into the United Kingdom, and the value:—

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	cwts.	£		cwts.	£
1863	11,436	30,994	1870	16,919	25,515
1864	12,243	30,567	1871	..	34,013
1865	17,691	34,813	1872	..	33,771
1866	20,264	33,868	1873	..	35,204
1867	20,786	29,393	1874	..	41,281
1868	15,321	23,111	1875	..	56,143
1869	15,870	22,875			

Bermuda.—The arrowroot from this island has always been considered the finest and the best quality made, its superiority either arising from the nature of the water or soil, or from greater care in the manufacture. In 1851 arrowroot to the value of 10,334*l.* was shipped, this gradually declined to 3000*l.* or 4000*l.* in 1866, and now the culture has been altogether abandoned and given way to more profitable crops. The shipments in 1870 were only about 25 cwts. against 500 cwts. in 1868.

In Bermuda arrowroot is planted in May and is ripe in March and April; the time for manufacturing is in April and May, when the cold winds set in, ranging from north-west to east. The whole process is done in water. The root is grated or torn into a pulp, this is strained through three different sieves, each one finer than the other, left to settle in the bottom of the tubs, then collected into one tub, and passed through the fine sieve into clean water. When settled the brown starch is taken off the top of the white. This brown starch is much more astringent and efficacious in bowel complaints than the white, and is locally preferred. The arrowroot is then passed through more clean water and a fine sieve for the last time, and settles in the tub. It is taken out, placed on cloths to harden, and then broken up fine on trays and dried in the wind and sun. Four barrels of peeled and cleaned roots will yield in good seasons about 100 lbs. of good arrowroot, and will take from five to six puncheons of clear soft or tank water, it will be about twenty-four hours in the water from the time of grinding till it is upon the cloths or drainers.

Jamaica.—The quantity of land under culture with arrowroot varies. In 1869 there were 65½ acres; in 1870, 49¼ acres; and in 1874, 64 acres. The exports have declined year by year as follows:

	Lbs.		Lbs.
1866	70,204	1870	6,343
1867	44,566	1872	13,328
1868	27,346	1874	4,592
1869	11,731		

When made by the labourers in the West Indies on a small scale, arrowroot is prepared much in the same manner as potato starch in this country for domestic use; the only implements required are a grater and wooden troughs and trays; when made on a larger scale, as on the estates of proprietors, the crushing of the root and the reducing it to a pulp are effected by simple and cheap machinery (a wheel and rollers) worked by water. The arrowroot is dried under sheds. Little or no use is at present made of the pulp after the extraction of the starch by lixiviation, but probably a serviceable paper might be made of it at a trifling cost.

In *St. Kitts* arrowroot and tous les mois are produced to some small extent. In 1850, 95,460 lbs. were shipped; in 1860, 35,128 lbs.; and in 1870, 13,268 lbs. were received from thence in the United Kingdom.

St. Vincent.—The amount of arrowroot exported from this island is now about 2,000,000 lbs.; in 1847 the quantity shipped was only 297,587 lbs.; and in 1851, 490,837 lbs.

Many circumstances have promoted this increased culture. When it began the price of the article was high, and the grower obtained a largely remunerative profit; its culture was not laborious; it was subject to few risks; it did not, for its success, require rich land or much manure; there was a constant and increasing demand for it; and in consequence of the abundance of pure water, great facilities were afforded for the manufacture, and that by a process so simple, easy, and cheap, as to require little skill in conducting it, and scarcely any capital.

St. Vincent is the only arrowroot-producing colony that has kept steadily progressive, as the following figures will show. There will necessarily be slight fluctuations in the out-turn, according to season, &c. From 1850 to 1854 the quantity made in the island ranged from 350,000 to 550,000 lbs., but of late years the production has often reached 2,250,000 lbs. In 1850 the shipments were 3573 barrels and 7493 boxes, valued at 15,864*l.* The value of the shipments in the three years ending 1870 was a little over 17,300*l.* per annum.

Of late there has been a steady increase in the production, so that instead of the stationary figure of 7500 barrels, at which the exports kept from 1860 to 1865, they have risen above the large shipment of 10,000 barrels in 1859. In 1867 and 1868 the average export was 12,000 barrels; in 1866, it rose as high as 14,645 barrels; in 1869, to 11,226 barrels, being a decrease on the previous year of 422 barrels; in 1870 the shipments were 10,438 barrels.

Barbados, Antigua, Montserrat, and Tortola used to produce arrowroot for shipment, but have given up the manufacture.

On many parts of the West African coast arrowroot is grown and prepared. The Canary Islands, Liberia, Lagos, Sierra Leone, and other districts produce it, but not in any quantity for shipment.

Culture in Natal.—The cultivation and manufacture of arrowroot has been very largely carried on in Natal for many years. It was a great favourite with early colonists, because it grows readily on coast lands unsuited for sugar and coffee. Its cultivation requires only a moderate capital, and yields quick and good returns. The root may be grown many years in succession in the same ground.

The land to be planted is well ploughed and broken up at the commencement of the rains: old ground is better than new. The sets are taken from old stools, planted thickly in a simple plough furrow, and covered over with earth turned out of a parallel furrow.

A sort of nursery is formed in this way: In October and November the shoots are planted out in holes made about 12 or 14 inches apart; the shoot is placed in the hole, set upright and pressed round with earth. Ten men, working methodically in gangs, can plant an acre in a day. The only care needed is to keep the ground between the plants free from weeds by hand hoeing. The soil best adapted for the cultivation should be fairly good, but light. Old bush or forest land is generally very excellent; stony and heavy soils are unsuitable, because the tubers are apt to get clogged in it; their growth is stunted, and it is very difficult to dig them up.

The crop is known to be ripe when the leaves fade; at that time the tubers and offsets are densely filled with starch, and ready to be taken from the ground for manufacture. They are dug up and turned over with a fork, while pickers follow and shake off the earth and pick out the bulbs and collect them in a basket; one forker keeps four pickers employed, and one picker can deal with from 250 lbs. to 300 lbs. of tubers in a day.

About 10 acres should be cultivated the first year, and by the time the produce is harvested there ought to be 20 acres of ground broken up, ready for planting, and calculated to yield a double income in the following years, with a decreasing expenditure.

The manufacture requires care rather than skill, and the crop is less affected by vicissitudes of weather than almost any other that can be produced. The manufactory buildings may be of the simplest description, all that is required being free ventilation and protection from wet. The abundant water-power of the colony affords ready means of working the machinery. A water-wheel of 4 horse-power is sufficient to manufacture from 4 cwts. to 5 cwts. of starch per day. Fifteen Kafir labourers suffice for the management of 25 acres of plantation. As a drawback, on the other hand, the market for the starch is very uncertain and apt to be easily overstocked; and the starch itself is so delicate in quality, that it is very liable to deteriorate and become damaged, even after it has been packed and shipped. The greatest cleanliness is required in its preparation.

In the process of manufacture the tubers are pressed against a revolving cylinder of rough tin (resembling a nutmeg grater), and the raspings are then subjected to repeated washings; the fibrous refuse rises to the surface and is skimmed away, while the pure starch settles into a white paste, which is dried on calico trays, then broken into lumps, and packed in boxes for market.

During the manufacture four hands are needed in the drying house and three in the grinding house. The arrowroot should be quite cold and ready to pack on the fifth day. As it readily contracts moisture from the atmosphere, it must not be packed in damp weather, and it should never be forgotten that the starch is apt to deteriorate in taste and colour if kept in proximity to substances that emit a strong odour, such as hides, sugar, or any decomposing organic matter.

The yield of starch is tolerably much the same whether the growing season has been wet or dry. In wet seasons the tuber is large and soft, but its greater size is made up of moisture, pulp, and fibre, and not of starch. About 15 per cent. of starch should be obtained from good bulbs, and this percentage would give one-third of a ton (worth about 13*l.*) of starch per acre. The refuse is excellent for manure.

In selecting the land and site of operations, it is obvious that the close neighbourhood of a good stream of water must be secured.

Much less capital is required for the manufacture of arrowroot than for that of any other article of tropical produce. No more is necessary than such as will just provide a residence for the planter, the simple buildings and machinery for the factory, the implements of husbandry, and food and wages for the labourers during the planting, manuring, and manufacture of the crop. One hundred acres of land should be purchased, at from 100*l.* to 200*l.* A rude dwelling and outbuildings may be erected for 70*l.* or 80*l.*; machinery and manufacturing appliances, 75*l.*; implements of husbandry and oxen, 120*l.*; wages and food of eight Kafir labourers for a year, 96*l.*; cost of living for the planter and his family until the return begins to come in, from 120*l.* to 150*l.* Taken altogether, a handy, industrious, and thrifty man may reckon upon making good his standing with arrowroot, if he starts with a capital of about 600*l.*

The Cape Colony and Natal—especially the latter—have given much attention to arrowroot production. *Maranta arundinacea* is the species grown. In Natal, in 1864, from 226 acres, the quantity obtained was 2347 cwts. It is chiefly in the counties of Durban, Victoria, and Tugela that the cultivation centres, but the quantity varies considerably, for 61 acres in Tugela yielded 1220 cwts.; 66 acres in Victoria, 639 cwts.; and 98 acres in Durban, 488 cwts. In 1870 there were 386 acres under arrowroot.

The following figures of the exports will show the progress made in production in this colony:—

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	cwts.	£		cwts.	£
1856	818	1,827	1866	2,804	5,744
1857	1,397	3,136	1867	4,305	9,139
1858	2,218	5,464	1868	3,201	5,501
1859	6,366	13,336	1869	3,042	4,684
1860	3,679	6,680	1870	3,323	4,696
1861	2,436	4,685	1871	2,722	3,858
1862	983	1,547	1872	3,633	5,647
1863	1,437	2,801	1873	1,076	1,435
1864	1,015	2,843	1874	1,206	2,226
1865	2,150	3,943			

India.—The *Maranta arundinacea* was introduced into India about 1840 by Mr. Elphinstone, and is now cultivated in many districts, especially in the Madras presidency.

M. Lepine, chemist, of Pondicherry, states that he has obtained of fecula from the roots after 12 months' growth, 16 per cent.; 14 months', 15; 15 months', 14; 16 months', 12; 17 months', 11; and 19 months', 10 per cent. The fecula is obtained from the underground shoots, which are white, fleshy, about 9 inches long by $1\frac{1}{2}$ to 2 inches in diameter. They contain nearly 20 per cent. of fecula, but by the rude processes of rasping and washing not more than 12 per cent. on the average is obtained. Arrowroot is in extensive use in India, and some is also shipped to Europe.

Australian Arrowroot.—Attention has of late years been much directed to the production of arrowroot in several of the Australian colonies, facilities having been afforded by the culture and distribution of the several plants from the excellent botanic gardens at Melbourne, Sydney, and Brisbane.

Canna Achiras, Gillies, native of Mendoza, is one of the few extra-tropical Cannas eligible for arrowroot cultivation.

C. glauca, Lin., and *C. coccinea*, Aitkin, yield, with some other Cannas, the particular arrowroot called *tous les mois*. *C. flaccida*, Roscoe, of Carolina, is probably also available for arrowroot.

C. edulis, Ker, the Adeira of Peru, is one of the hardiest of the arrowroot plants, for seeds, even if many years old, will germinate, and are commonly called Indian shot.

This species has been extensively introduced into Australia, and, according to Baron Mueller, yields an excellent starch at Melbourne, Western Port, Lake Wellington, Ballarat, and other localities, from plants supplied by the Melbourne Botanic Garden.

The Rev. Mr. Hagenauer, of the Gipps Land Aboriginal Mission station, obtained 220 lbs. of arrowroot from $\frac{1}{8}$ of an acre of this Canna. The gathering of the roots in Australia is effected about April. The plants can be set in ordinary ploughed land. Captain James Hall, of Hastings, prepared also starch largely from this root. The starch grains, it is well known, are remarkably large.

New South Wales.—*Maranta nobilis* appears to be the species chiefly cultivated for arrowroot in New South Wales.

In 1870 there were 84 acres of land under arrowroot in New South Wales, from which 13,567 lbs. of arrowroot were obtained, being 18,251 lbs. less than were made in the previous year from only 31 acres of land. In 1872 from 26 acres 26,454 lbs. were made.

Queensland.—This colony appears to be peculiarly suited for the cultivation of arrowroot, which is gradually supplanting the imported West Indian product in the Australian market. A very small price, about 3*d.* per lb., remunerates the grower who manufactures on a large scale. The plants grown are *Maranta arundinacea* and *Canna edulis*. *Manihot utilissima* and *Janipha*, and a Japanese variety, *M. Japonica*, are also cultivated.

From Queensland, 26,368 lbs. of arrowroot, valued at 548*l.*, were exported in 1869, the first shipment of a few packages having been made in 1860. The cultivation and manufacture of arrowroot is becoming an important affair in that colony. The export of the article has gone on increasing for the last five or six years. In 1863 it scarcely had an existence; in 1870 the export had reached 30,000 lbs. But the quantity exported is small in comparison with the quantity consumed in the colony; for it is in favour with all classes of the community, and forms an easily digested, but nourishing and most appropriate article of food during their long, hot summer. As the majority of farmers on the coast lands, and not a few of the inland farmers as well, have a patch of roots and a mill and appliances for reducing them, the total quantity of starch made will probably be about 100,000 lbs.

Pacific Isles.—A plant largely cultivated is the *Tacca pinnatifida*, Forster, which is indigenous to the sandy shores of the South Sea Islands, and is known in Oceania, but especially in Tahiti, under the native name of *Pia.* This plant is, however, now widely diffused. It is met with in China and Cochin-China, according to Loureiro. It is cultivated in the Moluccas, Arracan, and other parts of India, and at Zanzibar. It is found in large quantities in Cook's Archipelago, the Hervey Islands, at Raiatea, Huahine, Bora-Bora, Maupiti, the Hawaiian Islands, the Samoas, Tonga, the Feejee Islands, &c. The tubercles bear much resemblance to the potato, but, unlike that root, the fecula is found chiefly in the centre and not towards the exterior. The proportion of starch yielded is 30½ per cent.

There is a large consumption of this starch in Tahiti, especially for children and invalids, and a considerable export of it under the name of arrowroot. The principal part of that which enters into commerce is made in the islands of the adjoining archipelago, Raiatea, Huahine, Bora-Bora, and Maupiti, where it can be purchased for 3*d.* to 3½*d.* per lb. In 1874, 27,746 kilos. of arrowroot were imported into Tahiti, but about 200 kilos. only are produced in the island. In the Hervey Islands it is sold at 2*d.*; and Tubuai and Raratonga produce it even cheaper. At Tahiti it retailed, a few years ago, at 4½*d.* to 5*d.* per lb.

From it the main supply of the Feejee arrowroot is prepared. The Tacca starch is much valued locally, and particularly esteemed in cases of dysentery and diarrhœa. Its characteristics are readily recognized under the microscope. A Tacca occurring on the Sandwich Islands yields a large quantity of the so-called arrowroot exported from there. Other species, including those of *Ataccia* (*Tacca*) *integrifolia*, Presl., occur in India, Madagascar, Guinea, and Guiana, all deserving tests in reference to their value as starch plants.

From Venezuela there was exported in 1873, 107,502 kilos. of starch (amidon).

MANIOC, OR CASSAVA.

This is the plant chiefly cultivated for food purposes in Brazil and in many of the West India Islands. No species of plants have been more changed in scientific nomenclature by botanists than these, for they have alternately been classed as *Jatrophas*, *Janiphas*, *Manihots*, *Curcas*, &c. I will adopt the names given by Pohl to the two principal species (for most of the others seem to be but mere varieties), the bitter or poisonous species, *Manihot utilissima*, and the sweet species, *M. Aipi.*

The manioc would seem to be a native of Brazil; it has been introduced into India, and is grown about Calcutta, Madras, the Straits Settlements, and other quarters. It flourishes better on the borders of the sea and on islands than in the interior of the continent. On the coast of Coromandel the roots are more fibrous, and, therefore, inferior to those raised in Malabar. It is extensively grown in Guiana, the West Indies, and various parts of Africa.

The tubers of the bitter cassava attain a length of 3 feet. They can be converted into bread or cakes. The volatile poison of the milky sap is destroyed by pressing the grated root in the first instance, the remaining acridity being expelled by the heating process. The starch heated while in a moist state furnishes the tapioca of commerce. Cassava is abundantly cultivated in Brazil and Venezuela—especially at Caraccas, where the singularly uniform temperature throughout the year is only 60° to 70° Fahr. It is a very exhausting crop, and stands in need of rich soil and manuring. The propagation is effected by cuttings from the ligneous part of the stem.

The soil destined for manioc must not be wet. In warm countries the tubers are available in about eight months, though they still continue to grow afterwards. The growth of the plant upwards is checked by breaking off the buds. The bitter species is the more productive of the two. The yellowish tubers attain sometimes a weight of 30 lbs. They do not become soft by boiling, like the Aipi or sweet manioc.

The sweet species, though a native of tropical South America, extends as far south as the Parana river. The root is reddish and harmless, and can be used, unlike the bitter species, without any further preparation than boiling as a culinary esculent, irrespective of its starch being also available for tapioca.

This plant will grow in almost any soil, but more luxuriantly in loose, dry, and especially sandy soils. The labour required for its cultivation is comparatively small and of the simplest kind. Except during the first month or two its growth is almost independent of rainfall or irrigation. Its productiveness is larger than that of any other article coming under dry cultivation. The mode of preparing it for the market, or for domestic consumption, is simple. The dietetic nature of it is excellent.

From the roots of the two species many food products are obtained, among others, coarse cakes made by rasping and pressing the root, which are cooked on a hot plate. The fecula, heated on hot iron plates, becomes partially cooked, and agglomerated in small, hard, irregular lumps, and in this form is known as tapioca. This substance, partially soluble in water, forms a nourishing food, much appreciated in Europe.

No less than thirty varieties of the mandioc (*Manihot utilissima*) are grown in Brazil, and of all the crops it is the one that gives the best return and the least trouble. An intelligent planter at Campos states that the square of 220 metres will grow 40,000 plants, which even in inferior soil will produce regularly 80,000 lbs. of farina. At the lowest valuation (60 reis per lb.) this would give a revenue of 520*l.*, a result superior to that derived from coffee, sugar, or cotton. The preparation of tapioca is easy and inexpensive, and also profitable. It has the further advantage of serving as food for cattle.

Farinha de mandioc, in its crude form, is often seen at Brazilian tables, but is more frequently mixed with water and baked in thin cakes, in this state forming the bread of the poorer classes. It thus forms a nourishing and cheap food.

Mandioc meal is produced on an extensive scale in the province of Santa Catharina, where they employ improved machines for preparing it, especially in the settlements. These producers supply the markets of the capital and of the other provinces. The foreign export of mandioc meal in 1845 was 145,722 alquieres. Mandioc is the staple article of food for the whole population. There are more than 14,000 manufactories, and the total production is calculated at upwards of 500,000 alquieres. In abundant years the meal and fecula fall as low as 1 or 2 milreis the alquiere (about thirty-six quarts), but in years of scarcity often rise to above 8 milreis. The foreign export was for some time checked by a tax of 2 milreis imposed on each sack exported, but this tax was abolished in 1865. The milreis is about 2*s.* 3*d.*

There are two modes of preparing the root—the wet and the dry processes. In the first, the grated root is put into water for four or six days, and afterwards kneaded with water, and pressed to extract the juice. The fecula which remains is sifted and baked in earth ovens, some fresh manioc paste, which has fermented, being always added. There are no less than fourteen varieties of the manioc distinguished in the province of Amazonas, some of which mature in six and others in twelve months.

The dry process is carried on as follows: The manioc is rasped by hand, water added within, and then put to be pressed; afterwards dried, sifted, and subsequently baked. In making the starch the deposit in the water is left for some time to allow the starch to settle down; it is washed three times, dried in the sun, and is then fit for sale.

The carima, or fine, creamy starch, is prepared by softening the puba manioc in water, after which it is strained and pressed in a sieve, and made into little balls, in which shape it comes to market, although sometimes reduced to farina. It is used in gruels and other food preparations, according to the custom of each locality.

The exports of tapioca from Brazil were 200,725 bushels in 1868, and as high as 332,823 bushels in 1866. In 1871 the exports were about 7,000,000 litres, valued at 26,050*l.* The values of our imports of farinaceous substances from Brazil (nearly all tapioca) have been as follows in thirteen years:—

	£		£
1863	4,193	1870	12,960
1864	5,413	1871	14,092
1865	6,404	1872	15,541
1866	8,024	1873	8,925
1867	13,812	1874	4,621
1868	15,188	1875	4,026
1869	8,974		

Twenty years since about 11,000 cwts. of tapioca used to be imported annually from Brazil, now we receive less than half that quantity.

The following shows the average annual exports of manioc farina from Brazil:—

	Kilos.
1839 to 1844	1,821,276
1864 to 1874	8,453,453

At Santiago, one of the Cape Verds, the crude farina of manioc costs about 1*s.* 6*d.* the decalitre, and prepared fetches as much as 10*d.*

the lb. One estate, the Praia Rei, on the island of St. Thomas, West Coast of Africa, produces about 150,000 litres of farina of manioc. In Angola, about 150,000 lbs. is manufactured annually. At Mozambique the Portuguese also prepare a good deal, which is sold for export at $2\frac{1}{2}$ to $3\frac{1}{2}$ francs the decalitre ($17\frac{1}{2}$ pints); dried slices of the root are sold in great quantity in the markets at 5*d.* to $5\frac{1}{2}$*d.* the decalitre.

The Straits Settlements.—In Singapore the tapioca manufacture has been very successful, but the crop is said to entirely exhaust the soil in five years.

From Pinang as much as 10,000 cwts. of tapioca and arrowroot is shipped annually to Great Britain and the United States.

The imports of tapioca from the Straits Settlements into the United Kingdom have been as follows:—

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	cwts.	£		cwts.	£
1851	92,021	..	1866	14,346	25,695
1855	90,600	112,118	1867	15,660	37,082
1862	20,301	27,727	1868	38,409	59,025
1863	27,792	30,107	1869	48,418	55,046
1864	27,530	36,268	1870	75,524	74,604
1865	18,191	27,509			

Since 1871 the value only has been given:—

	£		£
1871	85,889	1874	51,022
1872	82,563	1875	104,274
1873	69,820		

Sago has been described at p. 267, under the section of "The Useful Palms."

Japanese Starches.—Some of the starches peculiar to Japan are worth special notice; these are the "kudzu," or starch made from the root of *Pueraria Thunbergiana*; the "kata-kuri," made of the root of a kind of dog's-tooth violet; and, finally, the starch prepared from the root of the fern *Pteris aquilina.* All these three plants grow wild, and the kudzu, which yields the best starch, is very abundant in certain places. It belongs to the Papilonaceous family, grows very rapidly, and in a short time its creepers cover the ground, spreading over the neighbouring bushes and trees their luxuriant foliage. The root is frequently over 5 feet in length, and as thick as a man's arm. For the manufacture of starch by the ordinary process of crushing the root, washing the starch out and decanting it, moderate-sized roots, 1 foot in length and 1 inch in diameter, are mostly used. The starch is of a fine colour, and has a most agreeable flavour; mixed with warm water it produces a fine transparent paste.

The method of preparing the two other kinds of starch from the roots of the dog's-tooth violet and the fern—the former of which merits special mention for its qualities—does not present any peculiarity. Both form articles of food, but the fern starch is also used in various industries, as it produces a very strong paste, called "shibu," on being carefully mixed with the sap of unripe persimmons. The fibres of the fern root, after the starch has been washed out, are made into ropes, which are used in the mud walls of the buildings, so as to afford a better hold for the loam. It may be added that the manufacture of starch sugar has long been known in Japan. Millet and rice are used for this purpose, and after having been steamed, they are mixed with a certain quantity of malt or ferment and kept for several hours at a fixed temperature in close vessels, after which the liquid portion is strained and concentrated by evaporation to a strong syrup or a solid mass, which is formed into bars while still hot. Vendors of this starch sugar are often to be met with in the streets, where, to the great enjoyment of children, they manufacture all sorts of animals and figures with this material, by a process quite similar to that of glass blowing.

Chayote (*Sechium edule*, Sw.; *Chayotis edulis*, Jacq.).—This climbing plant of the Cucurbit family, yields excellent fruit, and the heavy tubercular roots contain a large quantity of starch. Of this starch good samples were shown in the Mexican section of the International Exhibition at Philadelphia in 1876. The fruit is green, large, and covered with thorns. In the mountains and inland parts of Jamaica the plant is much cultivated to fatten hogs with the fruit. The fruit is sometimes boiled and served up at table, but the flavour is rather insipid. When sown in a sandy soil it grows luxuriantly in the first year, yielding abundant fruit. The second year it produces tubercles, which can be taken off without killing the plant. This operation may be repeated for six or eight years. A plant under favourable circumstances will produce from 80 to 100 pints and a great number of tubercles. The culture is very simple, and the chayote is not subject to the diseases which affect other tuberous plants. The ancient Aztecs cultivated this vegetable largely, giving it the name of Chayotli, which means squash covered with thorns. The roots have a large proportion of starch, as is shown by the following analysis of Professor Herrera:

Water	71·00
Starch	20·00
Resin, soluble in water	0·20
Sugar	0·32
Albumen	0·43
Cellulose	5·60
Extractive matter Tartrate of potash Chloride of sodium Sulphate of lime and silica	2·25
Loss	0·20
Total	100·

SECTION IV.

THE PRINCIPAL VEGETABLE DYE-STUFFS OF COMMERCE.

INDIGO.—One of the most important vegetable blue dye-stuffs made is indigo. The various kinds which enter into European commerce are, from India: Bengal, Tirhout, Oude, Kirpah, Bimlipatam, Madras, and Kurrachee. From the Eastern Archipelago, Manila, and Java.

From South America: Guatemalan, Mexican, New Granada, and Caracas.

The total imports of indigo into the United Kingdom have been as follows for a series of years:

	Cwts.		Cwts.		Cwts.
1840	65,209	1853	66,409	1865	66,506
1841	70,487	1854	70,173	1866	74,256
1842	83,823	1855	59,760	1867	71,995
1843	58,285	1856	81,314	1868	75,874
1844	97,960	1857	68,243	1869	86,721
1845	90,424	1858	66,198	1870	79,255
1846	71,013	1859	63,237	1871	106,307
1847	74,410	1860	77,321	1872	87,320
1848	59,127	1861	83,109	1873	87,233
1849	81,332	1862	69,589	1874	85,707
1850	70,482	1863	85,395	1875	59,608
1851	89,944	1864	76,214	1876	88,680
1852	83,565				

The great bulk of these imports are re-shipped to the Continent. The average quantity retained for use in Great Britain being from 15,000 to 20,000 cwts.

The imports and exports of indigo for the United Kingdom are shown in the annexed returns for quinquennial periods:

Year.	Imports.	Exports.
	cwts.	cwts.
1840	65,029	40,959
1845	90,424	50,380
1850	70,428	54,108
1855	59,760	64,167
1860	77,321	59,366
1865	66,506	66,547
1870	79,255	46,279
1875	59,608	56,800

The following shows the variations in our sources of supply of this dye-stuff in twenty years:

1855.

	Quantity.	Value.
	cwts.	£
Holland	338	9,261
French possessions in India ..	806	22,084
Central America	2,102	52,025
British India	55,415	1,518,371
Honduras	318	7,871
Other countries	781	19,443
	59,760	1,629,055

1875.

Holland	374	12,619
France and French possessions	838	19,200
Austrian territories	435	12,350
Mexico	643	13,978
Central America	9,115	182,955
New Granada	670	18,816
Bombay and Scinde	186	6,249
Madras	12,135	279,116
Bengal and Burmah	34,470	1,057,036
Other countries	742	16,534
	59,608	1,618,853

The plants which yield this dye-stuff chiefly belong to the genera *Indigofera* and *Isatis*, but indigos are also obtained from:

Nerium tinctorium, Rottl.	In the Carnatic.
Ruellia sp.	Assam and Pegu.
Tephrosia tinctoria and *T. apollinea*	Egypt and India.
Polygala tinctoria	Arabia.
Polygonum Chinense, *P. tinctorium*, *P. barbatum*, and *P. perfoliatum*, Lin.	China and Japan.
Polygonum aviculare	Asia and Africa.
Wrightia tinctoria, R. Brown	Pala indigo of India.
Amorpha fruticosa	Carolina indigo.
Baptisia tinctoria	Wild indigo of the United States.

The *pastel* or woad of Europe is the colouring matter of *Isatis tinctoria*.

The species described by Linnæus were: *Indigofera Anil*, *I. tinctoria*, *I. argentea*, and *I. caroliniana*, plants which grow in a wild state in India, South America, and Africa. Modern botanists have largely extended the list of species. Decandolle raised the number to over one hundred and forty, besides a host of varieties. M. Perottet has well described in his 'Flora of Senegambia' twenty-five species; and in his 'Art de l'Indigotier,' Paris, 1842, has published much interesting matter on the whole subject of the culture and manufacture of this dye-stuff. In this he enumerates and dilates on the different works and treatises, to the number of about twenty, which had been published up to that date.

The greater proportion of the indigos of India are prepared from *Indigofera tinctoria*, which is extensively cultivated for that purpose, in Bengal and other provinces from the 20° to the 30° N. lat., and in Tinnivelly, Madras. There are two processes for manufacturing the dye-stuff: one the *dry leaf*, and the other the *green leaf* process. The latter is considered the best, and is in most common use. It is as follows. When the plant begins to flower, it is cut down at about six inches from the ground, and carried to the steeping vats with as little delay as possible, strewn horizontally in the vats and pressed down by means of beams fixed into side posts, bamboos being placed under the beams. Water is immediately run in, just sufficient to cover the plant. If water is not at once let in, the plant will heat, and become spoilt. The time for steeping depends much on the temperature of the atmosphere, and can only be learnt by experience and careful watching of the vats, but in close sultry weather, with the thermometer at 96° in the shade, eleven or twelve hours are sufficient. In cooler weather, fifteen or sixteen hours are requisite. If the plant is very ripe, the vat will be ready earlier than if the plants were young and unripe. The following are indications that the vat is ready to let off:

1. As soon as the water begins to fall in the vat.
2. When the bubbles that rise to the surface burst at once.
3. On splashing up the surface water it has an orange tinge mingling with the green.
4. The smell of the water. When ripe, it should have a sweetish, pungent odour, quite different from the raw smell of the unripe green-coloured water.

About seven men enter the vat and agitate it, either by the hands or with a wooden paddle, at first gently, but gradually increasing as the fecula begins to separate, which is known by the subsidence of the froth, and the change of the colour of the water from green to dark blue. The time necessary for this beating process is generally from $1\frac{3}{4}$ to 3 hours.

The following tests may be employed to ascertain if the heating has been sufficient.

1. Take a little of the water in a saucer and let it stand. If the fecula subsides readily, and the water remains of a Madeira wine colour, the beating may be stopped.
2. Dip a coarse cloth in the vat, and wring out the water, observing the colour. If green, the beating must be continued, but if a brownish colour, it is ready.
3. When sufficiently beaten, the surface of the water will, as soon as the beating is suspended, become of a peculiar glassy appearance, and the froth will subside with a sparkle and effervescence like champagne.

Three or four chatties of cold water or weak lime water are then sprinkled over the surface, to hasten the precipitation of the fecula, which does not completely take place in less than three or four hours. The water is drawn off from the surface through plug holes in the wall of the vat. The fecula at the bottom is then removed to the boiler. It is brought to the boiling point as quickly as possible, and kept there for five or six hours. While boiling, it is stirred to keep the indigo from burning, and skimmed with a perforated ladle. When sufficiently boiled, it is run off to the straining table, where it remains twelve or fifteen hours draining. It is then taken to the presses and gradually pressed. This process takes twelve hours. It is then ready to be taken out, cut, stamped, and laid in the drying house to dry.

A good sized steeping vat is 16 feet by 14 feet, by $4\frac{1}{2}$ feet in depth. The beating vat is somewhat shallower. Two hundred maunds of the plant (16,400 lbs.) do very well to yield one maund of indigo (82 lbs.). A vat of the above size holds about 100 maunds of plants. The plant sown in June is cut three months afterwards and manufactured. A second crop will be taken from it in the following August. This cutting produces the largest quantity and best quality.

In the manufacture of indigo the ordinary processes of fermentation, of drawing off the liquor, of beating and of collecting the fecula, or precipitate of indigo from the liquor, and pressing, are generally well known and are followed with but trifling variations in different provinces and manufactories in India.

The main points appear to be the watching the soaking plants, so as to be able to tap off the infused liquor exactly at the right point of fermentation, and next, to beat the liquor in the second vat long enough. Knowledge of these things can only be acquired by careful observation and long experience.

The indigo of commerce is the result of the action, by atmospheric oxygen, on the liquor drawn from a vat in which the plants have been decomposed in water, the oxidation producing an insoluble granulation of particles, commonly known as Indigo fecula, which is found deposited at the bottom of the vat. The indigo blue is derived from a substance similar to the *Indican* of woad, that exists in the plant as a glucoside compound, and which is dissolved during the steeping process.

Mr. Paul Michea, by Indian patents dated December 20, 1875, and November 12, 1876, adopts some improvements in the processes, and thus utilises the whole of the natural alkalies of the plant. He introduces solutions of sugar or glucose in the steeping vat along with the water, at a higher degree of temperature (95° to 100° Fahr.) and a longer fermentation, and thus increases the production of indigo blue.

Similar results are also obtained by replacing the effects of a higher temperature, or a prolonged fermentation, by an artificial supply of alkalies, principally ammonia. It is necessary to remark, that the glucoside juice in the plant varies considerably under the difference of latitude and the various countries where indigo is grown, and also according to seasons.

It is only when the quantity of indican is deficient, as in plants grown in a poor soil and under a dry climate, that the ordinary manufacturing process can utilise the whole or nearly the whole of the indican for its transformation into indigo blue; but, on the contrary, plants grown in a rich alluvial soil and under a damp hot climate will contain an abundance of that glucoside juice which the present process of manufacture cannot possibly utilise, so that the richer the plant and the more indican it contains, the greater is the waste in the ordinary process.

The indigo plant is chiefly cultivated in Bengal, in the Delta of the Ganges, on those districts lying between the Hooghly and the main stream of the former river. The ground is ploughed in October and November, after the cessation of the rains; the seeds are sown in March and beginning of April. In July the plants are cut when in blossom, that being the time when there is the greatest abundance of dye-matter.

A fresh moist soil is the best, and about 12 lb. of seed are used for an acre of land. The plants are destroyed by the periodical inundations, and so last only for a single year. When the plant is cut it is first steeped in a vat till it has become macerated and parted with its colouring matter; then the liquor is let off into another vat in which it undergoes a peculiar process of beating to cause the fecula to separate from the water; the fecula is then let off into a third vat, where it remains some time, and is then strained through cloth bags and evaporated in shallow wooden boxes placed in the shade. Before it is perfectly dry, it is cut into small pieces an inch square: it is then packed up for sale. Indigo, however, is one of the most precarious of Indian crops, being liable to be destroyed by insects, as well as inundation of the rivers. It is generally divided into two classes, viz. the Bengal and Oude indigo. Madras indigo is not much inferior to that grown in Bengal. The green leaf manufacture is followed in all the indigo growing districts of the Madras Presidency, save the province of South Arcot. In the latter the dry leaf process is still persevered in, but probably it is so only because of the distance to which the leaf has generally to be carried before it reaches the factory, and the consequent partial drying that takes place on the journey. The best indigo comes from the districts of Kishnagur, Jessore, Moorshedabad, and Tirhoot.

The fecula is much improved after being collected by being boiled in coppers and then pressed into boxes. Indigo is sometimes manufactured by simply collecting the fecula, and dropping it down in cakes to harden in the sun; this is termed "gaud indigo."

Good indigo is known by its fine purple-blue colour, and by its fracture; but when exposed to the continued action of air or water, or any other agents, it undergoes certain changes, which differ very materially in different grades or qualities of the article, and, unless a person is a good judge, he will be unable to tell the grade and quality. This can only be determined by closely examining the indigo in some test process. Good indigo is always very light—the lighter the better—that is, the freer it is from all foreign earthy matters; and if rubbed against a white cloth it does not easily colour it. Another sure test is its handsome copper gloss. This may have been caused by the rubbing of the angles of the pieces while in transportation, or it may be made by rubbing them with any hard substance. This copper gloss is the consequence of the mechanical thickening of the colouring matter with which indigo abounds; in this it resembles all pure colouring matters.

One thing to be especially remarked is the fine dark colour of the indigo powder, which can easily be obtained by rubbing and grinding the indigo lumps. By closely observing the above directions a person will be less at fault in his selection of an indigo, as some show a greenish colour, break with a brownish edge, and have white veins through, or show white veins in the heart of the lump.

The quantity of indigo exported year after year is largely dependent on the crops, the culture of which is always very uncertain; but the value fluctuates according to the needs of the European markets and the abundance or otherwise of supplies from South America, as well as the quality of the dye produced in India. The chest of indigo from Bengal weighs about 260 lbs.

The following shows the total exports of indigo from British India to foreign countries for the last thirteen years:

Year.	Quantity.	Value.
	cwts.	£
1863	101,115	..
1864	81,898	..
1865	87,010	1,860,141
1866	85,752	..
1867	84,504	..
1868	86,162	1,823,926
1869	99,206	2,893,823
1870	98,085	3,178,045
1871	103,184	3,192,503
1872	115,414	3,687,762
1873	115,312	3,426,824
1874	115,980	3,555,299
1875	81,466	2,576,302

The falling off in the exports of 1874–5 followed on one of the shortest crops ever known in Bengal, which province is the chief seat of the indigo industry. Exports from Madras were also much below those of the previous year.

The value of the indigo exported from British India ranges from 1,750,000*l.* to a little over 3,500,000*l.* a year. It is however a very variable crop.

The following shows the fluctuations in the money value of the indigo exported, leaving aside the quantity retained for local use:

	£
1851	1,980,896
1871	3,192,503

The Commissioner of Sind is directing attention to the cultivation of indigo in Upper Sind and in different parts of the Kurrachee Collectorate. The soil there is the same as that on which indigo is so successfully raised in Bengal. The government are willing to encourage the ryots, with whom the cultivation is rising in favour, to extend it, by offering rewards to the most successful among them, and giving long leases of land to parties who will venture on the speculation on a large scale. Nothing will be effectually done till Europeans and European capital are engaged on it, and a fee-simple of the land will soon draw these to Sind.

In 1870 there were 267,000 acres under indigo in the Madras Presidency, and 101,000 acres under chayroot and other dye stuffs, chiefly in Bellary and Tanjore. In July, 1876, there were in Madras only 55,367 acres under indigo assessed, showing a decrease of 35,854 acres compared with the same period of the previous year.

The yield of indigo in the districts of Nuddea, Jessore, and Moorshedabad during the official year 1875–76 was below the average. In 1873–74 the crop amounted to 5124 maunds in Jessore, 5171 maunds in Nuddea, and 3,003 maunds in Moorshedabad, while in the last year it was 3000, 4000, and 3600 maunds in the respective districts. In the 24 Pergunnahs district a small cultivation has been revived in the Baraset sub-division, which was once a principal seat of the indigo industry. The present system is described as a perfectly voluntary one, in which the cultivators do not even take an advance for seed, but sow of their own accord. The co-operative system of cultivating indigo, which was introduced by some native landowners in the Nuddea district, is not gaining ground, and the past season has injured its popularity.

Indigo cultivation has increased in Behar, while its area has diminished in Bengal. In Maldah, Moorshedabad and Rajshahe the constant changes in the River Ganges supply ample alluvial soil, well adapted for indigo crops. In Maldah alone there are twenty working factories, turning out 2,000 maunds. But one-half the exported produce is from Behar, and almost entirely from the districts on the north side of the Ganges, Tirhoot, Chumparun, and Sarun.

In 1872–73 the export of indigo from Calcutta amounted to 162,860 maunds, worth 2,704,408*l.*

The system on which indigo is grown is nearly uniform in all the districts to the north of the Ganges, but is quite different from that carried on in those to the south of the river.

In the northern districts of Tirhoot, Chumparun, and Sarun, the dye is cultivated in villages let to the planter by the zemindars, and is either *assamiwar* or *niz*. Under the former system, when the lease is completed, the ryots attend the factory and execute agreements to cultivate a specified portion of their uplands in indigo. The common proportion agreed upon is two or three cotthas (of 720 square feet) per beegah of upland or bheel, though in some few factories the proportion demanded is larger, amounting to five or six cotthas, which it appears was the rate prevailing in Chumparun and Sarun, before the indigo difficulties in 1867. The agreement is generally for the same term as the lease. At the time of executing it, an advance is given, which remains unpaid without interest till the end of the term, and during each year the price agreed on to be paid for the cultivation is given in advance at the beginning of the year.

The sum paid varies according to whether it includes the rent of the land or not, and also according to the size of the beegah. The average rate in Tirhoot, where the beegah is about 4225 square yards, is from Rs. 8-8 to Rs. 9, inclusive of rent, and in Sarun, where the beegah is the same as in Tirhoot, it is from Rs. 7 to Rs. 9. In Chumparun where the beegah averages 7225 square yards, the usual rate is now about Rs. 15, but up to the last few years Rs. 12 was generally paid. In all cases lands for indigo are assessed much below the average rent paid for other lands of similar quality.

In Chumparun the rent is generally included in the price paid to the ryot, and the same practice is pursued in Sarun, where lands are taken from the ryots; but in the latter district the majority of the planters cultivate their own lands, and consequently the arrangements made with cultivators affect but a comparatively small number. In Tirhoot the more usual practice is to write off the rent of the land in the factory books, and to give the ryot Rs.5 to Rs.6-8 per beegah.

The lands taken from the ryot are retained for three to five years by the factory, after which they are useless for growing indigo; though, as the plant has a long tap root, and draws its nourishment from the sub-soil, they become improved for the growth of cereals and green crops, which subsist upon the surface soil, which has the advantage of a long fallow, and of being manured by the indigo leaves. In lieu of the lands given up, other land is taken from the ryots for the rest of the term of the agreement; and in some instances a clause is inserted that these exchanged lands shall be selected by the factory from the best of those in the ryots' holding.

Speaking generally, the crop may be said to be sown in February, and the cutting and manufacture to commence early in July. A second cutting of the khoontee crop generally takes place in September, and the land is clear in October, except in a very few instances, and these are mainly to the south of the Ganges, where poppy lands are taken for the growth of a crop of irrigated indigo. No other crop can be grown during the same year, as when the crop is taken off the ground in October, the preparations for fitting the ground for the next year's crop are begun. The soil best fitted for it is a rich loam with a good sub-soil, neither too sandy nor too stiff. Old river deposits not liable to inundation give the best yield; but fine crops are also grown in inland villages, or uplands or bhit.

The cost of cultivation to the ryot may be taken at Rs.4-11 per beegah, so that with the highest rates paid him the profit is small, whereas the profit of a rubbee or winter crop on the same land is calculated to be Rs.3, and considering that the best lands are taken for indigo, this is a low valuation. The following figures show the cost of cultivating one beegah of indigo (4225 yards):

	R.	a.	p.
Two ploughings before digging up the soil	0	4	0
Digging	1	0	0
Two ploughings after digging	0	4	0
Two additional ploughings	0	4	0
Clearing the land	0	5	0
Diagonal ploughing	0	2	0
Second clearing	0	3	0
Ploughing the crop	0	2	0
First weeding	0	8	0
Second ,, ...	0	4	0
First cutting	0	6	0
Second ,, ...	0	5	0
Ploughing the khoontee	0	4	0
Second growth—			
Incidental expenses, such as extra ploughing and raking after rain	0	8	0
Total	4	11	0

The foregoing remarks apply chiefly to the culture by ryots, but we must not ignore the large area of land held by planters in their own hands, and cultivated by them at their own expense. In many factories, especially in Sarun, the area thus cultivated is far larger than that occupied by the indigo grown by ryots, and as long as these lands are what they are supposed to be, viz., lands let to the factory by the zemindar, or in villages leased to the planter, lands known as "zeerat," that is, lands by immemorial custom set apart for the use of the landowner or the lessee as his representative, there can be nothing to object to in this mode of cultivation. Additions to this area may also be legitimately made, from lands abandoned by absconding ryots, and from those lapsing owing to the failure of heirs to former tenants. The out-turn from the Sarun district is estimated at 12,000 maunds on a cultivation of 45,000 acres.

The industry is managed almost entirely by Europeans, as the few zemindars and bankers who have invested their money in the business almost all employ European managers, those who do not manufacturing on a very petty scale. In Sarun, however, native capitalists have lately taken to the business with some eagerness. Twenty-one factories with 19 attached outworks are owned by natives, and 17 of these factories have sprung up within the last five or six years.

In the districts south of the Ganges, the system is different from that above described. The area is much less, and in Gya and Patna the business scarcely worth mentioning. An attempt by a native to start a factory in the Patna district promises to be anything but successful. The cultivation is for the most part *niz*, and is carried on in lands leased by the factory from the zemindars or ryots. The expenses of cultivation are paid directly by the planter, who employs his own labourers and bullocks. The seed is sown at the beginning of the rains, and the plant remains on the ground during two years, in each of which it is cut. In strong lands, a third year's crop is sometimes taken, but generally speaking the land is given up at the end of the second year (when it is eagerly sought after for the growth of green crops), and engagements are made for other lands. Many factories have running agreements for two sets of lands, one of which is occupied by indigo, and the other remains in the hands of the ryots.

The little indigo that is cultivated by ryots is grown on poppy lands and irrigated. The crop is sown in March or April, and reaped at the end of the rains, in time to allow a crop of opium being taken off the land. The crop is cut by the ryots, but is carted to the factory which supplies the seed, gratis at its expense, and the bundles there weighed, measured, and paid for at the rate of four bundles, measured with a five-cubit chain, to each rupee; but the frequent disputes arising out of the measurement, have in some factories given rise to a practice of appraising the crop on the field. Arbitrators are appointed, selected by both parties, who calculate its value before it is cut, and this system is said to be preferred by the ryots. The sums paid to them vary, according to the quality of the crops, from Rs. 5 to Rs. 20 per beegah, the average being about Rs. 11-8. As the sole expense to the ryot is that of cultivation, and he is able to take a second crop off the land, the arrangement may be considered as profitable, the more so as he generally gets an advance of from Rs.5 to Rs.6 per beegah. The expense of a beegah of irrigated indigo is Rs.7-8. For a fair out-turn a ryot gets Rs.20 a beegah from the factory, and sometimes as much as Rs.30.

In these districts the industry is neither so important nor flourishing as in the north. Owing probably to the drier climate and less favourable soil, the dye is inferior to that of Tirhoot, and brings a lower price. Frequent droughts cause the crop to be exceedingly precarious, and the smaller profits realized by the planters renders them less able to weather bad years than those in the north.

Of late years a considerable quantity of indigo leaf has been sent from the Mofussil to Pondicherry, there to be made into dye. The reason for this is that the leaf is free of duty, while the manufactured dye pays a duty of Rs.3 per maund. About 2000 lbs. of dry leaf, or 1000 lbs. of green, are required to make a maund of indigo.

In the French territory surrounding Pondicherry, there were in 1860, 1100 hectares of land cultivated with indigo, which produced 6,962,000 kilos. of dry leaves, from which 37,131 kilos. of indigo were made. There were then 92 indigo factories, and 121 dye houses, which turned out 415,723 pieces of stuff, measuring 16 yards long by 1 yard wide.

The quantity of indigo shipped from Pondicherry for France in 1874 was 255,954 kilos. The number of indigo manufactories in Pondicherry and Karikal, was 108, and of dye houses 61; 505 hectares were under culture, which produced 2,086,565 kilos. of dry leaf.

M. Jules Lepine gave in 1862 the following as the expense of cultivating a small cani (53 ares 51 centiares with indigo in Coromandel; the are is equal to a square of 1076 feet):

	Francs.
Labour	9·60
Manure	7·20
Seed	2·40
Weeding	4·80
Cutting	9·60
Drying and separating the leaves	3·00
Land tax	5·78
Total	42·38

The three cuttings made during the year produce 20 hectolitres of leaves, which, being sold for 47 frs. 20 c., leaves a profit of 24 frs. 20 c. for the cultivator.

Sometimes sesame is sown in the same land, which is harvested before the indigo leaves are cut.

Cochin China.—This invaluable plant, one of the most important in modern manufactures, and which even the aniline dyes are not likely to dethrone, must be regarded as one of the chief products of Cochin China and Cambodja, where it grows with extraordinary vigour.

Of the numerous species two or three only have attracted the attention of cultivators. The plants which grow in Cochin China are equal to those of India proper, and the *indigotine*, or dyeing quality possessed by the local species (*Indigofera tinctoria*), contains all the necessary principles to enable the plant producing it to take a high rank.

On attaining its full growth, it is about 6½ feet in height, and even taller if it has not been cut back. It is cultivated in beds of sand, or on the light alluvial washings of the upper tertiary formation, that is to say, in light soils seldom subject to the effects of heavy floods.

Although capable of living many years, it is advisable to renew the plants annually. Its growth takes place between February and July. When it has arrived at maturity, the leaves are collected in bundles and carried to the factory, where the process of manufacturing the paste is carried out: this, in order to be of first-class quality, should be light in weight and of a very light sky-blue colour.

The experiments made by M. de Fiennes at Gho-viap (near Saigon), and at Cambodja by M. Caraman, have been crowned with the greatest success. The latter has planned a factory, which, at a cost of about 1000*l.* sterling, will be capable of producing annually more than 20,000 cakes of indigo.

The original native method of production was so defective and primitive in its nature that it does not deserve mention. All has to be done afresh by a new and more intelligent process.

M. Caraman is unable to estimate the profit to be obtained from the cultivation of the plant, but hazards the conjecture that under an accurate system of management and well-planned labour the factories of Cochin China can supply not only the whole of Europe but also America.

Siam.—A small quantity of indigo is produced in Siam. In 1875, 481 piculs, valued at 200*l.*, were shipped.

China.—Although there exist in China varieties of *Indigofera tinctoria* and *I. anil*, these are not much cultivated. Dr. Williams states *I. coccinea* is grown, and Loureiro, *I. tinctoria.* In the southern provinces there are plantations at Konang-si, Konang-ton, and Fokien. *Isatis indigotica*, Fortune, is grown in almost every province of China. *Ruellia indigotica* is cultivated for its dye in the province of Tche-kiang. Preference is given in the north to *Polygonum tinctorium*, especially about Pekin; but *P. chinense*, *barbatum*, *perfoliatum*, and *aviculare*, are also employed.

In 1875, 600 tubs of indigo, equal to 30,000 piculs, were imported into Ningpo, chiefly from Tamsuy and its neighbourhood.

Indigo received in Chinese ports by foreign coasting vessels:

	Piculs.		Piculs.
1868	32,380	1871	44,987
1869	42,797	1872	32,941
1870	26,566		

Japan.—Large indigo manufactories have recently been started, and are now in working order at Osaka, Matsubara, and Tunaki, in the province of Omi, Japan, and it is proposed to establish more in other provinces of the same country.

The indigo here is obtained chiefly from the *Polygonum tinctorium.* The plants, which grow to a height of 2 to 3 feet, are cut into three parts, the upper part with the greatest number of leaves being the richest in colouring substance. For the best quality the leaves only are used; these, after having been exposed to the air and sun during a few hours only, when they darken considerably, are put into straw bags and kept for the purpose of afterwards undergoing a longer treatment. This consists in moistening the leaves with a certain amount of water, the exact quantity of which depends on the nature of the leaves, and the greatest care must be taken to prevent its being either in excess or in deficiency. They are then spread out upon and covered with mats during a few days, after which the operation is repeated during a period of eighty days, about twenty-five times for the best, and about nine times for the inferior leaves. Having undergone this kind of fermentation, they are then pounded in wooden mortars, and in quantities of about 30 lbs., for two consecutive days, so as to become reduced to a sort of paste, which is then formed into balls of a dark blue colour. These balls of crude indigo, with an addition of bran and potash lye, prepared from wood-ashes, form the material used by dyers in the steeping vat.

Java.—Indigo is grown principally in the middle provinces, where there are some eighty plantations. In 1863 the exports were 915,000 lbs. In 1870 the shipments were 587,882 Amsterdam pounds, and 510 piculs. Holland exports annually about 1,500,000 kilos., obtained from its possessions in the East.

Mr. Joseph Sayers, of Java, has carried out some improvements in the manufacture of indigo, which are remarkable for the increase of indigotine obtained, and the uniform results shown. These are stated in the following comparative analyses of various kinds of commercial indigo, as published by Mr. Henri Bergé, chemist to the city of Brussels, and professor of chemistry at the university of the same town. It shows the sources, marks, and prices of some, in cents.

Kind of Indigo and Marks.	Indigotine.	Mineral Matters, or Ash.
Indigo of Java, SK, at 75 Cent.	57·19	14·28
„ „ ABCD, at 125 „	27·28	44·47
„ „ KP, at 225 „	55·13	9·02
„ „ GWG, at 460 „	68·68	5·09
„ „ WJF, at 550 „	69·82	2·18
„ „ CFE, at 600 „	75·78	2·69
„ of Bengal, at 450 „	72·17	2·93
„ „ at 525 „	75·36	1·99
„ of Manilla at 60 „	14·47	45·63
„ „ at 125 „	24·55	37·98
„ of Sayers of Java, No. 1	69·37	2·31
„ „ No. 2	72·35	2·82
„ „ No. 3	74·03	2·59
„ „ No. 4	69·32	3·48
„ „ No. 5	66·98	4·25
„ „ No. 6	65·38	3·95
„ „ No. 7	69·63	2·89
„ „ No. 8	71·20	1·53
„ „ No. 9	71·40	2·36
„ „ No. 10	74·53	1·61
„ „ No. 11	71·11	2·14
„ „ No. 12	67·89	2·76
„ „ No. 13	67·85	2·66
„ „ No. 24	76·70	2·50

The characteristics of the indigos made by Sayer's process are the small quantity of ash they contain, for while the analyses of ten different kinds of indigos show an average of 16·62 per cent. of ash, those of Sayers only give 2·77, or a difference of 13·85 per cent. The proportion of indigotine is also much greater, the average being 70·58, and never lower than 65 or 66; while that of good ordinary Bengal has only an average of 61·4 of indigotine. We sometimes meet with 75 to 80 per cent. of indigotine in very fine samples of Java and Bengal indigo, but these are exceptional cases. The fact is that in commerce we only meet with about 10 per cent. of very fine indigo, 35 per cent. of medium quality, and 55 per cent. of ordinary. Indeed it may be said that not 10 per cent. of the indigos of commerce contain more than 65 to 66 per cent. of indigotine, which is the minimum proportion of the Sayers' indigos of Java.

Philippines.—The indigo plant is found in several provinces, but the best quality comes from the north of Luzon.

The leaf is at times affected by the attacks of locusts and by storms, but growers in good years realise as much as 90 per cent. profit. The process of making the indigo is primitive enough, and is somewhat as follows :

The plants are cut in April or May ; they are then placed in casks filled with water. After being left to steep for some time they are removed, and a certain quantity of lime mixed with the water. The water is then poured into other casks, where it remains until the colouring matter is deposited. As soon as this has taken place the water is drawn off, and the indigo left to dry. It is then cut out in small pieces.

Imperfect as this way of manufacturing the indigo is, it still fetches in the market from 35 to 75 dollars the cwt. The plant is rich in indigotine, but the defective preparation makes it rank second in quality as compared with Indian indigo. The exports in 1864 were 98 tons; and in 1875, 3165 cwts.

Africa.—On most parts of the eastern and western coasts of Africa species of indigo are indigenous.

According to Dr. Barth and all the travellers who have visited the Soudan, the indigo plant grows wild in all the forests. In each town vats are met with, in which the plant is steeped and the dye prepared into cakes. Cakes brought from the Soudan and analysed were found to contain 53 to 54 per cent. of indigotine. The indigo is taken by the caravans by the way of Mourzouk to Egypt.

In Tunis indigo is cultivated at Nabel and certain parts of the coast, but of a quality very inferior to that imported.

At Sierra Leone, Liberia, Abeokuta, and parts of the Niger, Natal, and the Cape Colony, indigo plants are abundant, growing wild, and many are utilised by the natives.

Southern States of America.—Endeavours are being made to revive indigo culture, which once formed an important source of profit in some of the States of North America.

The best Venezuelan indigo has sold for one dollar per pound, but this is of better quality than that produced in the North. However, it is quite likely that, by the use of better appliances, and more scientifically skilled labour than is believed to obtain anywhere in South America, this inferiority in intrinsic value might be avoided. This done, the crop would be a very profitable one, a moderate yield being about 50 lbs. of marketable indigo to the acre of ground devoted to the cultivation of the plants. The crop seems adapted to a wide range of country, the Hispaniola indigo growing in a deep, rich soil; the Bahamas variety in the poorest ground of South Carolina; and the wild or indigenous kind being stated to be hardy and thrifty under almost all conditions. In South Carolina the seed has been sown after the first spring rains, and the plants cut successively in the early part of July and toward the end of August. The weeds must be kept down with the greatest care. Formerly one labourer was allowed to every two acres of ground, but it is believed that with improved machinery twice this area can be cultivated per man employed. The manufacture is described as follows:—

"When the plant is beginning to blossom, it is fit for cutting. When cut, great care should be taken to bring it to the steeper without pressing or shaking it, as a great part of the beauty of the indigo depends upon the fine farina which adheres to the leaves of the plant. The apparatus for making the indigo is inconsiderable and not expensive, for, besides a pump, the whole consists only of vats and tubs of cyprus wood.

"The indigo, when cut, is first laid in a vat about 12 or 14 feet long, and 4 feet deep, to the height of about 14 inches, to macerate and digest; then this vessel, which is called the steeper, is filled with water; the whole having laid from about twelve to sixteen hours, according to the weather, begins to ferment, swell, rise, and grow sensibly warm. At this time spars of wood are run across to mark the highest point of its ascent; when it falls below this mark they judge the fermentation has attained its due pitch, and begins to abate; this directs the manager to open a cock and let off the water into another vat, which is called the *beater*. The gross matter that remains in the first vat is carried off to manure the ground, for which purpose it is excellent, and new cuttings are put in, as long as the harvest of the weed continues. When the water, strongly impregnated with the particles of indigo, has run into the second vat or beater, they attend with a sort of bottomless buckets, with long handles, to work and agitate it when it froths, ferments, and rises above the rim of the vessel that contains it. To allay this violent fermentation, oil is thrown in as the froth rises, which instantly sinks it. When this beating has continued for twenty, thirty, or thirty-five minutes, according to the state of the weather (for in cold weather it requires the longest continued beating), a small muddy grain begins to be formed; the salts and other particles of the plant, united, dissolved, and before mixed with the water, are now reunited together and begin to granulate. To discover these particles the better, and to find when the liquor is sufficiently beaten, they take up some of it from time to time on a plate or in a glass. When it appears in a hopeful condition, they let loose some lime-water from an adjacent vessel, gently stirring the whole, which wonderfully facilitates the operation, the indigo granulates more fully, the liquor assumes a purplish colour, and the whole is troubled and muddy; it is now suffered to settle; then the clearer part is permitted to run off into another succession of vessels, from whence the water is conveyed away as fast as it clears on the top, until nothing remains but a thick mud, which is put into bags of coarse linen. These are hung up and left for some time, until the moisture is entirely drained off.

"To finish the drying, this mud is turned out of the bags, and worked upon boards of some porous timber with a wooden spade. It is frequently exposed to the morning and evening sun, but for a short time only, and then it is put into boxes or frames, which is called curing; exposed again to the sun in the same cautious manner, until, with great labour and attention, the operation is finished, and the valuable dye-stuff fitted for market.

"The greatest skill and care are required in every part of the process, or there may be great danger of ruining the whole; the water must not be suffered to remain too short or too long a time, either in the *steeper* or *beater;* the beating itself must be nicely managed, so as not to exceed or fall short; and in the curing the exact medium between too much or too little drying is not easily attained."

Colombia.—The preparation of indigo is a business still in its infancy in Carthagena. Little more than experiments have been made as yet, but the result is encouraging, samples having been valued in Paris at 8 to 11 francs per lb.; 503 lbs. were shipped in 1873.

Humboldt states that the indigo plants grown in Mexico are *I. anil*, *I. tinctoria*, and *I. disperma.* This product is obtained in large quantities in the States of Yucatan, Oanaca, and Colima.

Costa Rica.—There is no obstacle, except the invariable one of want of labour, in the way of indigo production here. What was exported from this republic some years back proved to be a fine parcel of "flores," and the undertaking was abandoned solely in consequence of a revolution, when the labourers were withdrawn from the works at an hour's notice for military service, involving the proprietor in heavy loss.

Guatemala.—The exports of indigo from Guatemala in 1872 were made to the following countries:

	Cwts.
England	15,598
France	3,830
Germany	10,933
United States	5,872
Belize	3,900
Total	40,133

Nicaragua.—Indigo was the staple article for exportation in the time of the Spaniards, and even for many years afterwards; but want of labour, capital, attention and proper protection, during twenty years of revolutionary tumult, has entirely suspended the raising of indigo. It has been found by experience that the indigo raised on the high lands of Nicaragua, although less in quantity, is far superior to the San Salvador indigo, which is now represented as being the best in Central America.

All the fine old indigo haciendas are mostly used for grazing cattle; no one will venture his capital in planting indigo under present circumstances. The total amount of indigo exported from Nicaragua in 1858 did not exceed 200 quintals. It is cultivated in the Val Menier, and three crops are obtained from one sowing.

Central America.—The value of the indigo shipped from Salvador in 1868 was $1,602,000. The progress of the culture in Central America is indicated by the following figures, showing our direct imports from thence:

	Cwts.		Cwts.
1851	5,697	1867	10,381
1852	3,458	1868	13,875
1853	2,017	1869	15,763
1854	206	1870	12,457
1855	2,102	1871	13,799
1862	4,750	1872	12,901
1863	4,281	1873	7,800
1864	3,731	1874	10,220
1865	9,362	1875	9,115
1866	5,641		

New Granada.—The imports of indigo into the United Kingdom from this State have been as follows:

	Cwts.		Cwts.
1862	4,391	1869	847
1863	1,368	1870	2,267
1864	3,743	1871	4,165
1865	2,381	1872	3,961
1866	6,565	1873	3,172
1867	1,338	1874	1,301
1868	4,221	1875	670

Venezuela.—In former times indigo was a flourishing industry here, but it has rapidly declined from several causes. Among others in consequence of submitting it to alterations which lower its value in the principal markets of Europe. Secondly, the tedious and unwholesome labour which its manufacture requires, and for which it is difficult to find hands. Hence the culture of other products are preferred. It is shipped in boxes and serons, in the form of irregular pieces and powder; but it is always mixed with foreign substances, and very inferior to the produce of Colombia and Guatemala. In order that the Venezuelan indigo might attain any importance in a commercial point of view, the manufacturer ought to be more careful. Whilst in 1867 only 300 serons were produced, it had increased to 1200 in 1871. The shipments from the ports of La Guayra and Puerto Cabello in 1872 exceeded by 1406 cwt. the exports of the previous year. In 1873 the shipments from Venezuela were 1633 cwts., 793 cwt. being sent from Puerto Cabello.

Madder.—This important vegetable dye, used in calico printing, is obtained from the root of the *Rubia tinctoria*, a plant indigenous to Turkey and Persia, and now extensively cultivated in France and the countries of Central and Southern Europe. The history of madder dyeing may be traced from its origin in Eastern India, three thousand years ago, through Persia, to Adrianople, Greece, Italy, and Western Europe. The colours were first obtained from a species known as Munjeet (*Rubia Munjista*); then came into use the Turkey madder-root. This plant was grown in England in 1624, at which time three qualities were known—cropp, fatt, and mill madders. In the year 1798 there were only eleven madder-mills in the whole of France, while now in the department of Vaucluse alone there are no fewer than fifty in operation. French madder-root has a peculiar smell, and a taste between bitter and sweet. Some kinds, as those of Alsace and Holland, when mixed with water and allowed to stand for some time, give a thick jelly; this is not yielded to the same extent by Avignon madder. If this madder is treated with an acid it produces a perceptible effervescence, owing to the quantity of calcic carbonate which it contains.

The increased use of aniline dyes will, it is expected, lead to the decline of the trade in madder roots. The producers, in view of a diminished demand, have already commenced to limit their cultivation of the plant. The total growth of madder was calculated a few years ago to amount to 47,600 tons, of a value of over 2,000,000*l.* sterling. The value of that used in Great Britain in 1874 was under 800,000*l.*, in 1875 only 411,000*l.*, and in 1876 but 238,874*l.* Dr. F. Versmann, in a paper "On Anthracene and Alizarine," read before the chemical section of the Society of Arts in March, 1874, gave some interesting details on madder. "In the East the madder plant has been known since the earliest times. In Holland it has been cultivated more than three hundred years; in France it has risen to great importance since the middle of last century, especially in Avignon, which now produces about one half of all the madder consumed, to the value of about 750,000*l.* per annum. Turkey and South Russia also supply considerable quantities of high quality. Some experiments in cultivating madder in Great Britain were made in Derbyshire, some years ago, but with indifferent results. The soil, the climate, and the weather have the most decided influence upon the growth of the plant, and the subsequent development of the colouring principle. The Dutch madder will dye red, but not purple, and the colour is not fast; Naples madder dyes red and purple, but the colours are fugitive; that of Turkey dyes good red and purple, and is very fast. France supplies the market with two qualities, called rosées, from their dyeing beautiful reds and pinks; and paludes, which give a good purple, besides fine reds, considered the best French quality. The last name is derived from the fact that the plants are grown on marshy land. The cultivation of the plant and the ultimate separation of the colouring principles is a matter of much time and uncertainty. The root must remain in the ground for a long time—in France, two or three years; in Turkey, five or seven years—and after having been dried and coarsely powdered, it must be kept another year or two to develop the colouring principles which are not ready formed in the root. For many centuries, and until the beginning of the present one, the root was used direct, and no attempt was made to separate the colouring matters or to apply them in a concentrated and pure form, but with the development of technical industry and scientific investigation, the concentration or separation of the valuable constituents gradually commenced. The first step was the manufacture of 'fleur de garance,' madder deprived of all substances soluble in water, and then dried again, which reduced the bulk to about 60 per cent. The washings contain a considerable amount of sugar, which by some French manufacturers is converted into alcohol. A ton of madder gives about 15 gallons of alcohol, of rather unpleasant flavour, but well adapted for technical purposes. Garancine is madder further treated with sulphuric acid, which destroys part of the ligneous fibre, yielding about 25 per cent. in the form of a fine powder of light-brown colour. Alizarine verte and purpurine are the results of treating madder with sulphurous acid, which dissolves both; after adding sulphuric acid to the solution, and heating to 40° C., purpurine separates about $\frac{1}{2}$ or $\frac{3}{4}$ per cent., and on further heating to 100° C., alizarine separates about 3 per cent. Yellow alizarine is obtained by further purifying this alizarine verte. Extracts of madder are mostly obtained by treating the root with boiling water, collecting the precipitates which separate on cooling, mixing them with gum or starch, and adding acetate of alumina or iron. This is, in fact, a mixture of colouring matter and a mordant, which may be used for printing, direct. These are the principal madder preparations; many of which are manufactured in this country."

The madder root season in Naples commences with August of each year and terminates in July of the following. It is customary to carry the residue stock of one year forward and to add it to the next season's crop. The estimates are made on bales of 9 cwt. each. The following is a statement of the crop of Naples madder roots. The shipments go chiefly to Liverpool and Glasgow, to Avignon *viâ* Marseilles, and to Holland:

	Bales.		Bales.
1869	20,909	1872	38,093
1870	20,375	1873	19,791
1871	16,903	1874	22,646

The shipments in the last named year were 19,650 bales, viz. to England, 5270 bales; to France, 14,084 bales; and to Holland, 296 bales; local consumption and shipments in garancine, 2600 bales, leaving a residue with which to commence the new season of 2396 bales.

The produce of madder roots in France was, in

	Cwts.
1857	420,000
1862	167,792
1872	238,568

The latter, at 93 francs 32 cents. per cwt., was equal in value to 22,268,709 francs, or about 890,750*l.*

A hectare in well-manured ground, and under favourable circumstances as regards atmosphere, will produce 12,000 lbs. of dry roots, while, under unfavourable circumstances, it will not yield more than one-half or one-fourth of that amount. As the yield varies greatly in successive years, it is difficult to give an average yield.

Madder is only cultivated in the south of France. The production was divided among the following departments in 1871:

	Cwts.
Vaucluse	177,009
Bouches du Rhone	41,720
Drome	19,992
Gard	18,343
Ardeche	6,524

According to the official statistics of France, the madder crop in 1871 covered an area of 11,659 hectares (29,147 acres). The average yield was 22·61 cwts. per hectare. The total production, 263,588 cwt., valued at over 665,000*l.*

The foreign demand for French madder is diminishing considerably, but for reds and rose tints madder is still preferred to the artificial alizarine for violets; however, the latter produces, much more economically, shades fully as rich as those obtained from the plant.

The madder preparation, known as *garancine*, which is largely imported from the South of France, is formed by moistening the ground root with sulphuric acid, and afterwards subjecting the same to boiling heat by means of steam. By this process the colouring principle is altered and improved, and a large proportion of it rendered soluble in water.

Madder is largely cultivated in *Holland.* The annual yield of roots in Zealand is 14,500,000 lbs. It is in the islands of Schowen and Duiveland, and in the zone of land comprised between the mouths of the West Escouit and the confines of Belgium, that they cultivate the best roots, and those most in esteem for their colouring matter. The average yield per hectare is, for the bi-annual plant, 2000 to 3000 kilogrammes; for the triennial, 3500 to 5000 kilogrammes. Seventy-eight machines worked by steam pulverize the madder, or dry and beat the roots in Zealand. In 1863 there was delivered 11,000 casks of 500 or 600 kilogrammes each, of pulverized madder, and 1,500,000 kilogrammes of roots.

In *Russia* madder grows wild in the south of the country of the Don Cossacks, and in the provinces of the Caucasus. The principal centre where it is cultivated is Kouban, in the Bakou Government, and in the neighbourhood of Derbend, the average production of late years has been from 200,000 to 300,000 pouds (of 36 lbs.) per annum. It constitutes a very important branch of commerce in the Caucasus, and the roots sell at 7 to 8 roubles the poud. It is exclusively employed in the native factories of the interior of Russia. The rapid extension of the aniline colours has, however, had a damaging effect on the native production. Although madder is cultivated on a large scale in the interior of Russia, the importation from Central Asia is continually increasing, and taking the place of cochineal. After the madder of Astrakan, Derbend, and of the Trans Caucasus (known as Persian), the best is that of Kohkand; next comes that of Bokhara, and lastly, that of Khiva.

In 1871, 3541 cwt. of madder roots, valued at 7082*l.*, were shipped from Cyprus, and madder to the value of 6260*l.* from Syria, chiefly to Great Britain.

United States.—Attempts have been made from time to time to introduce the culture of madder as a staple crop in New England and the Western States of America. At Columbus and Birmingham, Ohio, at Montague, Franklin county, Massachusetts, and on the Connecticut River, good crops have been raised. In composition the madder was somewhat deficient in lime, but this being restored in the dyeing process, the colours were found fully equal to those obtained with the best French madder. These experimental trials were so far satisfactory that they proved the crop to be entirely exempt from injury by insects, and from the weather, after the first season's growth. The plant is perfectly hardy, stands frost well, and also heat and drought, excepting that during the first winter after planting, there is danger on some soils of the ground heaving by frost, and exposing the roots to the air, which would kill them. Although in Europe, the plant seeds, in the United States it produces little or no seed, and imported seed does not vegetate freely. In France and Holland it is cultivated by the roots or sprouts. The soil best adapted for it is deep rich loam, containing a good proportion of salts of lime, this element entering largely into the composition of madder, and affecting its quality. The sprouts are placed in small furrows, running 3 inches deep, and 8 feet to 10 feet apart, across the whole field, the plants having about one foot space between each root. Little care is required for the crop after this, besides hoeing and keeping the field free from grass and weeds; as soon as the plants are 12 inches or 15 inches high, the tops are to be bent down to the surface of the ground, and all except the ends covered with earth. The operation is generally repeated three or four times during the first season, and until the vacant place between the furrows is nearly filled up. The plants by the end of the third or fourth year are ready for gathering, which is usually done in the month of September. The roots are then thoroughly washed in a machine, dried, and stacked away. Before grinding and preparing for market the roots require to be further dried in a kiln or oven, constructed in the simplest manner. They are extremely brittle, and can be ground in a grist or bark mill. The ground madder is then packed in casks or barrels, and is ready for market.

Within a comparatively recent period it has also been ascertained that the spent madder, if treated in a similar manner, can be made to yield a considerable quantity of additional colouring matter, equal for some purposes to that obtained from the fresh madder.

The Industrial Society of Mulhouse, France, recently published a report on the effect of the introduction of artificial alizarine upon the consumption of madder. The employment of the former product is constantly augmenting, and it is manufactured on a large scale in Alsace, Germany, and Russia. It is believed, however, that the large demand will not greatly affect the normal consumption of madder; or, in other words, the proportion of pure madder used in the arts, before the introduction into commerce of extracts of madder, will remain unchanged. It is with these extracts that artificial alizarine comes in competition, but only to a certain extent; for while it produces violet shades of greater brilliancy and beauty, its reds are inferior. In order to completely replace madder, another principle of that material must be present in the artificial product, namely purpurine, which furnishes fine orange reds, but of which at the present time even the chemical constitution is not definitely known. Hence it is considered that the best tints can be obtained by artificial alizarine and madder extract combined, employing the latter of the shade of red most closely approximating orange.

The imports of madder, madder root, and garancine, into the United Kingdom, are shown in the following figures:

Year.	Madder and Madder Root.	Year.	Garancine.
	cwts.		cwts.
1840	250,210	1850	6,133
1850	261,860	1860	38,344
1860	283,295	1870	42,195
1870	173,318	1875	25,865
1875	100,287	1876	15,398
1876	59,137		

Munjeet.—The majority of the substances used in India for dyeing red partake of the character of madder. The place occupied by this dye stuff in Europe is supplied in India by the Morindas and Munjeet. The munjeet of Neilgherry is referred to *Rubia tinctoria*, and that of Affghanistan to *Rubia cordifolia*, Lin., or *R. Munjista*, Roxb. It is cultivated in Assam, Nepaul, Bombay, and other parts of the country, and has occasionally been exported to England, but has never been much used in Great Britain, as the colours produced from it are neither so fast nor so bright as those obtained with the European madder. Munjeet fetches 29*s.* to 31*s.* the cwt.

Chay Root (*Oldenlandia umbellata*, Lin.; *Hedyotis umbellata*, Lam.); another plant belonging to the order Rubiaceæ, is also known as Indian madder. It is much cultivated in sandy situations on the Coromandel coast, and used to a great extent in the southern parts of Hindostan by the native dyers. The celebrated red turbans of Madura are dyed with it, and the Madras handkerchiefs or "pulicats" are also dyed with it.

In 1856 the land under culture with this root in Rajahmundry, Masulipatam, and Guntoor, amounted to 2453 acres, besides the quantity of wild produce.

Safflower (*Carthamus tinctorius*) is a tall annual, rather handsome herb. The florets produce yellow, rosy, ponceau, and other red shades of dye, according to various admixtures. The pigment principles are carthamin and carthamus yellow. Its colouring matter, called carthameine, "safflower carmine," is a resinoid substance of a very beautiful, but unfortunately not very permanent red colour; when exposed to action of air and light, it slowly combines with oxygen by elimination of water and carbonic acid, and is converted into a yellow substance. The "pink saucers" sold in shops for various purposes, contain carthameine, and mixed with talc it forms the *rouge* used by females for painting their faces.

In France and Spain, the small flowers composing the heads of the thistle are picked off and dried in the shade, whilst in Egypt and India they are squeezed, washed with cold water to remove useless materials, slightly pressed into lumps, and dried in the shade; the latter have about double the value of the former. The safflower so prepared only contains three to six parts per thousand of the colour-giving principle, which has received the name of carthamic acid. We also import a small quantity of "extract of safflower." The dried flowers, which are very much like saffron in appearance, have been employed to adulterate that drug. The florets are used by the Chinese to give rose, scarlet, purple, and violet colours to their silks. They are thrown into an infusion of alkali, and left to macerate. The colours are afterwards drawn out by the addition of lemon-juice in various proportions, or of any other vegetable acid. The dye-stuff is imported into England from many parts of Europe, and from Egypt, for dyeing and painting. It is also used in cakes, but if too much is used has purgative qualities. The dried florets yield a beautiful colouring matter, which attaches itself without a mordant. It is chiefly employed for colouring cotton, and produces various shades. In Bangalore silk is dyed with it, but the dye is fugitive, and will not bear washing. An alkaline extract precipitated by an acid will give a fine rose colour to silks or cotton. The flower is gathered and rubbed down into powder, and sold in this state. When used for dyeing, it is put into a cloth and washed in cold water for a long time to remove a yellow colouring matter. It is then boiled, and yields the pink dyeing liquid. The Chinese safflower is considered superior to the Indian. In Assam, Dacca, and Rajpootana, it is cultivated for exportation. That from Bombay is least esteemed. The mode of gathering the flowers and preparing the dye as practised in Europe, where the plant is much cultivated, is as follows. The moment the florets, which form the compound flowers, begin to open, they are gathered in succession without waiting for the whole to expand, since, when allowed to remain till fully blown, the colour is much faded. As the flowers are collected, they are dried in the shade. This work must be carefully performed, for if gathered in wet weather, or badly dried, the colour will be much deteriorated. These flowers contain two kinds of colouring matter, the one yellow, which is soluble in water, the other red, which being of a resinous nature, is insoluble in water, but soluble in alkaline carbonates. The first is never converted to any use, as it dyes only dull shades of colour. The other is a beautiful rose red, capable of dyeing every shade, from the palest rose to the cherry red. It is therefore requisite before the flowers can be made available to separate the useless from the valuable colour, and since the former only is soluble in water, this operation is a matter of little difficulty. The flowers are tied in a sack and laid in a trough, through which a slender stream of water is constantly flowing, while still further to promote the solution of the yellow colouring matter, a man in the trough treads the sack, and subjects every part to the action of the water. When this flows without receiving any yellow tinge in its passage, the washing is discontinued, and the safflower, if not wanted for immediate use, is made into cakes; these are known in commerce under the name of stripped safflower. It is principally used for dyeing silk, producing poppy-red, bright orange, cherry, rose or flesh colour, according to the alternates employed in combination. These are alum, potash, tartaric acid, or sulphuric acid.

The cultivation of the safflower, known as Coosumban in Bengal, is receiving attention at the hands of the local government. The prosperity of Bengal, though it mainly depends upon the jute trade, is in some measure attributable to the demand for safflower. The principal Dacca dealers report the total outturn of safflower at from 15,000 to 16,500 maunds; of which about 11,000 or 12,000 maunds are produced in the Dacca district. The remainder is chiefly from Mymensingh, Tipperah, and Furreedpore. Taking the average price of the dye at Rs.60 per maund, the value of the export from Dacca would be from nine to ten lacs of rupees, 90,000 to 100,000*l*.. The cultivation is said to be largely extending.

Safflower is grown, but to a limited extent, in Bengal, and does not grow promiscuously all over the district. It is cultivated mostly in the tract of country between the Ganges and the Dhulleseray. Six seers of seeds are required to sow one beegah of land, which under favourable conditions will yield about ten seers of flower. The time for sowing is October and November, and the plucking commences in March and April, when the petals of the flower assume a deep orange colour. After being kept saturated in water for one night the flowers are trodden upon by the ryots the next morning. This is repeated for a few days until the impurities are drained off, and the pulpy substance is then divided into cakes and dried in the sun. This process of dividing them into small portions is done by women, who are occupied by it till a late hour of the night. It is a most profitable source of industry, for, besides the sale of the flowers, the returns from which are very handsome considering the trouble and outlay expended on it, a certain kind of oil is pressed out of the seeds which answers remarkably well for culinary as well as other domestic purposes. The seeds are also consumed by the natives when cooked in milk and sugar. As potash forms the preponderating element in the leaves and stalks of the plant, its ashes are used as a substitute for soap by the common people. During the close of the last century the demand for safflower in the country itself was so great that not an ounce was exported, but in the year 1800, a reaction set in, and there was a large shipment. The greatest quantity then exported was in 1824–25, when about 8500 maunds passed the Calcutta Custom-house, valued at nearly three lacs of rupees. The export has somewhat fallen off of late years, owing both to the decrease in the produce of the plants and to the adulteration carried on by the natives in its manufacture. When in a pure state it ranked next to China safflower in European markets. The former yields two kinds of colour, the yellow and the red. According to a reliable authority on the subject, the yellow is soluble in cold water, is removed by repeated washings, and the residue yields the red colour by digestion in a cold solution of carbonate of potash, from which it is precipitated by weak citric acid. The red colour, or "carthamic acid" as it is called by some chemists, exceeds in beauty the colour of cochineal, but cloths dyed with it will not stand the action of soap nor exposure to the sun for a long time.

Safflower, one of the great staples of Eastern Bengal, is a sure source of income to the ryot. Land subject to annual inundation is the best fitted for the plant, and if it has remained fallow for a time, the crop gives a good return for three years. The yield is good in the first year, and then somewhat less and less. The soil is then given up, and rotation practised, as the crop is exhaustive. After ploughing, the seed, about four or five seers in weight, is either sown broad-cast or put into the ground by means of pressure with the finger. The field is divided into compartments in order to enable the ryot to go on with weeding. Rain, when the tree is a foot high, does it good, but after the appearance of the flower rain injures it, and washes away the colour. One beegah yields about 1 maund 10 seers of flower, the price being about Rs.105 per maund of 82 tolahs—10 annas to the seer.

The flower, after being gathered in, is trodden down in mats in order to expel the viscid juice which it contains, and then taken to the river and washed three days three times; the more the flower is washed, the better is the colour, river water being preferred to tank water. This substance is then made up into flat balls, about a dollar in shape. Males and females both work alike at the manufacture. There are picking cycles of three days in the same field. The stalks of the plant are used as fire wood. When the stalks are burnt they supply a potash for bleaching cloths.

The plant flowers in three and a half months, and the flowers mature in about fifteen days. Thus the produce of seed sown in December is gathered at the end of March, while the flowers of plants sown a month later are not plucked till the end of April. The corollas only of the flower are gathered, as they mature after intervals of two or three days, and the pluckings take place generally four or five times. The first flowers are generally undeveloped, and being deficient in colour, yield dye of an inferior quality. The last pluckings are also inferior, as the plant is then old and dried up, and the colour often entirely void of that deep crimson which is so much valued. The operation of plucking is principally carried on by women, who are often employed in this manner for eight hours a day and receive two annas (3*d.*) for each day's work. Some skill and much attention are required to ascertain when the flowers are ready for plucking, and a sufficient number of hands must be employed to gather all the matured petals in one day, otherwise the colouring matter will be injured by delay, and indeed may eventually vanish altogether. The corollas of the flower when gathered are placed on a mat in the shade and kneaded with the feet for about an hour on the evening of the day they are plucked, and then left for the night in baskets, no water being used on the first day. Next morning they are placed on a mat so arranged as to allow the water to run freely away, while one man kneads the mass with his feet and another pours clean water on it. Filtered water is best for the purpose; but, if this is not obtainable, the water must be allowed to stand in vessels for twenty-four hours before it is used. Muddy water often spoils the colour. After being worked up in this way for about two hours, the pulp is again placed in baskets and sprinkled with water, so as to keep it moist until the afternoon, when it is again kneaded in the manner above described for two hours, and quantities of clean water poured on it. To make good cakes this kneading process must be repeated morning and evening for three days, and the pulp, which is thus kneaded six times, kept thoroughly damp day and night in the interval, and never allowed to dry. The chief components, combined with the woody fibre of safflower, are—(1) a glutinous substance, (2) a yellow colouring matter, and (3) a red colouring matter. The first two are readily soluble in water, but not so the third, which, however, is small in proportion to the two others. This repeated washing and kneading of the pulp gets rid of the valueless and easily soluble compounds, and the importance of this object readily explains how the great art of making good safflower lies chiefly in the manufacture. To prove whether the pulp is ready to be made into cakes, it must be placed in clean water, so that any discoloration can at once be detected, and when it will no longer yield colour to the water it is fit for use. The cakes of safflower are made round by squeezing the pulp well between the palms of the hands, they should be about $1\frac{1}{2}$ inch in diameter, and about $\frac{1}{8}$ inch to $\frac{3}{16}$ inch thick in the centre, and tapering to the edges. Large cakes are very brittle, and hence small cakes are preferred by the purchasers. The cakes are placed on mats in the sun to dry for three or four days, and are then ready for sale. While the cakes are being dried, rain or damp cloudy weather is very injurious to the colouring matter, and the drying process takes a longer time. As moisture discolours the cakes, they should be kept in jars or other dry covered receptacles. After the petals are plucked, as above described, the plants are allowed to stand for about three weeks to allow the seed to mature, and are then uprooted or cut down and spread out in the sun to dry. After being sufficiently dried, the plants are beaten with sticks; and the seed, which is easily separated by this process, is winnowed and made into oil, which is used for lighting and cooking, as well as medicinally in rheumatic and paralytic complaints.

The following have been the receipts of safflower from British India in the United Kingdom:

	Cwts.		Cwts.
1862	17,186	1869	8,870
1863	7,130	1870	12,126
1864	10,304	1871	13,951
1865	6,187	1872	7,830
1866	8,946	1873	9,495
1867	9,091	1874	13,625
1868	32,170	1875	3,029

The imports in 1876 were 1334 bales.

Safflower is extensively cultivated in France and the more southern parts of Europe, both broadcast and in drills. There is a very important diversity, however, in the mode of manufacturing the dye. In France the flowers are picked by hand in dry weather, and then carefully dried in a kiln under pressure. In Europe the flower yields two sorts of colouring matter, one soluble in water, producing a yellow dye, of no great beauty, the other resinous, and best dissolved by the fixed alkalies. It is the last that is esteemed so highly, producing a carmine colour, exceeding in beauty and delicacy any that can be obtained even from cochineal. The colour does not stand, however, and is principally employed for imitating upon silk the colours produced by cochineal upon woollen textures.

The beautiful rouge, known as *rouge végétal*, is extracted from safflower dye by a peculiar chemical process. There is not a very large demand for safflower in England. The great centre of its use appears to be Lyons, where it is employed for the colouring of silks and satins. The Bengal ryot subjects the flowers to repeated washings, to get rid of what are described as—(1), a glutinous substance therefrom, and (2) the yellow colouring matter which they yield. By the French process the flowers are simply very carefully dried in a kiln under pressure, and it would be interesting to know which process yields the finest dye.

Safflower appears to be grown to some extent in China, for 5766 piculs (7207 cwt.), valued at 91,834*l.*, were shipped from Hankow in 1875.

Poultry fatten on the seeds, which somewhat resemble those of the sunflower. An oil, of a light yellow colour, is also pressed from them, which is used for lamps and ordinary purposes. The seeds, which are called in India curdee seeds, contain about 28 per cent. of oil. They are imported into this country among other oil seeds. The marc, or oilcake, is given to cattle.

Saffron (*Crocus sativus*).—This is a pretty bulbous plant of the natural order Iridaceæ. It is alike useful in food, industry, and medicine. Although used to a small extent in pharmacy, and as a dye-stuff, its chief employment is as a condiment.

The number of species is very great, but they may be divided into those which blow in autumn and those which flower in spring. The bulbs grow wild in large quantities on the sides of mountains, and in the valleys of Sicily, Greece, Turkey, Persia, Spain, Portugal, and other countries.

Mr. Hanbury well remarks that saffron, either as a medicine, condiment, perfume, or dye, has been highly prized by mankind from a remote period, and has played an important part in the history of commerce.

A peculiar preference for saffron as a condiment exists in some countries, especially Austria, Germany, and certain districts of Switzerland. This predilection prevails even in England—at least in Cornwall, where the use of saffron for colouring cakes is still common. Saffron is largely used by the natives of India in religious rites, in medicine, and for the colouring and flavouring of food. As a dye-stuff saffron is no longer employed in this country, having been superseded by less costly substances.*

Saffron contains a yellow matter, which, if extracted and dried, is

* Pharmacographia.

red, but when wet is yellow; it has a bitter taste, is easily dissolved in warm water and still easier in alcohol, also in ether and the essential oils. The colouring matter is about 42 per cent. of the saffron. It is used in the morocco trade for colouring skins.

The colouring power of saffron is very remarkable; a single grain rubbed to fine powder with a little sugar, will impart a distinct tint of yellow to 10 gallons of water.

This plant grows wild in many countries, and is cultivated in several, such as Austria, Hungary, Russia, Greece, Italy, Asia Minor, Egypt, France, and Spain. The two principal countries of production are the arrondissements of Pithiviers (Loiret), in France, and the province of Avignon, in Spain.

The production in France was estimated in 1862 at 33,000 lbs., the greater part of which was sent to Germany, the price being about 75 francs the kilogramme, or a total value of 1,000,000 francs, equals 40,000*l.*

The production of saffron in France is chiefly confined to three departments, of which Loiret produces the largest amount and of the best quality. A saffron field is not in full bearing till the end of the second year, at the end of three years it is exhausted, and, according to a local proverb, the land is then so poisoned that it cannot be used for the same purpose for 15 or 16 years more. The average crop of the second and third year is various, from 10 to 30 kilogrammes per hectare, or from 9 lbs. to 27 lbs. per acre of dry pistils. Each acre produces 600,000 to 700,000 bulbs, and each bulb two or three flowers. About 30,000 flowers are required to produce 2 lbs. of fresh pistils, which, when dried, are reduced to one-fifth of that weight; the pistils are the only productive part of the flower, the rest is waste. The labour of picking such enormous quantities of flowers by hand is great, and when the crop is large and labourers are scarce, the flowers are carried into the villages and small towns round about, to be picked by women and children at home. In such cases all the world is busy saffron-picking; artisans, shopkeepers, gentlemen, and ladies, freely assist in the work, the poor working for their own profit, the rich for the benefit of the necessitous. The farmer has to pay from about 10*d.* to 4*s.* a pound for the picking, according to the abundance of the crop. When the pistils are separated they have to be dried, and this operation is effected by placing about a pound of fresh pistils at a time in a horsehair sieve, suspended over a little charcoal furnace. As soon as it is dry the saffron is ready for sale. Commercial travellers generally buy up the saffron, which goes by the name of the most famous district, the old province of Gâtinais, principally for Germany, where it is said to be mixed with Spanish saffron and resold as a German product.

Saffron requires a peculiar soil, and the land which suits it is worth from 3*l.* to 4*l.* per acre, or double that of ordinary land in the same district. The saffron sells on an average for 30*s.* or 2*l.* per pound, and when very fine for double those rates.

The following is an analysis of a good saffron growing soil in the neighbourhood of the town of Pinseaux, in the celebrated district of Gâtinais :

Quartzose sand	0·268
Silica and alumina	0·279
Oxide of iron	0·020
Carbonate of lime	0·370
Water and organic matters	0·063
Total	1·000

A good description of the culture and preparation of saffron in France, by M. H. Dumesnil, is published in the sixteenth volume of the Bulletin of the Paris Society of Acclimatation, p. 205, for 1869; and in the volume for 1874, p. 356, there is a descriptive note of the results arising from some foreign species of crocus introduced into France.

In the Midi the culture of saffron is only carried on in the department of Vaucluse; but the quality, although appreciated, is considered inferior to that of the ancient French province of Gâtinais. There has long been a large commerce in saffron carried on at Marseilles. In 1862 the French imports were 43,974 kilos. from Spain, of which 12,210 kilos. were re-exported. In 1874, 45,687 kilos. were imported at Marseilles, nearly all from Spain. The exports thence rose to 31,535 kilos. The total exports from France were, in—

	Kilos.
1872	59,844
1873	99,467
1874	83,440

The production of Spain is about double that of France, and, adding the growth of other countries, the value of the saffron produced must exceed a quarter of a million sterling.

In Sicily and in a number of the provinces of Southern Germany, saffron is planted with care in gardens, and when brought to perfection fine results are obtained in the shape of good colouring material. Under culture it rapidly thrives, and it is from these sections that a large amount of the saffron used in the arts and manufactures is obtained. On the seed-bearer of the flower there is a threadlike hook or fork, which at its upper end terminates in three thick dark orange-coloured nerves or masses; to save and collect these tissues the flowers are gathered in the fall, just as they are breaking or a little before; they are plucked only in the morning, and these little masses are then pulled out with a considerable portion of the threadlike stem to which they adhere. It is the dried stigmas, the trifid orange-coloured tops of the central organ of the flower. The remainder of the flower is useless. The next operation is to dry them in a graduated heat; stoves are made on purpose for this; the heat must be applied gradually.

Saffron as it generally comes into the trade, consists of a large number of crooked and mixed up threads, of a rather whitish colour; if of a very good quality it has a peculiarly sharp, rooty, and pungent smell, and a bitter balsam-like taste. There are a number of varieties, the Oriental from Asia, the Asiatic from Turkey and other sections of the East. Since its price has risen in the market there have been numerous methods of adulteration invented; these occur, for the most part, in the saffron sold in France, Bavaria, and Austria. The Italian saffron is paler; it, however, dyes a very good colour. The English saffron is always very dry, and is easily pulverized, and therefore is poorer. The poorer saffron comes from Spain, and is made heavy by the introduction of a fatty oil. This can be easily distinguished by rubbing a quantity between the fingers, when an oily feeling is noticeable, which is never present in the pure saffron that has not been tampered with.

Mr. Henry Groves, in giving an account of saffron culture in the Abruzzi district of the Apennines, states that adulteration is carried out in various ways, the chief one being by mixing with it shredded beef, of which a suitable piece is boiled, and then shredded into small fibres, which are stained with saffron water and then dried. The filaments of the stamens are also dyed in the same manner and intermixed. To make the saffron water about 15 grammes of the stigmata are tied up in a cloth and soaked with a little water or wine, which after a time is pressed out, and the process repeated as long as any colouring matter remains. The exhausted saffron is used by the country people in their polento, to which it imparts some slight flavour.

One of the richest centres of cultivation of crocus is Safranboly, in the vilayet of Kastamouny, in the province of Anatolia, near the ports of the Black Sea, and therefore not far from Constantinople. Its prosperity is entirely owing to the growth of saffron. The bulbs are transplanted in April; they multiply very rapidly, and in three years' time yield an abundant crop in autumn, which fetches about 65 francs per lb. It is frequently met with in a sophisticated state, owing to its high price; indeed, according to Pereira, it takes nine flowers to make up a grain of marketable saffron, so that it does not require less than 4320 flowers to yield one ounce. Some assert that to produce 1 lb. of dry saffron 107,520 flowers are necessary; while others put the quantity as high as 203,920 flowers. According to Dumesnil (Acad. des Sciences) 7000 to 8000 flowers are required for yielding $17\frac{1}{2}$ oz. of fresh saffron, and this weight is reduced to one fifth by drying. The adulteration is effected by the admixture of safflower, marigold, or slices of the petals of the pomegranate.

Saffron of an excellent quality is produced in the Regency of Tunis. The culture is carried on about the town of Tastus, but only on a small scale. Saffron is grown in China and Japan, and the mountains of Cashmere, but it is not the same species as that grown in Europe.

Turmeric.—This dye-stuff is the produce of the rhizomes of *Curcuma longa*. These as entering into commerce differ materially in their exterior form, and have hence been attributed to different plants, but they are all the produce of *C. longa*. Messrs. Fluckiger and Hanbury, in their 'History of the Principal Drugs,' give a good definition of the two sorts of rhizome which enter into commerce, the central or round, and the lateral or long. "The former are ovate, pyriform or sub-spherical, sometimes pointed at the upper end, and crowned with the remains of leaves, while the sides are beset with those of roots and marked with concentric ridges. The diameter is very variable, but it is seldom less than three-fourths of an inch, and is frequently much more. They are often cut and usually scalded in order to destroy their vitality and facilitate drying, as they are exposed to the sun for three or four days.

"The lateral rhizomes are sub-cylindrical, attenuated towards either end, generally curved, covered with a rugose skin, and marked more or less plainly with transverse rings. Sometimes one, two, or more short knobs or shoots grow out on one side. The rhizomes, whether round or long, are very hard and firm, exhibiting when broken a dull, waxy, resinous surface, of an orange or orange-brown hue, more or less brilliant. They have a peculiar aromatic odour and taste.

"Several varieties of turmeric, distinguished by the names of the countries or districts in which they are produced, are found in the English market; but although they present differences which are sufficiently appreciable to the eye of the experienced dealer, the characters of each sort are scarcely so marked or so constant as to be recognisable by mere verbal description."

China turmeric is the most esteemed, but it is seldom to be met with in the European market. A good deal is imported from Takow, in Formosa, to Chinese ports, as the following figures show:

	Piculs.		Piculs.
1868	8460	1870	7692
1869	7231	1871	7587

3871 piculs were imported at Shanghai in 1871; 559 piculs at Amoy; 1049 at Ningpo; 2104 at Tientsin, and 209 at Newchwang.

Madras turmeric is a fine sort, in large bold pieces, called "fingers." Sometimes packages of it contain exclusively round rhizomes, while others are made up entirely of the long or lateral. Bengal turmeric differs from the other varieties chiefly in its deeper tint, and hence is the sort preferred for dyeing purposes. It fetches about 22*s.* per cwt.

Java turmeric presents no very distinctive features, it is dusted with its own powder, and does not show when broken a very brilliant colour.

Cochin turmeric would seem to be the produce of another species of *Curcuma.* It consists exclusively of a bulb-shaped rhizome of large dimensions, cut transversely or longitudinally into slices or segments. The cortical part is dull brown; the inner surface is horny, and of a deep orange-brown, or when in thin shavings of a brilliant yellow. The entire rhizomes are thick, short, conical, and of enormous size, some attaining as much as 2½ inches in diameter.

The *Curcuma longa* grows wild in the province of Mysore, and is probably indigenous to various other parts; it is cultivated very generally in most districts of India. It thrives well in a rich light soil, and is readily increased by offshoots from the roots. An acre yields about 2000 lbs. of the fresh roots.

It is chiefly used in Europe as a dye-stuff, and the powder affords without a mordant a yellow dye, which is brilliant but not permanent. It is largely used by native females in India to colour their faces. Mixed with the pulverised sappan wood it forms the red powder used by the Hindoos, under the name of *faug*, in the Huli festival games. It is extensively used in cooking in the East, especially as an ingredient in curry powder; indeed there are few articles of food that are not there flavoured with turmeric.

It used to be used medicinally in this country, but maintains a high reputation among native practitioners in the East as a cordial and stomachic, as antiscorbutic, and stimulating the digestive organs. It is frequently given in the fresh state as an anthelmintic, and in diarrhœa. The imports are comparatively large. Twenty years ago we only imported 27 tons. From 1857 to 1859 it averaged 2200 tons, now the average is 2000 tons yearly, of which about half is reshipped to the Continent, for use in France, Russia, and Germany.

Mr. R. S. Hepburn, chemist, of Panama, writes me under date February 20, 1877, that the turmeric grown in the Isthmus is very fine, but the growers there are ignorant of its commercial value. The price now (March 1877) ranges from 12*s.* 6*d.* to 26*s.* per cwt.

The imports were as follows in the years stated; no later official details have been published:

Year.	Quantity.	Value.
	tons.	£
1866	1499	34,799
1867	1814	40,555
1868	2183	46,523
1869	3214	65,218
1870	2245	44,639

Our receipts are chiefly from Madras and Bengal. The imports into London in 1876 were 1827 tons. The shipments made from Bombay (some 30,000 cwt.) go chiefly to Sind and the Persian Gulf, and but little from thence reaches Europe.

Cutch.—Perhaps less is known in commercial circles of the history and origin of the inspissated extracts known as cutch and gambier, which are now imported to so large an amount for tanning and dyeing purposes, than of any other products. The misnomer of "Terra Japonica," which was so long applied to gambier in the official trade returns, has now been got rid of, and the two extracts appear under their proper names. Although they are frequently confounded by many, cutch and gambier are obtained from different sources and different plants. It may, therefore, be well to give some detailed description of them, and of the great progress they have made, until our imports of these two products now reach a value of nearly three quarters of a million. The imports in the last two years were as follows:

Year.	Cutch.		Gambier.	
	Quantity.	Value.	Quantity.	Value.
	tons.	£	tons.	£
1875	5,821	141,412	23,299	606,050
1876	4,956	120,872	21,712	493,120

The cutch of commerce is obtained chiefly from two species of *Acacia*. The common name, catechu, under which it sometimes passes, is derived from *Cate*, a tree, and *chu*, juice. It is usually called in India kat or kut. The trees from which it is prepared are chiefly: (1) *Acacia Catechu*, Willd.; *Mimosa Sundra*, Roxb., a tree 30 or 40 feet high, with dark-grey or brown bark, reddish and fibrous internally. This tree is common in most parts of India and Burmah, where it is highly valued for its wood, which is used for posts, and for various domestic purposes, as well as for making catechu and charcoal, while the astringent bark serves for tanning. (2) *A. Suma*, Kurz; *Mimosa Suma*, Roxb., is a large tree, with white bark, nearly related to the preceding, but not having so extensive a geographical range. It grows in the south of India (Mysore), Bengal, and Guzerat. The bark is used in tanning, and catechu is made from the heart-wood, but not so extensively as from the former species. The process for preparing it varies slightly in different districts. The tree is reckoned to be of proper age when its trunk is about a foot in diameter. It is then cut down, and the whole of the woody part, with the exception of the smaller branches and the bark, is chopped into chips. Some accounts state that only the darker heart-wood is thus used. The chips are then placed with water in earthen jars, a series of which are arranged over a mud-built fireplace, usually in the open air. Here the water is made to boil, the liquor, as it becomes thick and strong, being decanted into another vessel, in which the evaporation is continued, until the extract is sufficiently inspissated, when it is poured into moulds made of clay, or of leaves pinned together in the shape of cups, or in some districts on to a mat covered with the ashes of cow-dung; the drying in each case being completed by exposure to the sun and air. The product is a dark-brown extract, which is the usual form in which cutch is known in Europe. In Kumaon, in the north of India, a slight modification of the process affords a drug of very different appearance. Instead of evaporating the decoction to the condition of an extract, the inspissation is stopped at a certain point, and the liquor allowed to cool, coagulate, and crystallise over twigs and leaves thrown into the pots for the purpose. How this substance is finished off we do not exactly know, but it is stated that by this process there is obtained from each pot about 2 lbs. of "kath," or catechu, of an ashy whitish appearance. This product is brought down from Berar and Nepaul to Calcutta. The cutch of Pegu has a high reputation. Catechu contains about 50 per cent. of tannin. It is used by dyers, not as a dyestuff, however, but as a source of tannic acid, which it contains in a very large quantity, and this has the property of forming, with a solution of a salt of sesquioxide of iron, an exceedingly deep, bluish-black liquid (ink). Catechu is used also in medicine as an astringent, on account of the large quantity of tannic acid which it contains.

According to some accounts cutch, or catechu, is prepared thus: The tree is cut down to about 6 to 12 inches from the ground, and the inner wood chopped into small pieces, the smaller branches and bark being rejected. The chopped wood is then taken to the place of manufacture, generally under trees in the open air, and placed over a brisk fire in mud jars, called *garrahs*, filled with about two-thirds of water. This is allowed to boil down, till, with the extracted matter, it forms a liquid of syrupy consistence. The contents of several jars are then poured into a larger jar and then placed over a brisk fire for a period of from two to four hours, and, when sufficiently boiled down, it is poured out over mats covered with ashes of cowdung and allowed to dry. The wood when dry is used for fuel.

The King of Burmah has the monopoly of this manufacture, of which a considerable quantity is exported. An official report, published at Rangoon, says:

"The reservation of the *Acacia Catechu* for the production of cutch, in portions of the Thayet and Prome districts of British Burmah, has been of much advantage to the trade, for the following figures show, that whilst during the last year or two there has been a large falling off in the imports from Upper Burmah, the out-turn within British territory has increased:

Year.	Exports from Pegu.	Imported from Upper Burmah.	Balance produced in Pegu.
	mds.	mds.	mds.
1871–72	224,564	97,536	127,028
1872–73	416,987	153,628	263,359
1873–74	247,468	62,581	184,887
1874–75	274,436	50,163	224,273

"There should be no serious objection to reserving further areas for the growth of this tree on the banks of the Naweng river in the Prome district, by which stream firewood and the cutch manufacture could easily be brought to market. There is a great demand for fuel for the river steamers, and the present supply is by no means of first-class quality; at the same time, the cutch market is in a satisfactory state, and is likely to continue so."

Other kinds of catechu are prepared in India. The commonest kind is that from the nut of the *Areca Catechu.* Heyne gives the following as the mode of preparation in Mysore:—The nuts are boiled for some hours in an iron vessel, which furnishes the astringent extract called kossa, which is black, and mixed with paddy husks and other impurities. After the nuts are dried, they are put into a fresh quantity of water and boiled again, and this water being inspissated like the former, yields the best kind of catechu, called cooney. It is yellowish-brown, has an earthy fracture, and is free from the admixture of foreign bodies.

The betel nuts are prepared for use in various ways. They are boiled, and when the water has become red and thick the nuts are taken out, cut in slices with a simple lever cutter, and dried in the sun; they are then once more steeped in the liquid and again dried. From the decoction of the nuts two kinds of catechu are obtained, one called cattacumboo, is used as a masticatory chewed with the betel leaf; the other, called cash cuttie, is used medicinally as an astringent.

The collection and preparation of the betel nuts are described under the head of the Betel Palm, p. 279.

Besides the quantity of cutch sent to Europe from Singapore there is a considerable export to Java, Cochin China, and other neighbouring countries; 15,252 cwt. of cutch were imported into Penang in 1870.

The imports of cutch into the United Kingdom were in—

	Tons.		Tons.
1866	2434	1872	5622
1867	2111	1873	6998
1868	3541	1874	4593
1869	2573	1875	5821
1870	5946	1876	4956
1871	5532		

British India supplies the largest portion.

GAMBIER.—The gambier plant is a stout, climbing shrub, a native of the countries bordering on the Straits of Malacca, and especially of the numerous islands at their eastern end. There would appear to be two species employed:—(1) The *Uncaria Gambir*, Roxb.; the *Nauclea Gambir* of Hunter. (2) *Uncaria acida*, Hunt. The cultivation and manufacture seem to have been commenced at Singapore in 1819, and it rapidly extended, until there were about 600 or 800 plantations; but, owing to a scarcity of fuel, without an abundant supply of which manufacture is impossible, and labour becoming also dear, they were reduced to about 400 in 1850, and in 1866 the cultivation was fast disappearing on the island. Of late years, owing to an increased demand for the product, and higher prices ruling, it has rapidly recovered. The first shipments from Singapore were 3234 cwts. in 1830; in 1834, 2322 cwts. were sent to England, the price being more moderate, and its use becoming better understood, an active demand arose, which has since continued. The culture is also largely pursued on the mainland, where, in 1851, there were 200 plantations. In the islands of the Rhio Linga Archipelago, lying south-east of Singapore, and on the Island of Bintang, the most northerly of the group, there were, in 1854, 1250 gambier plantations. In the three years ending 1870, there was imported, chiefly from Rhio, into Singapore an average of 240,000 cwts. of gambier. The total exports from Singapore in 1870 were 34,550 tons, and in 1871, 34,248 tons, of which 19,550 were received from Rhio and the Malay Peninsula. In 1872, 190,600 piculs were made in Rhio. The plant is propagated either by seeds or cuttings, but the latter are preferred. At the expiration of fourteen months the first cutting of the branches, with the leaves on, is made. The plantations are often formed in clearings of the jungle, where they last for a few years, and are then abandoned, owing to the impoverishment of the soil and the irrepressible growth of the "lalang" grass (*Imperata Koenigii*, Beauv.), which is more difficult to eradicate than even primeval jungle. It has been found profitable to combine with the cultivation of gambier that of pepper, for which the boiled leaves of the gambier form an excellent manure. The gambier plants are allowed to grow from 8 to 10 feet high, and as their foliage is always in season, each plant is stripped three or four times in the year. The apparatus and all that belongs to the manufacture of the extract are of the most primitive description. A shallow cast-iron pan, about 3 feet across, is built into an earthen fireplace. Water is poured into the pan, a fire is kindled, and the leaves and young shoots, freshly plucked, are scattered in and boiled for about an hour. At the end of this time they are thrown into a capacious steeping trough, the lower end of which projects into the pan, and squeezed with the hand so that the absorbed liquor may run back into the boiler. The decoction is then evaporated to the consistency of a syrup, and baled out into buckets. When sufficiently cool, it is subjected to a curious treatment. Instead of simply stirring it round, the workman pushes a stick of soft wood in a sloping direction into every bucket, and placing two such buckets before him, he works a stick up and down in each. The liquor thickens round the stick, and the thickened portion being constantly rubbed off, while at the same time the whole is in motion, it gradually sets into a mass, a result which the workman affirms would never be produced by simply stirring round. Though we are not prepared to concur in the workman's opinion, it is reasonable to suppose that his manner of treating the liquor favours the crystallization of the substance in a more concrete form than it might otherwise assume. The thickened mass, which is said by another writer to resemble soft, yellowish clay, is now placed in shallow, square boxes, and when somewhat hardened, is cut into cubes and dried in the shade. The leaves are boiled a second time, and finally washed in water, which water is saved for another operation. A plantation with five or six labourers contains on an average 70,000 to 80,000 shrubs, and yields from 50 to 60 lbs. of gambier daily. ('Pharmacographia.')

The following have been the imports of gambier into the United Kingdom:

	Tons.		Tons.
1866	12,845	1872	21,155
1867	13,237	1873	22,514
1868	20,239	1874	16,728
1869	16,267	1875	23,299
1870	19,050	1876	21,721
1871	25,175		

Annotta, or Arnotto.—The culture of the plant producing this dye-stuff is chiefly carried on in the French colonies of Guadaloupe and Cayenne, where it is known as roucou, and in other parts of South America as achiote. It is washed off from the seeds of a small tree or shrub, the *Bixa orellana*, a native of the warm parts of South America, the East and West Indies, and Africa. The plant is grown in the Deccan and other parts of India and the Eastern Archipelago, in the Pacific Islands, Brazil, Peru, and Zanzibar. The fruit is like a chestnut, a two-valved capsule covered with flexible bristles, and contains a certain number of seeds smaller than peas. These seeds are covered with a soft, viscous, resinous pulp, of a beautiful vermilion colour, and unpleasant smell like red lead mixed with oil, and it is this substance which constitutes annotta, or arnotto. The modein which it is obtained is by pouring hot water over the pulp and seeds, and leaving them to macerate, and then separating them by pounding with a wooden pestle. The seeds are removed by straining the mass through a sieve; and the pulp being allowed to settle, the water is gently poured off, and the pulp put into shallow vessels, in which it is gradually dried in the shade. After acquiring a proper consistence it is made into cylindrical rolls or balls, and placed in an airy place to dry, after which it is sent to market. It used to be most common in this form of small rolls, each 2 or 3 ozs. in weight, hard, dry, and compact; brownish without and red within. The other process of manufacture is that pursued in Cayenne. The pulp and seeds together are bruised in wooden vessels, and hot water poured over them; they are then left to soak for several days, and afterwards passed through a close sieve to separate the seeds. The matter is then left to ferment for about a week, when the water is gently poured off, and the solid part left to dry in the shade. When it has acquired the consistence of solid paste, it is formed into cakes of 3 or 4 lbs. weight, which are wrapped in the leaves of the banana, and known in commerce as flag arnotto. This variety is of a bright yellow colour, rather soft to the touch, and of considerable solidity.

Labat informs us that the Indians prepare an annotta greatly superior to that which is brought to us, of a bright shining red colour, almost equal to carmine. For this purpose, instead of steeping and fermenting the seeds in water they rub them with the hands, previously dipped in oil, till the pulp comes off and is reduced to a clear paste, which is scraped off from the hands with a knife, and laid on a clean leaf in the shade to dry. Mixed with lemon juice and gum, it makes the crimson paint with which Indians adorn their bodies; and they employ the leaves and roots in cookery to increase the flavour and give a saffron colour.

It owes its value to the colouring matter bixin and orellin, which constitute about 20 per cent. of good dry annotta. Fresh annotta contains more than half its weight of water. It was formerly employed in dyeing wool and silks, but its colour though beautiful at first soon fades, and hence it has been abandoned for more permanent dyes.

Annotta is principally consumed by painters and dyers; but it is also used to colour cheese with a pale yellow or flesh colour. The Dutch use it for heightening the colour of their butter, and it is employed for the same purpose in some American and English dairies.

The following shows the position of the production of this dyestuff in the two French colonies:

Year.	Guadaloupe.		French Guiana.	
	Hectares under Culture.	Produce.	Hectares under Culture.	Produce.
		kilos.		kilos.
1869	385	313,200	2,182	626,362
1870	496	379,400	2,456	691,998
1871	687	675,938	2,233	659,295
1872	725	668,896	1,945	487,579
1873	661	542,850	1,832	463,087
1874	528	369,600	1,783	445,915

In Guadaloupe there are 48 plantations on which it is grown, employing 1044 labourers. In French Guiana there are 563, which employ 2110 hands. The net value of the crop in 1874, after deducting expenses of culture, &c., was stated at 3567*l.*

The Board of Trade having ceased to particularize the imports of this article into the United Kingdom, there are no later returns available than those of 1870. The following are the imports and value for a few years in cwts.:

Year.	Roll.	Flag.
	cwts.	cwts.
1866	1209	2631
1867	2480	2860
1868	1035	2981
1869	2670	3111
1870	773	3903

The flag annotta is worth double the price of roll annotta. The prices in March, 1877, were 2*d.* to 9*d.* per lb. for roll, and 5*d.* to 1*s.* 6*d.* for flag.

Henna (*Lawsonia alba*, Lamk.; *L. spinosa*, and *inermis*, Lin.; *Alcanna spinosa*, Gaert.). This plant grows plentifully in Egypt and in most parts of the East, as far as India. From the leaves a paste is compounded with which every Eastern beauty colours her hands and feet. Nay, so ancient is the custom, that mummies have been found with their nails dyed with henna. In later times, Mahommed used henna as a dye for his beard, and the fashion was followed by several of the caliphs. The use of henna is scarcely to be called a caprice in the east. There is a quality in the drug which gently restrains perspiration in the hands and feet, and produces an agreeable coolness, equally conducive to health and comfort. It forms an important article of commerce in all the Arabian towns. The production in Egypt is said to exceed 6,500,000 lbs.; 2216 cwt., valued at 3545*l.*, were shipped from Morocco in 1873.

Henna is largely used throughout Turkey, Egypt, Syria, Persia, and India, as a substantive dye-stuff. It is but slightly, if at all, soluble in cold water, but warm water into which a little lime has been thrown readily dissolves out the colouring matter.

Henna is cultivated on a large scale at Touat; a portion of this region bears the significant name of the Henna Touat. The caravans of Sahara supply all the Moghreb with it, and great use is made of the plant as a cosmetic. European industry obtains from it a good black dye. It is sold at Touat, 0·10 to 0·20 centimes for the rotal of 1500 grammes.

Henna appears to have been known in India in the time of Arrian, as may be inferred from his statement that the people of India daub their beards white, red, purple and green. It is used by the western Hindoos, and the plant is abundantly cultivated in the vicinity of Bombay. It is generally planted in India in the gardens and fields around houses for the aroma of its flowers. It blooms all the year round, and forms hedges in some places. The leaves are used to dye the hair and skin, and it is also employed to tinge the nails and the skin of the Indian women, especially those of the Mussulman race; it is mixed with catechu. Medicinal properties are also attributed to it; the natives use it in cutaneous affections, in epilepsy and jaundice.

The Turks and Arabs are very fond of dyeing the manes, tails and hoofs of their white or grey horses of a fine mahogany brown with henna. They also use it for their own braids of hair, a fine natural black being afterwards obtained by a second dyeing with indigo.

Henna has been known from antiquity, and sought for the perfume of its flowers. These are employed to scent the oils and pomades used to anoint the body and give it suppleness. It was also used for embalming, as the heads of flowers have been found in mummy cases. The ancients prepared with the leaves a powder called Archenda, now known as henna. The females use it to improve their appearance, and to colour their hands, feet and nails, of a rose-orange, a custom formerly very extended, but which is not now so fashionable in the East.*

Some botanists enumerate two species, *L. inermis*, and *L. spinosa*, while others hold that, although the leaves of the former are larger than those of the latter, they are both the same species, in spite of one bearing thorns and the other not. The best henna comes from Mecca, and is brought to Constantinople by returning pilgrims. In general appearance it closely resembles the common privet. It is propagated by cuttings planted in shady situations, and is a fast-growing shrub; when the shoots reach the length of about 3 feet, they are cut with a sickle and stripped of their leaves, which are dried in the sun and finely powdered in a kind of rude hand-mill. In about two months or so, when a fresh set of shoots have reached the proper size, a second gathering is made, each plant yielding two or even three crops a year. If the plant is cultivated for the sake of the flowers, the shoots are allowed to grow to the length of 5 or 6 feet before they are cut. The fresh flowers, which give out a delicious odour, have been sold in the streets of Alexandria and Cairo from time immemorial.

Alkanet Root.—The dark blood-red root of *Anchusa* (*Alkanna*) *tinctoria*, growing on sandy places around the Mediterranean Sea, enters into commerce to a small extent. It is insoluble in water, but soluble in alcohol, ether, and bisulphuret of carbon. It is not at the present day employed as a dye-stuff, its chief uses being in pharmacy to colour medicines; in perfumery to colour oils and greases, to stain woods, and to give a tint to the lime-wash used for the walls of private dwellings.

In China this root is used to bring out the eruption in smallpox and to colour candles. It fetches from 35 to 44 dollars the picul; in London it sells at 29*s*. to 31*s*. the cwt.

* 'Chemist and Druggist,' 1876, p. 388.

SECTION V.

THE OIL SEEDS AND VEGETABLE OILS OF COMMERCE.

Great as has been the extension of commerce and the progress of our foreign agricultural supplies, the Oil Seeds of commerce are yet far from commensurate to the increasing wants of Europe. It is therefore a wise provision that new discoveries crop up from time to time, arising from the progress of scientific research, or the extension of foreign agriculture to meet in some measure these increased demands. When the oils yielded by the whale fishery declined, and by their enhanced price became too expensive for manufactures, increased attention was given to the production of vegetable oils, and larger quantities of oil seeds for crushing, from Europe, Africa and the East, were obtained. Even these were found insufficient for the increased demand, till the discovery of the mineral oil springs came in to supply the wants. The vegetable oils, however, provide, and will long continue to do so, the bulk of the consumption.

In the section on "The Useful Palms," some of the chief vegetable oils, such as Cocoanut oil and Palm oil, have already been described, and I now proceed to notice others.

The Olive.—The olive (*Olea Europea*) is supposed to have been originally a native of Asia, and grows abundantly about Aleppo and Lebanon, but it is now naturalized in Greece, Italy, Spain, and the South of France, where it has been extensively cultivated for an unknown length of time, for the oil expressed from its fruit. The wild olive is found indigenous in Syria, Greece, and Africa, on the lower slopes of the Atlas. The cultivated one grows spontaneously in Syria, and is easily raised on the shores of the Levant. Much attention has, of late years, been paid to olive culture by the French in Algeria. Tuscany, the South of France, and the plains of Spain, are the parts of Europe in which the olive was earliest cultivated. The Tuscans were the first who exported olive oil largely, and thus it has obtained the name of Florence oil; but the purest is said to be obtained from Aix in France.

The olive in the western world followed the progress of peace, of which it was considered the symbol. Two centuries after the foundation of Rome, both Italy and Africa were strangers to that useful plant: it was naturalized in those countries, and at length carried into the heart of Spain and Gaul. Its usefulness, the little culture it requires, and the otherwise barren situations which it renders productive, quickly spread it over the western face of the Apennines. According to Humboldt the olive is cultivated with success in every part of the old world where the mean temperature of the year is between 58° and 66°; the temperature of the coldest month not being under 42°; nor that of summer below 71°. These conditions are found in Spain, Portugal, the South of France, Italy, Turkey, and Greece. The olive also flourishes on the north-west of Africa, but is not found south of the Great Desert, except in parts of the Cape Colony, where it has been introduced or grafted on indigenous species.

In Europe it extends as far north as latitude 44½°, in America scarcely to latitude 34°—so much greater is the severity of the winter on that side of the Atlantic. In the neighbourhood of Quito, situated under the equator, at a height of 8000 feet above the level of the sea, where the temperature varies even less than in the island climates of the temperate zone, the olive attains the magnitude of the oak, yet never produces fruit.

Olive oil may be said to form the cream and butter of those countries in which it is pressed; the tree has been cultivated in all ages as the bounteous gift of heaven, and the emblem of peace and plenty. There is a common saying in Italy that "if you want to leave a lasting inheritance to your children's children, plant an olive."

In Italy the young olive bears fruit at two years old; that is in two years after it has been placed in the plantation. In six years it begins to repay the expense of cultivation, if the ground is not otherwise cropped. After that period the produce is the surest source of wealth to the farmer.

The exports of olive oil from the principal producing countries are as follows, according to the latest returns:

Spain, 1873	52,129,000 kilos.
Italy, 1873	60,260,500 „
France, 1875	3,600,000 „
Greece, 1873	9,213,257 ocques.
Tunis, 1873	3,472 tuns.

We receive supplies from Portugal, Spain, Italy, the Austrian territories, Greece, Turkey, Tripoli, and Tunis, Morocco and other countries.

Imports of olive oil into the United Kingdom:

	Tuns.		Tuns.		Tuns.
1840	8,783	1853	10,102	1865	32,005
1841	4,734	1854	12,888	1866	23,690
1842	14,095	1855	25,449	1867	19,993
1843	12,094	1856	21,415	1868	17,585
1844	14,962	1857	18,862	1869	28,240
1845	12,315	1858	25,121	1870	23,202
1846	8,534	1859	19,786	1871	38,281
1847	8,692	1860	20,859	1872	24,025
1848	10,086	1861	17,325	1873	35,121
1849	16,964	1862	21,095	1874	22,720
1850	20,784	1863	19,866	1875	35,453
1851	11,503	1864	16,705	1876	23,975
1852	8,898				

There are two plants covering all the Peninsula—the vine and the olive tree. They grow alike luxuriously in the cool north, on the shores of the Po, and in the sunny south, where their green leaves form the ornament even of Vesuvius and Etna.

The olive tree demands a dry and limy soil; its introduction into Italy was therefore very successful. The soil of the Apennines, which extend through the whole Peninsula and branch off in all directions, consists mostly of lime, and is very favourable to the growth of the olive tree. We find the stately tree, with its beautiful crown and evergreen leaves, spread over the whole Peninsula where the temperature does not fall below 60°.

The best olive oils of Italy come from Genoa, Lucca, and Tuscany, but excellent qualities are drawn from the Neapolitan country and Sicily. The total production was estimated in 1862 at 1,767,000 hectolitres, including the frullino oils, which are thick, coloured, and only applicable to industrial purposes, and the oils obtained from the residues, which are treated by sulphide of carbon. The fine and ordinary oils are clear, limpid, and of excellent flavour. The mean production of fine oil is estimated at 13,000,000 of kilogrammes, and of ordinary at 9,000,000.

The exports have been as follows:

	Kilos.		Kilos.
1871	12,161,000	1874	26,544,000
1872	20,668,000	1875	6,007,000
1873	52,129,000		

The most extensive use is made of the olive. Its harvest begins when scarcely ripe. The green olives are put into a solution of salt; they are kept there for some time, to cause them to lose their natural bitter taste, then carefully preserved in vinegar, mixed with different spices, and sold in bottles or small barrels. Those of Tuscany and Lucca are considered the best, on account of their light green colour and strong flesh. In all parts of southern Europe they are, in this form, a daily food.

The treatment of the ripe olive is more important. They are gathered in the fall, when they are as large as common plums; their colour is dark green, and the soft kernel has changed into a hard stone, which contains a savoury almond. The flesh is spongy, and its little cells are filled with the mild oil, which pours out at the least pressure.

The olive tree bears about ten pounds of fruit, but in very rich years double that quantity can be gathered. The finest oil is the so-called virgin oil. To obtain the oil no preparation is needed; the freshly gathered olives are put into little heaps, and by their own weight the oil is pressed out, and is caught in some vessel. It is clear, like water, has a delicate nut-like taste, with little or no odour. When the fruits cease to give the oil by themselves, they are pressed with small millstones. The oil gained by this process is also clear and of pleasant taste. After this treatment the olives are still rich in oil, which only demands some work to draw it out. To accomplish this, the fruits are put into sacks, boiling water poured over them, and they are pressed once more. The oil gained by this process is yellowish-green, has a sharp taste, and an unpleasant smell, because it contains some mucilaginous matters. Sometimes the so-treated olives are once more pressed and boiled over; the oil thus obtained is called in France "huile d'enfer," and is only used for burning or similar uses. The olives may also be brought to a fermentative process, before pressing them, which gives more oil, but of a less fine quality.

At Marseilles the olive oils are classed into manufacturing oil, for burning or for factories, refined, oil from the pulp or husks, and table or edible oil. The latter is divided into superfine, fine, half fine, and ordinary. The quantity taken for consumption of the different kinds was as follows:

	1874.	1875.
	kilos.	kilos.
Refined oil	3,200,000	6,200,000
Oil of pulp or husks	1,500,000	2,600,000
Manufacturing oil	3,000,000	5,700,000
Exported	4,000,000	3,600,000

The imports at Marseilles were 15,200,000 kilos. in 1874, and 22,600,000 in 1875.

The Italians keep their oil in stone jars, as did their classic ancestors. The oil for sale is filled into barrels of oak wood imported from Germany. The oil needs always a very attentive treatment. By a long rest some slimy part of it settles at the bottom; these dregs must be removed, or the oil would become rancid; therefore the barrels are tapped every six months, and filled anew. The treatment resembles that of wine, but with this difference, that oils of a finer quality can seldom be kept more than three years.

The oil made in the district of Oneglia is better than that of Southern Italy, and large quantities are refined before being exported. The process of refining the oil is very simple. Large shallow tin boxes are made, with small holes pierced in the bottom; this is then covered with a thin sheet of wadding. Four, five, or more of these boxes are placed on frames, one over the other, and the oil being poured into the top box, is allowed to soak through the wadding and drop into the next box, and so on until it gets into the last, when it runs off into the tanks. The wadding absorbs all the thick particles contained in the oil when it comes from the mills, and leaves it perfectly clear and tasteless. The oil thus refined is almost exclusively exported to Nice, where it is put into flasks, and sent all over the world as "Huile de Nice."

From the island of Crete about 2250 tuns of olive oil are shipped, valued at 100,000*l*., and 77,000 cwts. of soap, worth as much more.

Balearic Islands.—The tree upon which the olive is grown is found wild in the mountain lands in these islands, as a shrub, producing a fruit which bears no oil. When brought under cultivation grafting is practised. In countries where more care is exercised in the preparation of olive oil than is displayed here, the "virgin oil" obtained from the fruit when first pressed is carefully separated, as being of a better quality than that which is procured by the application of hot water to the bruised fruit, and by the application of greater pressure. But the quantity of virgin oil produced in these islands is quite insignificant, although it is of excellent quality. All the oil that can be squeezed out of the olives by means of the antiquated machinery still in use is generally poured into one common tank and left to clarify as best it may; or, at most, the olives are roughly sorted, the inferior ones being made into oil for the soap-boilers. The fruit, whether ripe, over-ripe, half-green, or wholly rotten, or whether it may have been knocked down by the beaters' canes, or blown down by the wind and rain in stormy weather, and trodden under foot, is too commonly all picked up about one time by the women and children who are employed at the gathering season. It is then, after being sorted or not, as the case may be, crushed under the millstone, and the oil drawn by the application of boiling water. The refuse of the olives after the last crushing, which is far from getting out all the oil contained in the pulpy mass, is used to feed the fires required to boil the water. Probably, nowhere may be seen more magnificent olive trees, or better olives, than those grown in these islands; but the oil, from being unrefined, is often acrid in taste and inferior to that of other countries.

Syria.—Olive oil is produced throughout the country, but chiefly on the plains of Safet, Nazareth, and Nablono. The average produce is estimated at about 7000 tuns. In 1871 about 1800 were exported, and prices ranged from 60*l.* 10*s.* to 41*l.* 10*s.* per tun. The plantations are being extended principally on the coast line between Latakia and Jaffa, the climate of which is peculiarly adapted for olive cultivation. Nearly half a million of new trees are said to be annually planted throughout the country. The quality of the finer sort of oil is found equal to the Italian, while that from the neighbourhood of Sidon is said to rival the finest qualities that Europe can produce. About one half of the oil is consumed in soap-making, one quarter in eating and burning, and the remaining quarter is exported chiefly to France. The oil press used is the rude native one, and there is but one European press in the country.

The exports of olive oil from Greece were in—

	Ocques.		Ocques.
1871	9,213,257	1873	6,384,471
1872	2,592,543	1874	2,919,421

Like most other trees that have been cultivated for a length of time, the olive has produced numerous varieties; different countries, or even different districts, cultivating their peculiar favourite.

The variety *longifolia* and its many sub-varieties are chiefly cultivated in France and Italy; the variety *latifolia* and its sub-varieties are those chiefly cultivated in Spain; the fruit of the variety *latifolia* is nearly twice the size of the common olive of Provence and Italy, but the oil is greatly inferior.

There are several varieties of olive, differing less in their fruit than in the form of their leaves: two of these have been introduced into the Cape Colony, one of them from England, by Mr. Thomas Berry, in the year 1821, and the other variety, I believe, from France, since that period. The European olive may be propagated in various ways. Cuttings of nine inches in length, taken from one year old shoots, may be planted in a rich light soil, and kept moderately moist; the ground ought never to be allowed to become very dry; these will root freely in a few weeks, and be fit for transplanting in twelve months. In Italy the propagation is conducted in the same manner in which it was during the time of the Romans.

"An old tree is hewn down, and the 'ceppo' or stock (that is, the collar or neck between the root and the trunk, where in all plants the principle of life more eminently resides), is cut into pieces of nearly the size and shape of a mushroom, and which from that circumstance are called novoli; care at the same time is taken that a small portion of bark shall belong to each novoli; these, after having been dipped in manure, are put into the earth, soon throw up shoots, are transplanted at the end of one year, and in three years are fit to form an olive yard."* Truncheons, or stakes of the olive, 2 inches thick and 5 feet long, may be driven into the ground where they are intended to remain, and root freely. Shoots of one or two years' growth may be laid down, giving them a twist to crack the bark; or slit them half-way through, when they root very readily. These operations should be performed in the month of August.

In France and Italy uncertainty prevails in the crops of olives; sometimes one that yields a profit does not occur for six or eight years together; and hence it is considered that the culture is less beneficial to the peasants of those countries than that of corn; but these circumstances do not appear to apply to the southern colonies, especially as the olive may be cultivated on ground which is impenetrable to the plough or spade.

France.—The olive is grown in 12 departments, all situated in the south; the departments where it is chiefly cultivated are: Var, Vaucluse, Bouches du Rhône, Gaud, and Alpes Maritimes. The extent of land occupied with this tree in 1871 was 129,143 hectares. The production in fruit amounted to 2,402,610 hectolitres. Allowing from this 15 per cent. for fruit eaten locally, there would remain 2,000,000 hectolitres converted into oil, which produced 260,000 cwts., valued roughly at 36,920,000 frs.

The olive tree is almost the only product of a large portion of the mountainous district of Nice, and produces (where there is no possibility of other produce requiring tillage and husbandry) a small return for the labour bestowed on the trees and the manufacture of the oil. Each small proprietor takes his olives as he gathers them to a mill in small quantities, using it in common with his neighbours, and paying for its use a percentage of his oil, and the refuse of his olives and the oil is taken to market for sale in small quantities, according to the daily produce.

More than 15,000 acres are planted with this tree in Nice, producing on an average 180,000 to 200,000 gallons of oil. The tree grows well even at great elevations above the sea, and will stand

* Blunt's 'Vestiges,' &c, p. 216.

10 degrees of cold; but the produce is uncertain, on account of the length of time which the fruit remains on. The olive tree grows slowly, and yields no crop until it is twenty years old. The olives are collected about December by beating the trees, a mode of treatment that bruises the fruit and injures the quality of the oil; in fact, neither olives nor oil are ever so good as when picked by hand. There are 168 oil mills in the district, 115 worked by water, the others by horse-power. Ten gallons of good olives will yield 1 to $1\frac{1}{2}$ gallons of oil, but the average quantity is about 10 per cent. There are very nearly 800,000 olive trees in the country of Nice, and each tree will give in a good year from 50 to 150 kilos. of olives, according to size.

There are five kinds of olive trees principally cultivated in the south of France, viz., Verdall, which yields good oil, and makes a good conserve; Blanquet, with a particularly sweet and delicate oil (these two have low-growing branches, which enables them to be picked by hand); Bouquettier, a very superior oil; Redouanou, which stands cold well; Olivier de Grasse yields excellent oil, but grows high, and is not so well adapted for picking.

Spain.—The oil from the olive holds a considerable place in the agricultural produce of Spain. It is calculated that 1,000,000 hectares are planted in olives. The oil is employed for every conceivable purpose, and although the consumption is very great, yet the exports increase year by year. Like the vine, the Spaniards are equally careless cultivators of the olive, and from want of attention the quality of the fruit is injured and the yield of oil reduced. During harvest time there is often a deficiency of labour, and after having knocked down the olives, it is customary to leave them in great heaps, there to shrivel up and ferment until the winter before extracting the oil. This renders the very best oils unfitted for use in the *cuisine* of any other country except Spain, where the tastes of the inhabitants are peculiar. There is no doubt that whenever the extraction of the oil is made at the proper season, and precautions are taken to avoid rancidity, there will be obtained in Spain oil equally good for the table as is to be procured even in Provence.

Algeria.—The climate here is especially suited to the olive, which grows spontaneously at all points of the three provinces. According to the latest details there are over 3,000,000 olive trees, the half of which are grafted. It may be remarked here that though the fruit of the grafted tree is larger and more fleshy, and contains therefore more oil, that of the wild olive tree yields a finer and pleasanter kind. The production of oil is increasing yearly, and there are improvements noticeable in its quality. The province of Constantine furnishes annually about 150,000 hectolitres, of which one-third is exported. And although there are no precise details as to the other two provinces, the production in these is equally considerable.

Morocco.—The olive gardens of the south form picturesque groves of great extent. Their produce constitutes the principal wealth of the provinces of Haha and Sus. But the oil, probably from the imperfect methods of preparing it, is greatly inferior to that of Spain and Italy. It is, however, exported from Mogador in large quantities.

Tunis.—Susa, Monastir, Media, Sfax, and Biserta, are the best olive districts in the Regency, there being at the former place upwards of 4,000,000 trees, and if the cultivation were more energetically attended to double the crops could easily be produced. The olives are gathered in December and January, the pickers using leather coverings to the fingers. There are two kinds of oil, the "masri," strong in flavour and smell, and the "drup-el-ma," which is deprived of both by being passed through water.

In the ten years ending with 1871 the quantity of oil shipped from Tunis amounted to 2,639,050 metalli, valued at 100,000,000 piastres. Italy and France receive the largest quantity, England and Austria rank next in order. In 1873 the shipments were 3472 tuns, valued at 125,893*l.*

Linseed Oil is obtained from the seed of the flax plant (*Linum usitatissimum*), formerly called lint-seed. We used to obtain almost all our supply of the seed from Russia, but now we get a good deal from India. Of the imports in 1875, 369,163 quarters came from India, and the rest from the Continent, chiefly Russia. The aggregate value of the seed received was 4,675,242*l.* As a general rule, the colder the climate in which the seed is grown the greater are the drying properties of the oil, although it is not so good in colour. The East Indian seed is much mixed with rape and other seeds.

There are two varieties of this oil. The most valuable is the "cold drawn," which is extracted by cold pressure, and is paler, less odorous, and has less taste than that obtained by the aid of heat. By cold expression, the yield of oil is from 21 to 22 per cent. of the seeds; with the aid of heat, combined with a powerful and long-continued pressure, as much as 28 per cent. can be obtained. If a very fine oil be required, the process of cold expression must be pursued; and as the utmost degree of purity is the great desideratum in varnish-making, this quality is generally employed by makers of high-class varnish. A very good oil, however, may be obtained by a steam heat not exceeding 200°.

The *marc* remaining after the expression of the oil is generally known as oilcake, and is an article of great importance to the agriculturists of those countries in which flax is grown, being extensively employed, especially in the winter season, as food for cattle.

The mode of expressing the oil is as follows: The seed is first passed between iron rollers, in order to crack the husks. They are then introduced into a hopper, through which, by means of a fluted roller, they are caused to descend between the crushing rollers, after passing which they fall into a receiver. They are then passed on to two vertical granite mill-stones, which bruise them to a pasty mass, and this is then heated to a greater or less extent by being placed in pans over an open fire, or in connection with steam or boiling water.

The object of the heat is to coagulate the albumen contained in the seeds and render the oil more limpid, and, therefore, more easily expressed. The mass is then transferred to a hydraulic press. The method of pounding the seed in hard wooden mortars, with pestles shod with iron, and set in motion by cams driven by a shaft turned by horse or water-power, was formerly used. The bruised seed was then transferred to woollen bags, which were wrapped in horsehair cloth and squeezed between upright wedges in press-boxes. This arrangement, known as the Dutch mill, is still obstinately adhered to in some districts of England and the Continent, it being supposed to be preferable to the hydraulic mills and presses, which have in modern times almost entirely superseded the old method.

The manufacture of linseed oil in 1860 was estimated at 65,000 tuns, of which 33,700 tuns were exported. As our imports of linseed are now half as much more than they were in 1860, the make of oil must proportionately larger.

Imports of linseed and flax seed into the United Kingdom:

	Quarters.		Quarters.
1840	444,759	1870	1,490,695
1850	608,984	1875	1,961,987
1860	1,330,623	1876	1,998,130

We exported in 1876 18,206,860 gallons of seed oils, valued at 1,898,830*l.*

In France there were in 1871 67,216 hectares under culture with flax and hemp, grown for the seed, which produced 567,693 hectolitres, of which 154,881 were reserved for sowing, and the rest converted into oil. A hectolitre of seed yields, on the average, a little more than 17 kilos. of oil and 32 kilos. of oilcake. Setting aside the less important usages of linseed, &c., and supposing the whole converted into oil, the following results are arrived at in the official French statistics:

Production of oil 70,303 metrical quintals, of the rough value of 6,817,529 francs; oil-cake of the rough value of 2,554,519 francs; total, 9,372,048 francs = 374,881*l.* The departments which principally produce this oil are Pas-de-Calais, Somme, Nord, Maine et Loire, Vendée, Haute Marne, Haute Garonne, and Lot-et-Garonne.

THE GROUND-NUT.—The plant (*Arachis hypogœa*) which produces the fruit, entering into commerce under the popular name of the ground-nut, is a little annual, with oblong leaves, growing in fours, and rather large yellow flowers, rising a little way above ground. It is one of a class which bury their pods in the earth, where they ripen, instead of raising them into the free air. In order to effect this, the flower-stalk, after the flower has passed away, gradually curves downwards, and at length forces its end perpendicularly into the soil, along with the very young pod which is seated there. Having buried itself sufficiently deep, the pod then begins to swell, and when ripe becomes an oblong, rugged, pale-brown fruit, containing about two seeds, as large as the kernel of a hazel-nut. It is now found in a state of cultivation all over the hottest part of the tropics. It was unknown until the discovery of America, and every region in the old world where it is now grown owes it to Brazil; so that we have in this plant a further example of the rapidity with which vegetables will take possession of soils where the climate is suitable, for it is grown very generally in different parts of Africa, in India, the West India Islands, and the United States. For the purposes of commerce, it is principally raised on the West Coast of Africa, in different quarters, from Senegal to Sierra Leone and the Gambia. Marseilles is the chief port to which they are shipped, and the following have been the imports.

The following shows the imports of ground-nuts into Marseilles in the last twenty years in metrical quintals:

Year.	In Shell.	Year.	In Shell.
1855	225,290	1866	298,170
1856	270,746	1867	403,020
1857	260,425	1868	423,370
1858	250,245	1869	329,070
1859	211,700	1870	417,650
1860	216,570	1871	419,120
1861	175,390	1872	435,890
1862	281,430	1873	445,760
1863	237,460	1874	624,650
1864	277,700	1875	559,430
1865	321,890		

Besides this quantity, 50,000 to 60,000 metrical quintals are imported shelled or husked. The imports of shelled nuts in 1875 were 64,000 metrical quintals.

Commencing with an export in 1837 of 671 tons, valued at 8053*l.*, the average annual shipment of ground-nuts from the Gambia between 1850 and 1860 was 11,196½ tons. In some years, as in 1871, it reached nearly 17,000 tons. The average of the four years ending 1873 was 13,748 tons per annum. The bulk is sent to France.

The ground-nut is principally cultivated down the borders of the river, and in British territory by the Serrawoolies. They are a nomadic tribe of Mohammedan farmers of the Senegambia; they leave their wives and children far up the country, and wander to the seaboard in search of fallow ground, to be left again as soon as the crops have worn out the soil. The native has unfortunately introduced, of late years, the pernicious system of beating, or threshing, instead of picking by hand, whereby the nuts are mixed with leaves, stalks, stones, and other extraneous substances, causing large deductions in the French market, and depreciating their value in the United States as an article of food, or, better to be described, as a favourite dessert for the tables of the rich in the latter country. The resident native, the Jolloffe, or the liberated African, surrounded by his Lares and Penates, in the shape of women, children, and domestic servants, or slaves, takes his time to pick the nuts, saving the haulm for the Bathurst market, where it meets with a ready sale as fodder for horses; but the Serrawoolie, who is anxious for quick returns, has not the time, and certainly not the energy, to pick two acres of ground-nuts between December and May, land which he can easily dress, work, and sow in June and November, hence he loses the fodder, but brings a larger quantity of nuts to the market.

Hand-shelled nuts may be advantageously used in Europe for eating and by confectioners, but those machine-shelled are only fit for oil-crushing and cattle-feeding purposes. The oilcake of the nuts when pure is highly esteemed for its fattening properties; horses, cattle, pigs, and poultry are very fond of the ground-nut in its natural state. A heaped imperial bushel of the nuts weighs from 25 lbs. to 32 lbs. Divested of their shell (1 per cent. of the weight) the kernels furnish as much as 45 to 50 per cent. of oil.

Owing to disturbances, the quantity exported from the Gambia fell off somewhat in 1872, the shipments being 13,000 tons, valued at 140,000*l.*, or 40*l.* per ton; the trade employs 15,000 tons of shipping from Bathurst.

The exports from the Gambia have been as follows:

Year.	Quantity.	Value.
		£
1858	15,729 tons	188,747
1859	8,593 „	68,745
1860	9,951 „	79,612
1864	635,206 bushels	79,431
1865	754,451 „	94,306
1866	1,309,097 „	130,910
1867	1,530,573 „	191,322
1868	1,288,937 „	161,117
1869	741,756 „	83,447
1870	13,481 tons	121,329
1871	17,000 „	..
1872	13,000 „	140,000

Our direct imports of ground-nuts from Sierra Leone, which used to average about 1000 tons annually, have ceased altogether, as they go now entirely to France. The exports from that colony were, in:

Year.	Quantity.	Value.
	bushels.	£
1858	147,750	14,449
1859	262,846	25,576
1860	471,509	34,514
1863	333,178	35,170
1866	218,845	28,840
1867	398,272	46,945
1868	547,528	57,221
1869	..	60,635
1870	713,524 and 350 tons	95,605

Besides the great value of its seeds for oil, this is also a good fodder herb. The plant is a very productive one, and yields a quick return. A light, somewhat calcareous, soil is best fitted for its growth. On such soil 50 bushels may be obtained from the acre. In tropical countries half a ton weight of seeds or nuts is obtained.

The oil is used for alimentary purposes, and for cloth-dressing, but its chief use is for the manufacture of soap, and for lubricating machinery. As a lamp oil it burns longer than olive oil, although its illuminating power is less. Compared with ordinary burning oils its power is feeble. It has the advantage, however, of keeping a long time without becoming rancid.

Under favourable circumstances, the nuts will produce half their weight of oil, and the quantity is much increased by heat and pressure. In India the mean yield of oil is only 37 per cent. at Pondicherry, and 43 per cent. in Madras. In Europe it is usually found that a bushel of ground-nuts produces one gallon of oil when expressed cold; if heat be applied a larger quantity is obtained, but of inferior quality.

In Brazil this seed is known under the name of "amendoum," and has long been used there parched for food and to extract oil from. The oil is used for cooking, medicinally for rheumatic affections, and for lighting. It is sometimes called pindar nut.

The roasted seeds are sometimes used as a substitute for chocolate; according to Dr. Davey, they abound with starch, as well as oil, a large proportion of albuminous matter, and in no other instance had he found so great a quantity of starch mixed with oil.

Dr. Muter, after giving the following analysis of ground-nut meal, urges its more general use as an important article of food:

Moisture	9·6
Fatty matter	11·8
Nitrogenous compounds (flesh formers) ..	31·9
Sugar, starch, &c.	37·8
Fibre	4·3
Ash	4·6
Total	100·0

From this analysis it is evident (he observes) that the residue from them, after the expression of the oil, far exceeds that of peas, and is even richer than lentils in flesh-forming constituents, while it contains more fat and more phosphoric acid than either of them. On these grounds we are justified in urging the adoption of the ground-nut meal as a source of food, it being superior in richness of all important constituents to any other vegetable products of a similar nature. Although in the raw state it possesses a somewhat harsh odour, similar to that of lentils, this flavour entirely passes off in cooking, and when properly prepared it has a very agreeable flavour.

This seed is held in such estimation for eating in the United States (where it is known as the "pea nut"), that flourishing sale-stands are seen at almost every street corner of New York. They are not much appreciated in England, except by children.

There are fully 550,000 bushels sold annually in the city of New York alone. Previous to 1860 the product in the United States did not amount to more than 150,000 bushels, and of this total nearly five-sixths were from North Carolina. Formerly it was largely imported into America, now they are supplied by the home crops raised in Virginia and the Carolinas.

It was estimated that Virginia, Tennessee, Georgia, and Carolina sent conjointly over 1,000,000 bushels to market in 1870, of which one-fourth went to New York. As much as 10*s.* to 12*s.* is paid for the bushel. The yield is from 80 to 120 bushels on an acre.

The ground-nut is now cultivated on a large scale in India, where the seeds form a considerable article of commerce, and there is also a quantity of the oil exported.

From Pondicherry there was exported in 1858, 8155 sacks; in 1859, 3269 sacks; and in 1860, 4739 sacks of ground-nuts; and of the oil, 45,634 veltes (of 1·64 galls.) in 1858; 72,369 veltes in 1859; and 99,330 veltes in 1860.

Ground-nut oil is used in parts of India for alimentary purposes; in some countries it is sold for olive oil; in North Arcot it serves to adulterate gingely or sesame oil, and at Pondicherry it is mixed with cocoanut oil.

At Mozambique the ground-nut is also largely grown, the price of the oil made from it there is 15 francs the decalitre. From Senegal there were exported to France in 1874, 11,483,080 kilos. of ground-nuts, valued at 3,789,416 francs; besides 33,792 kilos. to foreign countries, and 1,333,556 kilos. unshelled.

Senegal and its dependencies, which exported in 1840 but 1210 kilos. of ground-nuts, now produce more than 12,000,000 kilos. Cayor and Casamance furnish the largest quantities; but some cargoes are also sent from Galam, which are more esteemed than from the other localities, on account of the thinness of the husk or shell and the superior yield of oil. It is one of the principal resources of the country, and the production is annually more and more extended, notwithstanding the impediments which the Moors throw in the way of its traffic, under the dread that their gums might be neglected. The principal market for Senegal proper is the large village of Gandiole. About Goree, the centre of supply is Rufisque; lower down Sedhiou and Carabane in Casamance, and Albreda, on the Gambia. At the Gaboon, where the population is thinly scattered, and little agricultural, all that is produced is locally consumed.

According to Dumas, it was a Marseilles house that first thought of introducing this substitute for olive oil. They commenced by experimenting with a few kilos., and now the imports into France exceed 55,000 tons, of an oil-seed unknown to commerce forty years previously.

Cotton-seed Oil has been produced in Egypt, France, England, and the United States; but until lately not on a very large scale, or for commercial purposes. Each pound of ginned cotton produced yields 3 lbs. of seed; the total amount in the United States is 3,600,000,000 lbs. One half being retained for planting, there remain 1,800,000,000 lbs. which might be manufactured. One hundred pounds of cotton seed will yield 2 gallons of oil, 48 lbs. of oilcake, and 6 lbs. of soap stuff; the total estimated value of all which is upwards of 7,000,000*l.*, very little of which is at present realized. The oil possesses excellent lubricating qualities. Soaps of every variety are made from it, and in New Orleans it has been used, with commendation, as a substitute for olive oil.

Numerous factories for the local manufacture of oil from cotton seed are now at work in the South, and a ready sale is found for the oilcake in the Northern States and in Europe, the product being of much value in feeding stock. The oil is one of the most useful of the vegetable oils, and brings, in New York, from 18*d.* to 20*d.* per gallon. The total production of cotton seed in the Southern States is about 2,230,000 tons, of which nearly one-third is produced in the valley of the Mississippi. The market price for the seed is $12 to $13 per ton.

Cotton seed is becoming one of the principal articles of export from Egypt. It has gradually risen from 1090 cwts. in 1860 to 3,490,080 cwts. in 1873, of the value of 770,000*l.* England takes nearly all of this.

Mr. McLagan, in the 'Edinburgh Quarterly Journal of Agriculture' for July, 1854, gave some interesting details respecting the feeding properties of the oilcake from cotton seed. Cattle do not take to it at first, but eventually get to like it and thrive upon it.

About 27 imperial stones of cake are obtained from 4 cwts. of seed.

The following figures show the quantity of cotton seed we have imported of late years. This seed was not separately enumerated before 1861:

	Tons.		Tons.
1861	20,034	1869	105,646
1862	33,162	1870	120,304
1863	62,159	1871	172,163
1864	84,642	1872	167,904
1865	114,851	1873	207,038
1866	93,957	1874	190,591
1867	93,643	1875	202,205
1868	94,759	1876	230,284

Oil-seed Cake.—The oilcakes imported are all classed together; there is, however, a large home trade in those resulting from the British crushing mills. The marcs or cakes include ground-nut cake, palm-nut cake, linseed cake, cotton-seed cake, and cocoanut cake, used for cattle food; and mustard, rape, castor oil, and undecorticated cotton-seed cake used for manure.

The following shows the progress of our imports of foreign oil-seed cakes:

	Tons.		Tons.
1840	71,039	1870	158,453
1850	65,145	1875	180,379
1860	108,826	1876	190,225

THE CASTOR OIL PLANT (*Ricinus communis*).—Although a native of India, this shrub is now widely distributed and cultivated in various parts of the world. In its native country it is a perennial, 15 or 20 feet high, with a thick stem. In cold climates it becomes an annual. There are many instances of perennial plants becoming annuals by change of climate.

The rapid growth of the plant is illustrated by an instance reported in Tennessee. A castor bean was planted in May, 1871, in a garden in Memphis, and in November it had grown to the height of 23 feet, with a spread of foliage 15 feet in diameter. The trunk, 10 inches above the ground, was 18 inches in circumference.

There are many varieties of this plant, but they are generally believed to be derived from a single species. The most notable are, *Ricinus sanguineus*, the stem, leaf stalks, young leaves, and fruit of which are of a blood-red colour; *R. Borboniensis*, which in southern climates attains a great height; and *R. giganteus*.

The following varieties may be enumerated, although described by some as species:

1. *Ricinus communis*, Lin., the most widely diffused, with glaucous-purple stems.
2. *R. inermis*, Jacq., a native of India.
3. *R. viridis*, Willd., also an Indian species.
4. *R. lividus*, Jacq., Cape of Good Hope.
5. *R. integrifolius*, Willd., Mauritius.
6. *R. speciosus*, Willd., Java.
7. *R. apelta*, Lour. (*Rottlera cantoniensis*), China.
8. *R. mappa*, Lin. (*Mappa moluccana*), Amboyna.
9. *R. tanarius* Linn. (*Mappa tanaria*), Amboyna.
10. *R. armatus*, or *communis*, Andrw. Malta.
11. *R. dioicus*, Forster (*Mappa tanensis*), islands of Southern Seas.
12. *R. tunisensis*, Desfont, Algeria.

The castor oil plant has been known from the remotest ages. Caillard found the seeds of it in some Egyptian sarcophagi, supposed to have been at least four thousand years old. Some people imagine it to be the same plant that is called the gourd in Scripture. It was called *aporave* by the Greeks, and *ricinus* by the Romans; in Hebrew, kikajon, and called by Pliny cici or kiki. It is singular that the oil expressed from the seeds of the cici should have been used by the ancients, including the Jews, as one of their pleasantest oils for burning and for several domestic uses, though its medicinal virtues were unknown. The modern Jews of London use this oil by the name of oil of kiki for their Sabbath lamps, it being one of the five kinds of oil their traditions allow them to burn on such occasions. The seeds are oval, somewhat compressed, about 4 or 5 lines long, 3 lines broad, and 1½ line thick; externally they are pale grey, but marbled with yellowish-brown spots and stripes.

The oil is obtained from the seed by expression, by boiling with water, or by the agency of alcohol. Nearly all that is consumed in England is obtained by expression. When the outer skin is first removed by rollers, previous to crushing and heating them, a clear and fine oil is produced, the outer cuticle being applicable for manufacturing and other purposes. By this process the thicker portion, or stearine, which is now lost (by being mixed and left with the outer skin or cuticle), is obtained, and the oleaginous or thin portion of the oil is not coloured and deteriorated. The oil thus obtained can be purified by jets of gas, acids, and heat, at about 150° to 160°.

Official returns state that 24,145 acres under culture in the State of Kansas in 1875 produced 361,386 bushels of seed.

In Iowa it is found a profitable crop, the yield being 15 to 25 bushels of seed per acre, worth $2½ to $3 per bushel.

In America, the seeds, cleansed from the dust and fragments of the capsules, are submitted to a gentle heat, not greater than can be borne by the hand, which is intended to render the oil more fluid, and therefore more easily expressed. The whitish oily liquid thus obtained is boiled with a large quantity of water, and the impurities skimmed off as they rise to the surface. The water dissolves the mucilage and starch, and the albumen is coagulated by the heat, forming a layer between the oil and water. The clear oil is now removed, and boiled with a very small quantity of water, until aqueous vapour ceases to rise, and a small portion of the oil taken out in a phial remains perfectly transparent when cold. The effect of this operation is to clarify the oil, and to get rid of the volatile acid matter. Great care is necessary not to carry the heat too far, as the oil would thus acquire a brownish colour and acid taste.

In the West Indies the oil is obtained by decoction, but none of it appears in commerce in this country.

In Calcutta it is thus prepared: The fruit is shelled by women; the seeds are crushed between rollers, then placed in hempen cloths, and pressed in the ordinary screw or hydraulic press. The oil thus obtained is afterwards heated with water in a tin boiler until the water boils, by which means the mucilage and albumen are separated. The oil is then strained through flannel and put into canisters.

Two principal kinds of castor seeds are known, the large and the small; the latter yields the most oil. The best East Indian castor oil is sold in London as "cold drawn." In some parts of Europe castor oil has been extracted from the seeds by alcohol, but the process is more expensive, and yields an inferior article.

Castor oil is a viscid oil, generally of a pale yellow colour, a nauseous smell and taste. Its specific gravity, according to Saussure, is 0·969 at 53° Fah. The acid taste which it sometimes possesses may be removed by magnesia (Gerhardt). At about 6° Fah. it forms a yellow, solid, transparent mass. By exposure to the air, it becomes rancid, thick, and at last dries up, forming a transparent varnish. It dissolves easily in its own volume of absolute alcohol; castor oil and alcohol exercise a mutual solvent power on each other. It is also soluble in ether.

There are chiefly three sorts of castor oil found in the London market; viz. the oil expressed in London from imported seeds, East Indian oil, and the American or United States castor oil. Castor oil is imported in tins, barrels, hogsheads, and duppers. It is purified by decantation and filtration, and bleached by exposure to sunlight.

It is not quite decided how many kinds of fats castor oil contains; according to Gerhardt several, but Saalmuller says only two. It is, however, principally composed of *ricinoleine*, with perhaps a little stearine and palmatine, and an acid resin. Its ultimate composition is shown by the following comparative analyses:

Carbon	74·00	74·18	74·35
Hydrogen	10·29	11·03	11·35
Oxygen	15·71	14·79	14·30
Total	100·00	100·00	100·00

Castor oil seed is grown over the whole of the North-West Provinces; it is not of a very good quality, the yield of oil being generally inferior to the coast seed of Coconada and that of Colgong. The Dessie supplies the largest quantity.

The castor oil plant is extensively cultivated all over India. The plant is cultivated at Lucknow as a mixed crop. It is sown in June by almost all the villagers, not extensively, but principally for their own use. Its cultivation can be extended all over Oude. The oil is extracted by bruising the seed and then boiling it in water; the oil is afterwards skimmed off. This is the only seed out of which the oil is extracted by boiling, as in this case it is found cheaper than the method used for other seeds, which is by pressure. The cost of the seed is one rupee per maund, and the price of the oil from two to five seers per rupee, according to the abundance of the crop in the season. The proportion of the oil yielded is about half the weight of the seeds boiled; it is only used for burning.

In Cuttack the plant is grown all over the province, a good deal in patches of newly-cleared land, in the jungles of the Tributary States and Sumbulpore. The oil is used for burning and culinary purposes, and also medicinally. Both the native methods of extracting oil are wasteful and tedious, and therefore expensive. European oil-presses, and a knowledge of some methods of clarifying the expressed oil, seem only to be required to render the oil-seed crops of this extensive division of great value. There are 67,000 acres under castor oil in the Madras Presidency, chiefly in Coimbatore. 5230 sacks of castor oil seed, and 111,790 veltes of castor oil, were imported into Pondicherry in 1867.

In a report on the industrial employment of castor oil, by M. Dareste, published in the third volume of the Bulletin of the Acclimatization Society of Paris, p. 349, he states that from the documents he had collected he found that a hectare under castor oil yielded 1800 kilogrammes. The average yield from oil-palms in intertropical regions was only 900 kilogrammes per hectare, and that of olives in the south of Europe but 600 kilogrammes. From subsequent researches he considers that the yield of oil from the castor oil plant would be even more, as he calculated the yield at 0·52 per cent., while subsequent trials proved that 0·62 to 0·64 could be obtained, differences which result from the mode of extraction employed.

Castor oil is said to be adulterated sometimes with croton oil, to increase its activity; this is a dangerous sophistication. It is also mixed with some cheap fixed oils.

Rape Seed.—From the seeds of *Brassica campestris*, *Brassica napus* (*Napa oleifera*, Spenn.), *annua* and *biennis*, and other species, all natives of Europe, is expressed the colza, or rape oil. The plants are extensively cultivated in the manner usually adopted in the culture of turnips, and raised solely for their value as an oil-yielding plant. The seeds are perfected the second year of their growth. The oil is extensively used for machinery and for burning in lamps. The refuse cake is a well-known cattle food.

The seed is sown broadcast, in the month of July, upon well-manured ground, and if possible during wet weather. This is the seed-bed for the future plant. It should be sown as turnip or cabbage seed is sown, when it is intended to transplant the young plants. In the months of September, October, and November, the plants are taken from the seed-bed, and transplanted for the future crop. The field is richly manured with farmyard dung, spread broadcast on the land, and ploughed in. The previous crop is usually wheat.

The plants are then set out in rows about 2 feet distant from each other, and each plant 18 inches apart. In good soil, as, for instance, land partly broken up from old pasture, or from wood, the crop will be much heavier, and ripen more equally, if planted at a greater distance. It is usually planted in every alternate furrow, but the manure plough is expressly constructed for breadth of furrow. The plant is exceedingly robust, and soon recovers itself after transplanting. It thus remains permanently planted out until the month of February, when the horse-hoe is set to work to pulverize the soil after the frosts. Good careful farmers then add some artificial manure to encourage the growth of the plant. The manure generally employed is guano or rape dust, and the rape cake, which proceeds from the manufacture of the oil. Rape cake, indeed, is one of the very best stimulants that the plant can receive. After this spring manuring, the double mould-board plough passes between the drills, so as to throw the earth well up to the stalks of the plants.

There is another method, which is, to sow as the Scotch farmers do turnips. Sow in drills (manure in the drills), apply guano or bone dust, or rape dust in spring, and in damp weather.

Do not transplant at all, but thin out, and cultivate as for Swede turnip seed. I believe the crop would be as heavy, and the expense diminished one half, especially when labour is dear or scarce. The after management of the colza seed is not difficult, but requires attention. The seed, when fresh harvested, is apt to sweat and heat. For this reason, careful farmers who wish to preserve the colour and strength of the sample, generally stow the seed away with a sufficient quantity of the seed-pod or husk. These substances mixed through the heap, prevent its taking heat. The bulk must, nevertheless, be repeatedly turned over, and the granary kept aired. The yield of oil, which is the ultimate and real test of the value of the crop, varies exceedingly. This variation is not so much to be attributed to the variety of grain as to the nature of the soil, the geniality of the season, and the care bestowed on the culture of the plant.

Nothing more is done till harvest, which occurs towards the middle of July. The chief enemy of the rape-seed crop is hail; the heavy rains of July are also often prejudicial. As soon as the straw and seed-pod become yellow, the crop is ready to cut. This is done by the sickle, and the reapers place the crop as it is cut across the ridges, so as to leave the air to circulate as much as possible. In from six to ten days the crop is ready for the flail. It is a seed that sheds itself with great ease, and must be handled tenderly, or much seed will be lost. The crop is threshed in the field. A large space is cleared, and a sail-cloth spread on the ground. A light species of hand-barrow or cradle is constructed, and lined with canvas. It is carried by two persons across the field, and they gather up the sheaves, which, as lightly as possible, they deposit in the cradle or hand-crib. When they arrive at the threshing place, they simply overturn the cradle and leave the sheaves on the floor.

The least possible stroke of the flail suffices to dislodge the seed. After threshing, the grain requires to be constantly turned in the store, or it will speedily heat, and consume the strength of the oil. The produce of *an excellent crop* is half a French bushel, or 25 French quarts (litres), to every perch of 24 square feet. In round numbers, the yield of the crop may be estimated at 25 bushels to the acre, and it often exceeds this. The profit is so very considerable, that for many years it was estimated that the Norman farmers paid rent and expenses from the rape-seed crop alone. The land rent may be averaged at 1 franc the perch, or 70 francs the acre, which includes all rates and taxes.

If the plant be cultivated too often upon the same soil, without adequate change of rotation, it will, as is often the case with clover, degenerate rapidly, and produce an inadequate return. A crop which stands well and thick on the land will not always turn out to be the best *oil-bearing crop.* The average is, that it requires 4 hectolitres, or 400 French quarts of seed, to give 200 lbs. of oil in the rough. The expressing the oil, facilities for purchase of steam fuel, or water power, and the chemical processes connected with rectification, are all elements of the expenditure. It is generally believed that the English market can be more readily and cheaply supplied by purchasing the grain in France, and crushing and refining in England, than by buying the article ready-made for use in France.

Colza culture extends through the regions of the north-west and the plains of the north, but is little known in the south and the mountains of the centre.

The production of colza has declined in France, owing to the more extensive employment of mineral oils. While there were in culture in France more than 300,000 hectares under oil-seeds in 1862, in 1871 there were only 226,667 hectares, which produced 3,198,398 hectolitres of seed. Seven-tenths of this were colza. Deducting 17,110 hectolitres used for sowing, there remained 3,181,288 hectolitres to be converted into oil. As one hectolitre of seed yields on the average 23·89 kilos. of oil and 38·11 of cake, this gives a total production of 759,348 cwts. of oil, of a value of 83,319,538 francs, and for the oil-cake 1,212,291 cwts., worth 19,593,080 francs, together 102,912,618 francs. The departments where this oil-seed is principally grown are Pas de Calais, Calvados, Seine Inférieure, Nord, Somme, Saone et Loire, and Eure.

The current prices of rape seed in the London market in the beginning of 1877 were, for Calcutta brown, 59*s.* 6*d.* to 60*s.* per quarter, and for Ferozepore, 59*s.*

Imports of rape seed into the United Kingdom:

	Quarters.		Quarters.
1840	81,745	1870	551,107
1850	107,029	1875	496,541
1860	269,403		

The following figures give the production of oil and oil-seeds in France at two periods. In 1870 there were 544,688 hectares under culture with oil-seeds.

	1852.	1862.
OIL-SEEDS—	hectolitres.	hectolitres.
Colza, poppy, cameline, turnip, &c.	3,525,000	4,422,339
Linseed	543,000	854,563
Hemp seed	920,000	922,390
OILS—		
Seed oil	1,422,000	828,855
Olive	246,000	399,155
Hemp	144,000	..

MUSTARD SEED.—A number of species of this family are cultivated for their seeds in Europe, north Africa, and northern and middle Asia. By some the plants are referred to *Brassica;* others continue them under *Sinapis*. The seeds of white mustard (*Sinapis alba*, Linn.) are less pungent than those of the black mustard (*S. nigra*), but are used in a similar manner. Dr. Masters enumerates *S. chinensis*, *S. dichotoma*, *S. Pekinensis*, *S. ramosa*, *S. glauca*, and *S. juncea* among the mustards which undergo cultivation in various parts of Asia, either for the fixed oil of their seeds or for their herbage. From 15 lbs. to 20 lbs. of seeds of the white mustard are required for an acre. In the climate of California 1400 lbs. of seeds have been gathered from an acre. In China an oil is expressed from *Brassica sinensis* in increasing quantities all through the valleys of the Yang-tze and Han rivers.

Very primitive machinery is used for the purpose. The seeds are crushed, steamed, and put into wooden cylinders, usually made by hollowing out the trunks of trees. The oil is squeezed out of the mass, placed in coarse bags, by means of wedges forced down by mallets, or by an arrangement similar to that by means of which piles are generally driven into the earth. In the last case water power is sometimes employed. The oil is of a dark yellow colour, thick, and has a pleasant odour. It is used for lamps, in cooking, and as a hair oil.

The seeds of *S. nigra* and *S. alba*, simply crushed and then sifted, constitute the mustard of commerce. The mixture is commonly two parts of black and three of white mustard flour, but the proportions used by different manufacturers vary. For medicinal use the black seeds are preferable for sinapism and other purposes. In rich soils this plant is very prolific. The chemical constituents are a peculiar acrid fixed oil, crystalline sinapin, the fatty sinapisin, myron-acid, and myrosin.

There are two sorts of mustard: the white mustard, which is grown for oilcake for sheep feed, and for green manure to be ploughed in for wheat; and the brown mustard, which is chiefly grown for use as a table condiment. On the marshy and wild coast soils of east England it is common to take three or four crops of brown mustard running, and in that way to pay for the fee simple of the land (from 60*l.* to 100*l.* an acre), when the opportunity is presented. The tillage required is next to nothing; a shallow furrow is ploughed, the seed is sown broadcast, a bushel of seed an acre, in April, and is ready for harvesting in June or July. The land is generally sufficiently seeded to produce another crop; which may, perhaps, be gathered in the autumn of the same year. In England brown mustard often fetches from 15*s.* to 1*l.* a bushel, and 40 bushels is no uncommon crop. White mustard is less remunerative and less speculative.

Mustard seed is cultivated in many departments of France, and especially in the Nord, Pas de Calais, Bas Rhin, and the Charente. The annual produce is about 650 tons, worth 6000*l.* Triturated in special mills, mixed with vinegar, and flavoured with some condiments, it is delivered to the trade ready for the table. The quantity produced in France was stated in the Official Catalogue of the Paris Exhibition of 1867 at 3000 tons, of the value of 2,000,000 francs.

Five or six species of *Sinapis* are cultivated throughout India for the sake of their oil, which is much esteemed in the country for cooking, for medicine, and for anointing the body, which it is supposed to invigorate. They are known as sarson seed. *Brassica juncea*, Hooker, *Sinapis juncea*, Lin., is largely grown in the south of Russia, and in the steppes north-east of the Caspian Sea. Eight hundred tons of the seed are used in one factory annually for making mustard, and the seeds yield more than 20 per cent. of a fixed pleasant oil.

The imports of colza and ravison seeds into Marseilles have ranged from 300,000 to 660,000 cwts. of late years, but they have been declining; in 1875 the quantity was but 244,920 cwts.

In 1872 there were sent from India to England and France 1418 tons of mustard seed.

Safflower Oil.—This is a light yellow clear oil, when properly refined or prepared; it is used in India for culinary and other purposes. This oil deserves more attention than it has hitherto received in this country; and, if once fairly introduced, there is no doubt whatever of its becoming a staple import. It is used in some of the Government workshops as a "drying oil." It is believed to constitute the bulk of the celebrated "Macassar oil." The seed is exported under the name of Curdee, or safflower seed. The Lucknow Exhibition Committee furnishes the following note: In Oude it is sown in October, either alone, or at the edge of wheat crops; both light and heavy soils are adapted to it. It is cultivated in every village, but not extensively. There would be no difficulty in farther cultivating it to any extent. The oil is extracted by pressing. The cost of the seed, which is called "Barré," is $18\frac{3}{4}$ seers per rupee, and the cost of the oil from 3 to 4 seers per rupee.

Sesame Seed (*Sesamum indicum*, Dec.), frequently called Til, or Gingely. This is an erect, pubescent annual herb, from 2 to 4 feet high, indigenous to India, but propagated by cultivation throughout the warmer regions of the globe. In Europe it is only grown in some districts of Turkey and Greece, and on a small scale in the islands of Malta and Gozo. It does not succeed well in the south of France. From southern Asia it extends eastward to Japan, and is cultivated as far as 42° N. lat. It has a wide range, being grown in parts of South and Central America, British Guiana, and the West Indies. In the former it is known as ajonjoli, in the West Indies as oily seed, and in Demerara as wanglo. When parched and pounded the seeds make a rich soup. Children are very fond of the seeds, which have a milky flavour. In Egypt they are eaten after being baked in an oven and sprinkled over bread and pastry. The residual cake, after the oil is extracted, is also eaten kneaded with honey.

Benni seed, as it is called in parts of Africa, is extensively used in Oriental countries for aromatizing the church bread and for the preparation of the renowned *Chalba*, which is eaten during fasts by all Orientals. It consists of the finely powdered seeds, which are mixed with honey, and oftentimes also with sugar.

The negroes use the seeds for making a sort of beverage, something like coffee, by roasting and infusing them in water.

Til seed is grown in the northern provinces of Siam; 50,000 cwts. were shipped from Bangkok in 1868, and 77,000 cwts., valued at 183,009*l.*, in 1870. There are 870,000 acres under culture with this oil-seed in the Madras Presidency, chiefly in the Godavery. Three varieties of sesame seed are cultivated in India, the white-seeded (*Suffed-til*), the red or parti-coloured (*Kala-til*), and the black variety (*Tillee*); it is the latter which affords the greater proportion of the gingely oil of commerce. A second sort of sesame oil, sometimes called "rape," is obtained from the red-seeded variety. Black sesame is sown in March and ripens in May. Red sesame is not sown till June. The word sesame is said to be derived from *simsim*, the Arabic name of the plant. One of the advantages of the culture of this plant consists in its quick return of produce, as it comes to perfection within three or four months. Its capsules contain numerous small, flat seeds. To collect them, the plant, when mature, is cut down, and stacked in heaps for a few days, after which it is exposed to the sun during the day, but collected again into heaps at night. By this process the capsules gradually ripen and burst, and the seeds fall out. The plant is found in several varieties, affording respectively white, yellowish, reddish-brown, and black seeds. The dark seeds may be deprived of a part of their colouring matter by washing, which is sometimes done with a view to obtain a pale oil. The white seeds produced in Sind are reported to yield the finest oil. The seeds are largely consumed as food both in India and tropical Africa. The island of Formosa grows a large quantity—3700 cwts. were shipped in 1871—and it is also cultivated in Zanzibar and Senegal. From the latter French colony 600 cwts. were shipped in 1870. This oil-seed now also appears in the markets of Bakel. The yield of oil from the seed is about 40 to 50 per cent., and its specific gravity 0·9253. The Jaffa sesame seed is all exported to France, as it is much appreciated there, and considered to be of the best kind on account of its making fine oil for eating purposes. It fetches the highest prices of any in the Marseilles market. The exports from Jaffa in 1862 were 2320 tons. From Syria there were shipped, in 1871, sesame seeds of the value of 23,610*l.*, and from Gallipoli, in the same year, 945 quarters, valued at 4080*l.* From Lagos, West Africa, there are now large shipments. The trade in the article only commenced with an export of 2½ tons in 1864, but in 1870 had reached 729 tons. The seed is there called Benni seed. The chief place for the manufacture of sesame oil is Marseilles, and the importance of the trade in it may be judged from the receipts at that port, in metrical quintals:

Year.	From the Levant.	From India and Africa.	Total.
1855	159,703	190,512	350,215
1865	60,260	259,510	319,770
1875	125,950	297,670	423,620

The oilcake made from it in 1875 was 440,000 cwts., the price ranging from 11 to 16 francs the cwt. The quantities furnished by India alone in the last six years were, in metrical quintals of 2 cwts.:

Year.	From Coromandel Coast.	From Bombay and Sind.	From Calcutta.
1870	368,000	29,100	183,100
1871	258,000	30	79,000
1872	224,200	1,800	4,000
1873	227,100	14,800	7,800
1874	276,720	130,900	56,200
1875	364,500	312,600	50,300

The following were the ranges of price in 1875 at Marseilles: for Jaffa, 43 to 53 francs, brown; Coromandel, 35 to 40 francs, white; Kurrachee, 37½ to 43 francs; Bangkok, 35 to 43 francs; and Mozambique, 38¼ to 41½ francs. The export of sesame oil in 1875 from Marseilles was 2,500,000 kilogrammes, or nearly half of all the seed oil shipped. The price ranged during the year from 67 to 80 francs for the 100 kilogrammes. The oil first expressed from the seeds is available for table use, and may be used for all the purposes of olive oil. As its congealing point is some degrees below that of olive oil, it is even more fitted for cool climates. The soot of the oil is used for making Indian ink. This oil is probably consumed to a greater extent than any other by the natives of India, and is second only to cocoanut oil in importance as an article of commerce. The residue, or cake, is eaten by the poorer classes of India as an article of food, and it is greedily devoured by cattle.

In Eastern Africa the sesame grows everywhere on the coast, and extends far into the interior, and is known as simsim. The seed is pounded dry in a large mortar; when the oil begins to appear, a little hot water is poured in, and the mass is forcibly squeezed by huge pestles; all that floats is then ladled out into pots and gourds, and used for cooking.

From Siam there was exported in 1875, 13,193 piculs of teel seed, valued at 21,003*l*.

The commercial value of gingely seed in England is about 50*s.* to 54*s.* for white, and 45*s.* to 48*s.* for brown.

Niger Seed.—Another oil-seed which enters into English commerce from India for oil-crushing is the small black seed of *Guizotia oleifera*. It is commonly cultivated in Mysore and the Deccan. The oil is sweet-tasted, and is used for the same purpose as the gingely oil, though an inferior oil. It is the common lamp oil of Upper India, and is very cheap. The seed is sown in July or August, after the first heavy rains, the fields being simply ploughed, neither weeding nor manure being required. In three months from the time of sowing the crop is cut, and after being placed in the sun for a few days the seeds are threshed out with a stick. The produce is about two bushels per acre. It is also called ram-til. It fetches in London about 40*s.* per quarter.

The following quantities of vegetable oils were made in the United States, according to the Census returns for 1870:

Oils.	Quantity.	Value.
	gallons.	dollars.
Castor	341,850	690,700
Linseed	6,819,730	7,239,773
Cotton-seed	2,490,883	1,547,218
Poppy-seed	125	375
Rape-seed	11,350	13,870
	tons.	
Cotton oilcake ..	6,750	113,000

The castor oil made was to the value of 593,000 dollars in 1850, and 320,370 dollars in 1860. Cotton-seed oil was only made, in 1860, to the value of 741,000 dollars.

Marseilles is the great entrepôt for oil-seeds, as the appended table proves, the quantities being in metrical quintals of 100 kilos., or 220 lbs.:

Year.	Oil-seeds.	Yield of Oil.	Oilcake.
1871	1,732,430	608,960	1,123,470
1872	1,675,510	561,890	1,113,620
1873	1,912,330	617,390	1,294,940
1874	2,070,630	660,000	1,410,630
1875	2,228,280	792,240	1,436,041

The progressive increase in the importations of oil-seeds at Marseilles has been remarkable, as is proved by the quinquennial returns, in metrical quintals:

1855 753,680	1870 1,849,860
1860 1,093,970	1875 2,228,280
1865 1,376,770	

The quantity and value of the various oil-seeds shipped from India is shown below :

Year.	Quantity.	Value.
	cwts.	£
1871	6,693,482	3,497,255
1872	5,079,009	2,702,048
1873	2,739,792	1,485,648
1874	4,401,994	2,342,953
1875	6,629,939	3,207,808

Gold of Pleasure (*Camelina sativa*, Crantz), an annual herb, is cultivated in middle and southern Europe. It is readily grown after corn crops, yields richly even on poor soil, and is not attacked by aphis. Thirty-two bushels of seed have been obtained from an acre, and from these 540 lbs. of oil. The return is obtained within a few months.

The gold of pleasure produces a finer oil for burning than the rape or mustard, having a brighter flame, less smoke, and scarcely any smell. It succeeds better than any of the other cruciferous oil plants on light, shallow, dry soils, and arrives so soon at maturity that in the south of Europe it produces two crops in a season. In several of the more northerly districts of the Continent, as the north of France, Germany, and Holland, although it will not produce two crops in the season, it is found very useful for sowing in June or the beginning of July, when other crops may have failed; and when sown in the early part of the season, it can be removed in time to be succeeded by turnips, grass seeds, &c. Besides the use of its seeds for oil, the stems yield a coarse fibre for making sacks, sail-cloth, &c., and being small, hard, and durable, are used for thatching temporary erections, and also for making coarse packing paper.

The seed may be sown in shallow drills, 10 inches apart, by the old-fashioned plan of a quart bottle with a quill through the cork, and will be ready for the sickle some three months after sowing; the return of an average crop may be estimated as 300 to 1. The *Camelina* is understood to be a non-exhauster of the soil, used as a rotation crop, enabling old land to recover itself in some measure; it prefers soil of a light sandy nature, and is very hardy, enduring both drought and wet. Its usefulness consists in its quality for fattening stock of any kind. Two tablespoonfuls of the seed boiled in a quart of water will produce about the same quantity of thick jelly; and this mixed with a sufficient quantity and bulk of food will, it is considered, fatten the largest ox in a short time; the chaff which is left, after threshing out the seed, is readily eaten by horses.

In some countries this plant is cultivated both for its stems, which yield a fibre applicable for spinning, and for its oleiferous seeds, especially in Flanders. Although the soils best adapted for its culture are those of a light nature, a crop will never fail on land of the most inferior description. It is usually sown in spring in March or April, and in the autumn about August. The quantity of seed required per acre is 14 lbs. It may be either drilled or broadcast; if drilled, the rows must be one foot apart. If sown early, two crops may frequently be obtained in one year, as it is fit for harvesting in three months after the plant makes its first appearance. The seed is ripe as soon as the pods change from a green to a golden colour. Care must then be taken to cut it before it becomes too ripe, or much seed will be lost.

When cut with a sickle, it is bound up in sheaves and stacked in the same manner as wheat. It is then put into a barn, and threshed out like other corn. The oil is useful for burning in lamps, for dressing woollen goods, the manufacture of soap, lubricating machinery, and for painters. It is said also to be beneficial in asthma.

Sunflower-seed Oil (*Helianthus annuus*).—The highly ornamental and extensive genus of plants to which this belongs derives its scientific name from *helios*, sun, and *anthos*, a flower, on account of the brilliant colour of the flower, and from the erroneous idea, propagated by poets and others, that the flowers always turned towards the sun; hence, also, the French name *tournesol*. It appears to possess far more profitable qualities than have been hitherto supposed, and may be cultivated with advantage and applied to many useful purposes. The great variety of valuable properties belonging to the sunflower seed has been more neglected than any other, when it ought to be paid greater attention to. No plant produces such fine honey and wax, and when the flower is in blossom bees abound on it. A few years ago one or two farmers cleared nearly 40*l.* by their honey alone. The produce will be according to the nature of the soil and mode of cultivation.

The sunflower has been long largely grown in parts of Russia for its oil, and the German farmers have lately taken up the cultivation. The plant grows readily in most climates. From the stalks of the plant the Russians manufacture a valuable potash, and the residue, after extracting the oil, is used for feeding cattle, made into oilcake. The leaves go to manure the soil.

The quantity of seed is much increased by dwarfing the plants; the best manure is said to be old mortar broken up. The plants should be kept clear and free from weeds; the quantity of seed required is about 6 lbs. per acre. They should have sufficient interval between them for exposure to the sun, as under such circumstances they become larger and more fully stored with seed. The oil extracted from the seed is said to be superior to both almond and olive oil for table use, and for use in woollen factories, making soap, and candles, and for lighting purposes. The leaves have been manufactured into cigars, possessing, it is stated, pectoral properties which might prove more efficacious than stramonium. The blossoms furnish a brilliant yellow dye which stands well.

The marc, or refuse of 50 bushels of seed, after the oil has been expressed, made into cakes, will produce 1500 lbs., and the stalks, when burnt for alkali, will give 10 per cent. of potash. The green leaves of the sunflower, when dried and burnt to powder, make excellent fodder for milch cows, mixed with bran. Sir Allen Crockden, of Seal Grove, by Sevenoaks, for many years cultivated the sunflower, for the purpose of feeding his stock. The oil makes most beautiful soap, particularly softening to the hands and face, and is most delightful to shave with. The cake is superior to linseed for fattening cattle. Sheep, pigs, pigeons, rabbits, poultry of all sorts, &c., will fatten rapidly upon it, and prefer the seed to any other; pheasants in particular, causing them to have a much more glossy plumage and to be plumper in the body. It increases the quantity of eggs from poultry fed with it. The seed, shelled, makes when ground very fine flour for bread, particularly tea-cakes. It will grow in any corner that may be vacant, and make all farms have a most agreeable garden-like appearance. It should be planted six inches apart, and about one inch deep, and when one foot high may be earthed up; it then will require no further attention. Every single plant will produce 1000 or more seeds; the main head generally produces 800 to 1000 seeds, and there are usually four collaterals, producing 50 to 60 seeds each. But it is not the seed only that is so valuable, the stalk is useful also; for by treating it exactly like flax, it will produce a fibre as fine as silk, and in large quantities. Now that rags have become so scarce, arising from the very unprecedented demand for paper, the stalk might be used for paper making. On some grounds two crops may be growing at the same time; when the farmer has given his early potatoes a last hoeing, he can plant his seed 12 inches apart in the ridges. The Chinese have it by thousands of tons, and worship it. There can be no doubt that many of their silk goods have a large portion of sunflower fibre in them. According to Boussingault, some experiments made by M. Gauzac of Dagny gave the produce per acre of seed at 15 cwts. 3 qrs. 14 lbs.; the oil per acre, 275 lbs., being 15 per cent., and the cake 80 per cent. Next to poppy-seed oil, sunflower oil burns the longest of any in equal quantities. The seeds vary in colour, being either white, grey, striped, or black. From them is expressed a palatable, clear, and flavourless oil, the demand for which in Russia is very great. It is exported from St. Petersburg at about 10*s.* 6*d.* the cwt., and is said to be extensively used, like cotton-seed oil, after purifying, for adulterating olive or salad oil. In Russia a considerable quantity is grown for oil pressing. The plant is largely cultivated in Kiels, and Podolia, eastward on the black soil lands; the stalks are used for fuel. The manufacture of the oil, which was formerly confined to the government of Voroneje, has recently been carried on in that of Saratov, and in the town of that name there were in 1867 at least 30 oil presses. Mr. Alexander Knobloch, of Sarepta, has one worked by steam power. The seed is supplied by the peasants of the neighbourhood. The production in Russia in 1867 (including a few other miscellaneous oil-seeds) was officially stated at 335,000 cwts. At Voroneje 6000 to 8000 poods (of 36 lbs.) of seeds are produced. In Russia the seed sells at about 40 copecks the pood, or 2 roubles 60 copecks the chetwert; the oil at 3½ to 4 roubles the pood. The following practical instructions may be given to produce the plant in perfection. There is required a light rich soil, as unshadowed by trees as possible. The earlier the seed can be got in the ground the better, say the end of September or the beginning of October, as the crop will be ready to harvest the latter part of February, which will be of the greatest importance to growers. The necessary quantity of seed required for an acre depends on the condition of the soil, and varies from 4 to 5 lbs.; but of course it is advisable to sow a little more than is actually wanted, to provide against accidents. The seed should be drilled into the ground; the distance from row to row 18 inches; the plants to be thinned out to 30 inches from plant to plant; and the number of plants at this distance would be about 11,000 per acre; at 18 inches from plant to plant 25,000 per acre; and at 12 inches from plant to plant 32,000. The produce varies considerably, according to the state of the soil, the climate, and the cultivation that is employed; but the average quantity of seed may be taken at 50 bushels per acre, and the yield of oil at a gallon per bushel.

The seed varies in relation of husk to kernel from 41 and 60 per cent. of the former to 40 to 59 of the latter, and the percentage of oil between 16¼ and 28 per cent. On the average, however, about 18 per cent. of oil may be obtained by expression.

Candle Nuts.—Under the name of candle nuts there are imported into this country an oil seed, the hard fruit, either in the shell or broken, of the *Aleurites triloba* and *A. Moluccana.* The French call them Bancoul nuts, and in the Pacific islands they are known as kukui. *Aleurites triloba* is a native of the Malay islands and Assam. It is also cultivated in Lower Bengal. The kernels are much relished there, having the taste of English walnuts.

Two or three species are known, spread over the Molucca Islands, Ceylon, and the archipelagoes of the Pacific Ocean. It is very common in the forests of Cochin China, New Caledonia, Tahiti, Reunion, &c. The fruit, produced in abundance, falls to the ground when it has arrived at maturity. This nut is composed of a hard and ligneous shell, containing an oily kernel, of which the following is the composition:

Water	5·000
Oil	62·175
Nitrogenous substances	22·653
Non-nitrogenous substances	6·827
Mineral matters	3·345
	100·000

In its normal state it contains:

Nitrogen	3·625 per cent.

According to this analysis, the kernel is rich in oil and in nitrogenous substances. It is worthy, therefore, of attracting the more prominent attention of manufacturers and agriculturists.

The nuts analyzed came from Tahiti. The French Minister of the Marine distributed them to several manufacturers of oil, in order to experiment on them in their factories. The following is the composition of the oilcake:

Water		10·25
Oil		5·50
Nitrogenous substances		47·81
Non-nitrogenous substances		24·04
Phosphoric acid	3·68	
Potash	1·53	12·40
Magnesia, lime, silica, &c. ..	7·19	
		100·00

In its normal state it contains:

Nitrogen	7·65 per cent.

This analysis shows that the cake is rich in nitrogen and in phosphates. It would be still more so if it did not contain a certain quantity of the remains of the shells, which could not be completely separated from the kernels. Monsieur Ed. Nay obtained from the kernels 55 to 57 per cent. of oil, 40 to 41 per cent. of cake. From these results, it must be admitted that the cake which is manufactured from perfectly shelled seeds might contain up to 9 per cent. of nitrogen, and 4 per cent. of phosphoric acid. It would therefore be a good manure of great value, superior even to ground-nut cake. It is not good for cattle food; at least, it must be supposed so. The oil expressed from the kernels is purgative, and could not therefore serve for alimentation. For lighting purposes it is superior to colza oil, and can be burnt without undergoing purification. A simple filtration suffices to render it clear and limpid.* It also appears that this oil is very siccative, for when applied in layers on the hull of a ship it preserves it for a long time from every kind of change. Some interesting experiments were made for this purpose on some men-of-war in Cochin China and at Guiana. Unfortunately the hard shell of the candle nut presents great difficulties. This nut only contains 33 per cent. of kernel. The remainder is the hard shell, which is probably useless. It therefore results that on account of the high price of freight from the places of production it cannot be imported whole. The shelling must be performed before its shipment. According to the experiments made by Monsieur Ed. Nay, this husking is a very laborious operation, on account of the excessive hardness of the shell; nevertheless, it may suffice to make known the interest which attaches to this question to excite the emulation of inventors. He who constructs a simple, cheap apparatus, which can be transported to the colonies, to perform the desired work, will probably make a good thing of it and render a signal service to commerce.

A larger quantity of oil is obtained from the nut, and with much less difficulty, if, after the reduction of the kernels into a coarse powder, by means of a pestle and mortar, roller, or hand-mill, they are submitted to a low heat. For this purpose a water bath is used, care being taken to constantly stir the powder with a wooden spatula,

* The Nukuhivians light their huts with the very oily candle nut (*Aleurites triloba*), threaded on a skewer, which does not give them much trouble.

in order to diffuse the heat equally throughout the whole mass. When the substance is sufficiently heated, it is placed in canvas bags and submitted to pressure. The oil escapes with much more facility, the heat having coagulated the albumen; it is clear and can be immediately filtered. The oil may also be prepared by previously roasting the nuts in ovens. When they are broken, the kernel then separates very easily from the shell, which is not the case with the raw nuts. In the latter case the fragments of kernel are separated with the point of a knife, which causes a great loss of time. The oil which is obtained after this roasting is of a much darker colour than that which is extracted by the preceding process. In all cases, the kernel must be completely separated from its outer shell, for in crushing the whole together, an enormous loss is experienced. The following are the returns which were obtained, and with a stronger pressure a larger quantity of oil would result: 224 lbs. of whole nuts give 4 lbs. of kernels; 224 lbs. of kernels produce 50 quarts of oil.

At the Sandwich Islands, where it is prepared in large quantities, this oil is 40 per cent. cheaper than linseed oil. In commerce in the Pacific it is designated under the name of *Kukui* oil. The oil of this nut has many useful applications. In the arts, it may be employed in painting as a drying oil; after having been boiled, it dries completely at the end of six hours. In the manufacture of soap it would replace at Tahiti with great advantage the cocoanut oil which is used. It is excellent for lighting purposes, and burns without the unpleasant odour which cocoanut oil gives out; it has not, like the latter, the disadvantage of deteriorating the lamps; lastly, it gives a very brilliant light. It may be reckoned among the drastic purgatives. Very good effects are obtained with a dose of 15 to 20 grammes in an aromatic potion. It is said to be used in Java at table, which must depend on a special mode of preparation, that is to say, the fresh kernel has alone been submitted to pressure. It will thus be seen this oil merits being prepared in Oceania and in New Caledonia. Indigenous to those islands, it grows everywhere; on the tops of the mountains, where it appears to be most common, on the sloping and inaccessible parts, in deep ravines, in fresh and fertile valleys. It is very abundant up to a height of 2700 feet; above that, it becomes rare, and disappears completely at 4000 feet.

The Japan Wax Tree.—In Japan a considerable quantity of solid vegetable wax, which melts at 128° and congeals at 132°, is obtained from the seeds or berries of several species of *Rhus;* that which is most generally cultivated is the *Rhus succedanea.* This is grown amongst vegetables more or less extensively almost everywhere in Japan, especially in the western provinces from the south northwards to the 35th degree.

The lacquer tree (*R. vernicifera*) also yields the wax, and differs but little in appearance from the other species, except that its geographical limit extends farther northwards, being at 38°. The *Rhus sylvestris*, a wild species, is also utilized for the purpose. The cultivated species was originally imported from the Loo Choo islands; the growers now distinguish seven different varieties of this tree. The wax tree grows in great abundance on the mountainous declivities of the province of Kinas, and in Hiozo, Hizen, Simabara, Chutugo, and Chekusin; the fields are hedged in with it. The seeds, which ripen in October and November, are of the size of a small pea, and united in bunches; the fat or wax is lodged between the kernel and the outer skin. When gathered they are exposed to the sun for a few days, and then stored in straw. When they have attained their proper maturity they are freed from the stems by threshing with flails of bamboo. They are crushed and winnowed, steamed, placed in hemp-cloth bags, steamed again, and afterwards pressed in a wooden wedge press all by hand. In order to facilitate the flow of the solid oil or vegetable wax, a small percentage of oil from the *Pirella ocimoides*, Lin., is added. The raw products form on cooling a coarse greenish, tallowy mass, which is remelted in an earthen vessel with water and ashes; the yield is about 15 per cent. of the berries used. The wax is reduced to small scraps by means of a kind of planing tool, then washed and bleached in the sun and air, when it assumes a pure white colour. It is much used in Japan for candles. The exports of this wax from Hiozo and Osaka were 7410 piculs in 1874, and 10,056 piculs in 1875. Prices ranged between $11\frac{1}{2}$ and $8\frac{1}{2}$ dollars per picul. The consumption has greatly fallen off in London within the last few years, owing to previous high cost of the article, which induced buyers to substitute paraffin and other cheaper materials, and even the above low prices have not left a profit to shippers.

The wax is now generally prepared in large square blocks or cakes of 133 lbs., in place of the old saucers or round cakes of from 4 to $4\frac{1}{2}$ inches in diameter and 1 inch thick, by which a saving in freight is effected. The value of this wax, shipped from Hiozo in 1875, was 93,277 dollars; from Osaka, 955 piculs, valued at 8986 dollars. The total value of the Japan wax exports were, in 1874, 215,642 dollars; in 1875, 186,244. Of vegetable tallow there was exported from Kew Kiang in China, in 1875, 2747 piculs.

Poppy-seed Oil.—The seeds yield by expression about 50 per cent. of a bland and very valuable oil, of a pale golden colour, fluid to within 10° of the freezing point of water. It dries easily, is inodorous, of agreeable odour, and partially soluble in alcohol. The seed is worth about 51*s.* to 53*s.* per quarter in the English market. By simple exposure to the rays of the sun in shallow vessels, the oil is rendered perfectly colourless. It is expressed by means of a heavy circular stone, placed on its edge, made to revolve by a long lever, and the apparatus is worked by draught bullocks.

Mr. Bingham furnishes the following note: "The seed has no narcotic qualities, but has a sweet taste, and is used, parched, by the lower class of natives as a food; it is also much used by the sweetmeat makers as an addition in their wares. This and the seed of the Teel (*Sesamum orientale*) are the only oil-seeds, with the exception of the cocoanut, which are used for that purpose. It produces, under the native method, a clear limpid oil, which burns very quickly. About 30 per cent. of oil is generally extracted, and the cake is then sold as a food to the poorer classes. The oil sells at about 5 seers per rupee at Shahabad. The production of this seed is only limited by the production of the poppy.

"In Oude each ryot sows from two to four beegahs in the month of October. The oil is extracted by the common native press. The cost of the seed is 10 seers for the rupee, and the oil sells for 3 seers for the rupee; two-fifths of the weight of the seed employed is about the proportion of oil yielded by the native process. The poppy seed is eaten by the natives made into sweetmeats, provided the opium has been extracted from the seed vessel, otherwise it is bitter and narcotic, and under these circumstances the oil extracted is also bitter. Used for cooking and burning."

Of poppy seed from India, the United Kingdom receives the greatest share: 286,390 cwts., and worth 157,513*l.*, in 1875. France took 115,728 cwts., valued at 63,649*l.* This export trade is almost entirely confined to Bengal, only a very small quantity being shipped from Bombay.

In France the poppy occupies an extent of 47,078 hectares of land in the region of the north-west, being grown for its seed.

Melon Seeds (*Cucumis melo*).—Under the local name of "petit beraf" large quantities of these seeds are collected in various parts of Africa, as in Senegal, Abeokuta, &c. They yield 30 per cent. of a very fluid oil much like olive oil, which is used for food and for soap-making. The production in Senegal in 1860 was 62,266 kilos., selling at 20 to 30 francs the 100 kilos. In China no less than 4295 piculs of melon seed valued at 3451*l.*, were shipped from Chefoo in 1875. The oleaginous seeds of other cucurbitaceous plants are also used; one called the "gros beraf" is the produce of *Cucurbita miroor*, and called by the natives iam-bosse.

Physic Nut (*Curcas purgans*, Lindl.; *Jatropha Curcas*, Lin.).—This small tree or shrub is grown in Brazil, the East and West Indies, and West Africa; but the principal seat of production is the Cape Verde Islands. In the tropics, hedges and enclosures are made with this shrub, as cattle will not touch the leaves. The seeds are excessively drastic, hence their general name of purging nuts.

This plant grows in abundance at Casamanca, and Gaboon and other parts of the African coast could supply this oil-seed.

The bush from which the seed is obtained is readily increased by cuttings, which rapidly take root. The seeds are three or four, contained in a thin skin, which is black; the seed is of the same colour, and grows in bunches; the stems of the bushes are not strong, but they answer excellently for fences, with split bamboo tied on each side to keep them straight and together, and the great advantage is that no kind of cattle eat them. The seeds are collected and the oil expressed in the usual way.

The oil obtained from the seeds is chiefly used for lamps, and also in cutaneous diseases and chronic rheumatism. The Chinese boil the oil with oxide of iron to make the black varnish used for coating boxes, &c. The oil is viscous, of a deep yellow, with a density of 0·918.

This oil has been frequently imported into England as a substitute for linseed oil. The colour is somewhat paler; it answers equally well. Quantities of the seeds are shipped from the archipelago of the Cape Verde Islands; the average export from thence is about 100,000 hectolitres annually; they are sold at the port for 5 francs the decalitre. The seeds are known under the name of Pignons d'Inde by the French, and Purgueira by the Portuguese.

The following shows the quantity of these seeds raised in 1869 in the Cape Verde Islands, the chief locality of production:

	Tons.
St. Jago	15,750
Fogo	900
Bona Vista	22
	16,672

An oil obtained from another species in India (*Jatropha glauca*, Vahl.) is also used locally in medicine and for lamps. In appearance and consistence it resembles castor oil. The seeds of other species, *J. multifida* and *J. gossypifolius*, are also purgative.

Croton Oil.—This powerfully cathartic oil, well known in this country for its medicinal properties, is procured from the seeds of *Croton tiglium*, a small tree, native of Hindostan, Ceylon, and the Moluccas. The oil is obtained by grinding the seeds, placing the powder in bags, and pressing them between plates of iron. The oil is then allowed to stand fifteen days, and afterwards filtered. The residue after expression is saturated with twice its weight of alcohol, heated on the sand bath from 120° to 140° Fahr., and the mixture pressed again. The alcohol is distilled off, the oil allowed to settle, and filtered after a fortnight. One seer (2 lbs.) of seed furnishes 11 fluid ounces of oil; 6 oz. by the first process, 5 oz. by the second. Sometimes the seeds are roasted before they are compressed. The seeds of *C. Roxburghii*, *C. Pavana*, and *C. oblongifolius* have similar purgative properties. So powerful, purgative, and emetic is this oil, that one or two drops are sufficient for a dose.

Chinese Oils.—Among the vegetable oils in China are cabbage oil or rape; Tung oil, from the berries of *Dryandra cordata;* ground-nut oil (*Arachis*); til seed (*Sesame orientale*); tea-seed oil, from *Thea viridis;* oil pea (*Dolichos viridis*); and the oil bean (*Soja hispida*). The latter product forms a considerable article of commerce in China. This pulse oil possesses a great analogy to the ordinary edible oils of commerce; its odour and flavour are agreeable, and it is useful for burning. Exposed to a low temperature it becomes pasty, and resinifies rapidly when exposed to the atmosphere. Being a drying oil, it might serve to replace linseed in some of its uses. The plant has the character of a shrub, it branches near the ground, and attains a height of from 3 to 4 feet. It yields about 18 per cent. of fatty matter, and the Chinese regularly obtain 17 per cent. of oil from it.

There are several varieties of this bean, white, yellow, and green. The yellow are made into a fermented mass, or cheese, called tan-fir, by macerating them in water and pressing them into a cake, adding lime and salt to precipitate the caseine, which is obtained in the form of a jelly. It is chiefly cultivated in the north of China, particularly in the province of Shantung. Upwards of 3000 junks are employed in its transport to the southern ports. From Che-foo there were exported, in 1869, 242,224 piculs of bean-cake, and 5570 piculs of bean oil, and about 10,000 piculs of the cake were imported into Foo-Choo-foo, valued at 42,000*l.* The cake is not only used for human food and for stock, but also as manure.

In the Madras Presidency in 1870 there were 1,018,000 acres under culture with oil-seeds, consisting chiefly of the following: 50,000 acres under rape seed in Tinnevelly; 67,000 acres with the castor oil plant, chiefly in Coimbatore; 870,000 chiefly under gingely, &c., in Godavery.

Oil of Ben.—From the seeds of two species of a leguminous plant, *Moringa aptera* and *M. pterygosperma*, is obtained an oil which is valued for its fluidity. It is mild, almost colourless, does not turn rancid, and is of a pleasant taste. The oleine, when separated from the stearine, is highly appreciated by watchmakers, and also by perfumers, as it retains the most fugaceous odours without diminishing their softness. Hence it serves to fix the odorous principles of certain flowers, such as the tuberose, the heliotrope, and the jasmine. It is, however, rarely to be met with pure in commerce, and is generally replaced by virgin olive oil. One species of the tree grows in several of the West India islands, whilst the other, *M. aptera*, is found principally in Egypt and India, whence small quantities of the seeds are occasionally imported.

SECTION VI.

THE PRINCIPAL FRUITS OF COMMERCE.

Vine Culture and the Grape.—The culture of the grape for the purpose of making a beverage from the juice is, literally, "as old as the hills"—it dates from the era of Mount Ararat. The vine is now grown in almost every portion of the inhabitable globe, but thrives best between 32° and 50° of latitude, the most favourable location for a vineyard being the southern declivity of a hill. Hitherto the best wines have come from southern Europe, Madeira, the Canaries, and the Cape. In Greece, Hungary, Italy, Portugal, France, Spain, and parts of Germany and Switzerland, as many persons are employed in the culture of the vine as in all the other agricultural pursuits.

In the United Kingdom the grape seldom ripens well in the open air, although very fine hothouse fruit is raised. Still there is a large import of fresh grapes from the Continent.

The imports of grapes into the United Kingdom have been:

Year.	Quantity.	Value.
	bushels.	£
1866	69,553	64,154
1867	85,226	78,930
1868	94,213	67,176
1869	102,670	74,761
1870	142,723	87,416

The official returns since 1870 do not particularize grapes.

Of dried raisins we take for consumption in the United Kingdom from 350,000 to 400,000 cwts. per annum, and of dried currants 870,000 to 900,000 cwts.

The muscatel grapes are those which by a costly process are made into "Pasas" or Malaga raisins. There are various qualities, which range in the following order, and of which the range of prices ruling in 1871, for cases of 25 lbs., show the comparative values:

	Francs.		Francs.
Prepared for America ..	8	Imperial	20
Choice	9	English, third quality	18
Superior	11	,, second ,, ...	22
Royal	15	,, first ,, ...	26

The exports were 23,178,120 kilos. in 1870.

In 1871, 426,750 cwts. of box raisins were shipped from Malaga, and in 1872, 563,023 cwts. The number of boxes sent to the United Kingdom in 1872 was 374,949. The average of the five years from 1867 to 1871 was 184,077 boxes.

The green grapes (*Uva porron*) are gathered almost entirely in the provinces of Granada and Almeria. These large and oblong grapes, with a thick skin, are sent, still green, during the months of August and September to the north of Europe, packed in barrels of 50 or 100 lbs. weight, and filled with sawdust to prevent bruising and becoming mouldy. The exports from Malaga were 10,076 barrels in 1870, and 18,224 barrels in 1871.

There are imported into London about 35,000 barrels (of 50 lbs.) of Spanish or Almeria grapes, which are sold at auction by the fruit-brokers. This is exclusive of the Lisbon grapes (of which there are no available figures), and the large imports direct to Covent Garden market from the Continent. The cargoes arrive at different times from about the last week in May to August. The following have been the quantities of raw fruit (not otherwise described) imported into the United Kingdom, which include pine-apples, melons, apples, &c.:

Year.	Quantity.	Value.
	bushels.	£
1867	237,598	139,079
1868	337,631	160,388
1869	303,565	150,619
1870	252,228	131,967
1871	1,128,568	596,107
1872	1,691,703	1,024,685
1873	1,324,608	762,710
1874	2,622,914	1,109,984
1875	2,220,412	986,248

The quantity of wine taken for consumption in the United Kingdom has been as follows:

Year.	Gallons.	Per Head of Population.
1845	6,736,131	0·24
1850	6,437,222	0·23
1855	6,296,439	0·23
1860	7,358,192	0·23
1865	11,993,760	0·40
1870	15,079,854	0·49
1875	17,243,942	0·53

The following figures show the exports of wine from some of the principal producing countries:

France, 1875	373,000,000	litres ($1\frac{3}{4}$ pints).
Spain, 1875	149,807,000	,,
Portugal, 1871	31,956	pipes of 115 galls.
Italy, 1874	352,195	hectolitres of 22 galls.
Greece, 1874	481,057	ocques.

The extent of land under culture with vines in some of the principal wine-growing countries, according to the latest returns, was:

	Year.	Acres.
France..	1873	6,379,309
Algeria	1874	45,660
German Empire ..	1873	335,064
Bavaria	1863	54,653
Wurtemburg	1875	58,579
Austria	1875	391,935
Hungary	1873	998,558
Portugal	1873	469,064
Spain	1875	1,000,000
Greece	1873	123,550
Roumania	1873	247,000
Croatia	1873	162,642
United States	1875	2,000,000
Cape Colony	1875	18,177
Australian colonies ..	1876	16,000

France.—The vineyards of France form a very important part of the agriculture of the country. The vine is cultivated in the south, in Burgundy, and the borders of the Moselle and Garonne. The vine covered, in the close of the eighteenth century, an area of a little more than 1,500,000 hectares, now it extends over about 2,500,000, very unequally distributed in seventy-seven departments.

Every year above 5,000,000 kilogs. of grapes enter Paris, bringing to the municipality a revenue of 300,000 francs, arising from the *octroi* duty at 5·75 francs per kilog. Between August, 1873, and August, 1874, the commission houses received 3,500,000 kilogs., and 1,500,000 kilogs. were sold by auction, making a total of 5,000,000 kilogs.

The vine occupied in France, in 1871, an area of 6,043,000 acres, or more than $4\frac{1}{2}$ per cent. of the total surface of the country. The production of wine was 59,025,680 hectolitres, roughly valued at 62,000,000*l.* The average produce per hectare was 24·42 hectolitres, and the mean price 26·27 francs. The average return per hectare being 641·42 francs. The departments where the production of wine was largest were:

	Hectolitres.
Herault	9,581,000
Charente Inférieure	5,255,000
Gironde	3,689,000
Var	3,323,000
Charente	2,833,000
Aude	2,583,000
Gers	2,341,000
Gard	1,799,000
Indre et Loire	1,566,000
Loire Inférieure	1,256,000
Côte-d'Or	1,247,000
Vienne	1,209,000
Lot et Garonne	1,104,000
Saone et Loire	1,025,000

These 14 departments, of which the first 8 are situated in the south, furnish of themselves 66 per cent. of the total produce.

Taking the value of the yield, the departments do not stand in the same order. For instance, the most productive are (reckoning in millions of francs) the following:

	Francs.
Herault	196,000,000
Gironde	166,000,000
Charente Inférieure	105,000,000
Charente	57,000,000
Var	56,000,000
Indre et Loire	47,000,000
Gers	46,000,000
Lot et Garonne	44,000,000
Côte-d'Or	43,000,000
Saone et Loire	41,000,000
Gard	32,000,000

The vine has barely maintained its production in the vineyards which produce the choice wines, but in other localities where it has been largely manured and more productive vines have been substituted for those which bear less fruit, they now obtain double the quantity of grapes yielded thirty years ago.

In 1866 the average produce of wine stood at 30·10 hectolitres per hectare, while in 1840 the mean yield was only 18·65 hectolitres.

The vine is trained in 100 different ways in France. It is generally propped or supported in Burgundy, Champagne, Lorraine, Orleans, Macon, Touraine, and Berry. Most ordinarily it is cultivated on trellises, more or less elevated, in Bordelais, the Dauphiné, and the county of Nice. It has no support in Lower Languedoc, Provence, Saintonge, and Annis, and the culture is called the low vine system.

Those which grow on the slopes of mountains, or in localities where the temperature is not very favourable to the ripening of the fruit, are supported by maples, walnuts, and willows.

The vines which furnish the choice wines do not yield on the average above 15 or 20 hectolitres of wine per acre. On the contrary, those yielding the common wines often give, especially in the regions of the south and south-west, 120 to 150 hectolitres per hectare. There are, indeed, in Lower Languedoc, vines which produce in good years 300 up to 400 hectolitres per hectare. The value of the ordinary wines has largely increased in the last thirty years. In 1840 the medium price which the grower obtained was 11·40 francs the hectolitre; in 1866 it had risen to 28½ francs.

The following has been the production of wine in France, according to the statistics of the Minister of Finance:

	Hectolitres (22 galls.).		Hectolitres (22 galls.).
1860	39,558,000	1870	53,537,000
1865	68,943,000	1874	63,146,000

If we take other decennial periods for comparison we find that the production in hectolitres was in:

	Hectolitres.
1852	38,060,000
1862	48,630,130
1872	54,920,181

In 1872 there were 2,428,737 hectares under vines.

About one-fourth of the produce is white wine, the rest red. The value of the wine in 1872 was set down at 63,500,000*l*. The production of wine in 1871 was 59,025,680 hectolitres.

It is estimated that out of 63,000,000 hectolitres of wine produced in France 30,000,000 cannot be preserved or transported, and is therefore consumed at the place of production in the natural state; 4,000,000 hectolitres of wine are lost by diseases of the vines, 6,500,000 hectolitres are subjected to distillation, to furnish the brandy for the fortifying of wines, which, without this, could not be preserved.

Algeria.—In 1875 there were 12,182 hectares under culture with the vine in Algeria by Europeans. The produce, owing to a bad season, prolonged rains and fogs in spring, was but 196,313 hectolitres of wine. The natives are also increasing their culture, and had 7862 hectares under culture with vines.

United States.—The geographical distribution of the indigenous or wild vines of North America extends over four different botanical regions.

1. The northern region, embracing all the States north of the 38th parallel.
2. Those of the Southern States, Carolina, Georgia, Florida, Alabama, &c.
3. Those of the south-west, including Louisiana, Texas, Arkansas, and the eastern part of New Mexico.
4. California, Sonoma, and western New Mexico.

Besides these, European varieties have been introduced and acclimatized in the valleys of New Mexico and California.

The wild or indigenous American vines are the Scuppernong, *Vitis æstivalis*, *punctata*, and *cordifolia*.

Those cultivated are the Catawba in the districts of Columbia and Boston, the Clinton, Henshaw, Isabella, Hartford prolific, Bartlett, amber, Lobrusca, and Scuppernong.

The Henshaw and Scuppernong contain only about 8 per cent. of sugar in the pound weight, while the others range from 10 to 11½ per cent. The Clinton and Catawba contain the most sugar and alcohol.

The production of wine in the United States has been steadily increasing. According to the Census returns, in 1850 only 221,249 gallons were made; in 1860, 1,627,192 gallons are recorded.

The cultivation of grapes for vintage in America has increased to enormous proportions. In California, Missouri, Ohio, Pennsylvania, and Michigan the industry is considered very remunerative. In 1869, the total production was 3,092,330 gallons; 1,814,656 gallons from California; 326,173 gallons from Missouri; 212,912 gallons from Ohio, and the remainder from the other states. In 1870, Ohio alone produced 2,577,907 gallons of wine, and 15,853,719 lbs. of grapes. In 1874, owing to wet weather and the *phylloxera*, the quantity fell to 1,031,923 gallons; in 1872, to 425,923; and in 1873, to 208,289. In 1874 the *phylloxera* disappeared, and Ohio again produced 1,078,056 gallons. The places of cultivation are principally located on the shores and islands of Lake Erie. Large shipments of wine are at present being made to Europe.

Within a radius of 25 miles of Cincinnati it is computed that there are 2500 acres of ground devoted to the culture of grapes. In favourable seasons the average of wine per acre is 200 gallons, equal to 500,000 gallons as the whole crop for the section described; worth, fresh from the press, $500,000.

The Catawba grape, an indigenous variety, is now extensively cultivated in the west and south-west, and the Catawba wine bids fair to become an important article of commerce. In 1854 the vineyards comprised less than 3000 acres, the greater portion of which was in the vicinity of Cincinnati, from whence the grape culture has since spread, along both banks of the Ohio, to Pittsburgh and Cairo, and in a southerly direction through Kentucky and Tennessee to Alabama, and westwardly into Missouri.

On the Ohio an acre yields on an average 500 gallons of wine, an immense yield, compared with the average of France. In 1853, which was a most fruitful year, the yield was extraordinary, averaging along the Ohio 650 gallons to the acre, some vineyards even producing from 800 to 900 gallons. The wine growers of Ohio are mainly Germans and their descendants.

California.—The growth of vines in California is increasing very rapidly, and proper attention is being paid to the selection of sorts suitable to the soil. There are upwards of 31,000,000 vines. The State of Los Angelos has 4,500,000 vines, producing annually 1,500,000 gallons of wine. The produce of an acre is 12,000 lbs. of grapes, worth 5*d.* per lb. The kinds grown are the Mission grape, the White Muscat, the Tokay Blassien, the Rose, the Peruvian, and the Black Morocco. Up to within a few years the production of wine was confined to the "Mission grape," a variety introduced by the Spanish missionaries nearly a century ago. This grape makes a coarse, rough wine, varying in some degree according to the soil, but always inferior to that made from the vines imported from Germany, France, and southern Europe. Wines assimilating to the Hock, Muscatel, and Burgundy of Europe are now manufactured in Sonoma, Solano, and Napa counties in considerable quantities, and where the requisite attention has been paid to their manufacture, and they have been kept two or three years before being offered in the market, the quality is excellent, and cannot fail to create a demand for them in the eastern States and England. The southern grape is more particularly suited to the manufacture of wines resembling port and Angelica, and the latter is decidedly a superior article. Port is made here from very ripe grapes, those that hang on the vines until after the first frosts. The foot hills are particularly adapted to the cultivation of the vine, and in a few years the value of the wine exports may approximate to that of their grain. The oppressive internal revenue laws have sadly interfered with the manufacture of brandy, and instead of 1,000,000 gallons, which could have been profitably produced of late years, less than one-fourth has actually been manufactured. The quality must, however, be improved before there is any export demand for it.

There were two disastrous failures in the wine crop, owing to late and severe frosts; the yield of 1872 was only 4,000,000 gallons; and of 1873, 3,800,000, besides about 176,000 gallons of brandy.

The production of wine in 1874 was 7,000,000 gallons, besides the quantity necessary for the distillation of 200,000 gallons of brandy, viz. about 1,000,000 gallons of must; 308,167 gallons of wine were exported. The vineyard proprietors have begun to introduce French and Germans, in order to improve the quality of their wine.

The yield of the Californian vineyards for 1875 was about 8,000,000 gallons. The State has vinicultural land enough to make as much wine as France, Germany, Hungary, and Spain combined could produce; and there is no shadow of doubt among those who have given the subject the closest study, that California will in some future time out-rank every other wine-growing region in the world. The foot hills of this State, which are held at one-tenth the price of land in France, have a vast productive capacity, and seldom fail to produce a good crop.

In the early days of California wine-making it was supposed that in order to make a good wine grapes had to be over-ripe; hence the wines contained too much alcohol, and were too heavy for constant use. Of late there has been much improvement in this respect, which has been brought about by the introduction of European vines, having less saccharine and more acidity than the California grape. Producers have also learned that it is better to pluck the grapes before they are fully ripe than to await over-ripening.

One firm (Kohler and Frohling) use yearly 5,000,000 lbs. of grapes from Los Angelos vineyards, and purchase annually several hundred thousand gallons of wine. In five years more it is anticipated 300,000 acres of barren hills, worthless for other purposes, will be green with the vines, which love those sunny slopes so well.

In the vicinity of Coloma and the portion of El Dorado country sheltered by the grand old mountains, nestling by the river, overgrown with verdure, are more than two score vineyards, with hundreds of acres of bearing vines. No disease has ever been known among vines in this region, except perhaps a little mildew, but the frost and other meteorological influences sometimes injure crops. Mr. Robert Chalmers, in his Coloma vineyard has planted, on 110 acres, 110,000 bearing vines, comprising over forty varieties of foreign grapes. He makes from 6 to 10 tons of raisins yearly. It takes 3 tons of grapes to make one of raisins. The raisin crop of California for 1876 was estimated at 60,000 packages. The white Muscat grapes seem to take the lead, the raisins selling for 10 cents a pound, while Malagas are only worth 8 cents. The Graingers shipped 500 boxes of the crop to China, where they expect to open up a good market for a portion of the California raisins.

Mexico.—Vine culture and wine manufacture, although prosecuted on but a small scale, have been very successful, especially in the northern sections of Mexico. In many of the mountains of the Sierra Madre, vines grow abundantly, and show to what degree of prosperity this industry may reach when the producer can find his way to foreign markets.

Brazil.—The vine has been cultivated successfully of late in the provinces of São Paulo, Rio Grande do Sul, and also in certain portions of Rio de Janeiro, and Minas Gerães. In 1873 about 800 pipes, or 320,000 litres of wine, were produced, of an average value of 17*l.* each pipe. In many places 1000 vines would yield 10 pipes, or 4000 litres. The American vine commands a preference.

In many of the British colonies the culture of the vine has occupied a fair share of attention, particularly in Australia and the Cape of Good Hope, but there are many others in which it might be profitably extended. A pure unadulterated wine can be supplied from the Australian colonies, not only equal, but superior to the wines now in general consumption imported into this country from the continent of Europe.

Our colonies may, before many years, become important purveyors to us of the pure juice of the grape. A little more than ten years ago the average consumption of wine per head in Great Britain was less than a quarter of a gallon, now it exceeds half a gallon, and is steadily increasing. Our colonies, hitherto, have contributed little or nothing to our supplies, but many of them have all the requisites of experience, soil, and climate, and, under encouraging circumstances, will send us hereafter considerable quantities.

The Cape Colony.—When we look back and see that in former years the Cape colonists could ship 1,000,000 gallons of wine, it seems strange to find how this colonial industry has retrograded. In 1855 there were about 12,000 acres under culture with the vine in the western district of the Cape Colony, and the produce was 34,221 pipes of wine, and 4496 pipes of brandy. Vines covered 18,000 acres in 1875 as compared with 16,000 acres ten years before, and 4,500,000 gallons of wine were made, besides 1,000,000 gallons of brandy and other spirits. In 1851 we imported 408,281 gallons of wine from the Cape. But the imports have been gradually getting less year by year, until, in 1870, we only received 40,235 gallons, and in 1875 but 11,200 gallons. Some goes, however, to other quarters, for the total exports of Cape wines in 1873 were 75,200 gallons of ordinary, 778 gallons of Constantia, and 1048 gallons of brandy, besides the large quantity consumed locally. Cape wines are principally produced in the districts of Stellenbosch, Worcester, Swellendam, and George. In 1859 about 1,000,000 gallons were shipped; in 1865 only 193,000 gallons, and in 1872 but 78,000 gallons, exclusive of 371 gallons of the sweet Constantia wine. This serious falling off is partly due to the heavy duties imposed under the provisions of the treaty with France of 1860, which fixes the scale of duty at 1*s.* per gallon for wines under 26° of alcoholic strength, and 2*s.* 6*d.* per gallon beyond that. It is found necessary to fortify Cape wines considerably, with a view of preventing deterioration and fermentation on the voyage. The wine growers of the Cape, in these circumstances, are naturally anxious that an uniform duty, amounting to say 1*s.* 6*d.* per gallon, should be imposed on all Cape wines admitted into the United Kingdom, and that South African wines should not have a higher rate of duty imposed unless they contain more than 38° of proof spirit. As compared with the wine growers on the Continent of Europe, the growers in both the Cape and Australia are, at present, at a disadvantage.

The following shows the exports of ordinary Cape wines:—

	Gallons.		Gallons.
1857	946,316	1866	93,164
1858	802,748	1867	71,263
1859	1,094,542	1868	84,569
1860	551,787	1869	130,966
1861	317,035	1870	88,533
1862	225,097	1871	61,689
1863	319,146	1872	77,999
1864	175,601	1873	75,199
1865	192,869	1874	77,802

Australia.—If there is one fruit more than another which luxuriates in the sunny clime of Australia, it is the grape. According to statistics there were more than 17,000 acres under culture there with the vine, distributed as follows:

	Year.	Acres.
Victoria	1874	5,222
New South Wales	1872	4,526
Queensland	1874	376
South Australia	1871	6,131
West Australia	1874	775
Total	..	17,030

The wine produced by these is, in Victoria, about 714,000 gallons; New South Wales, 500,000 gallons; South Australia, 800,000 gallons. This is exclusive of the brandy distilled and about 10,000 tons of grapes sold.

The cultivation of the vine in Australia does not seem to have increased in the last few years, although a larger quantity of wine is made, the vines having become more productive. In the three principal wine-making colonies, New South Wales, Victoria, and South Australia, there were only 14,600 acres in 1875–6, but the production of wine is now more than 2,000,000 gallons against 1,800,000 in 1870. Almost all the wine is consumed in the colony where it is made, the export from the three colonies in the last recorded year having been only 80,000 gallons. The local consumption of European wines shows little diminution, and is still more than half a million gallons in those colonies.

South Australia may now be regarded as one of the wine-producing countries of the world. There the vineyards average for forty miles round Adelaide, at least 30 acres each; some exceeding 1000 acres and many attaining to 50. The whole of the country about the capital seems formed to be the home of those vines, which nature has destined to produce strong generous, full-bodied wines. If as much well-directed care and attention were bestowed on studying the true nature and capabilities of the must, as seems to have been expended on striving to force it to yield wines of a French or German character, the produce of South Australia would, ere now, have acquired even a better name than it enjoys.

In South Australia nature herself is opposed to the production of these high bouquet wines; there she demands consideration for body, sweetness, spirit, and other high qualities of generous wines. The Riesling and Verdeilho when not tortured, yield wines second only to the Bucellas of Lisbon, and the sweeter kinds of Madeira; while the Donzellinha, the Black Portugal, the Schiras, Malaro, and Grenache yield wines of the character of good port, such as it is known in Portugal, the strongest of Hermitage, and that peculiar produce known as Roussillon. The produce of the Australian vineyards may vie with those of the most favoured countries of southern Europe. The local consumption of colonial wines increases year by year, and it is considered that they would compete successfully with the light wines of France in the English market, were they admitted at the same rate of duty. The price is yet too high to enable Australian wines to come into consumption here; but if the rapid progress of production continues, there will soon be a large surplus to export to other countries.

Although at present wine can scarcely become an article of much export from Australia, it is interesting to watch the progress of the cultivation and to observe the rapid development of the vine. It was remarked in the Jury Reports of the London Exhibition in 1862, that with care and time, there is every prospect of these colonies becoming the great wine-growing countries of that part of the world. Since that opinion was enunciated, remarkable progress has been made and the quality of Australian wines has received high favour at the Dublin Exhibition of 1862; that of Paris 1867; Vienna 1873; and London 1873. There is, as might be expected, in dealing with an area almost continental, and considering the numerous varieties of the vine that have been introduced from all parts of Europe, an infinite difference in the produce. We there find wines of the character of the German wines, others resembling the French wines, whilst some have the substance and body of the wines of Spain. It was at one time considered that Australian wines would not keep well, but the question has now been settled in the affirmative, for their natural strength is such that they require no fortifying. The raisins dried in some of the Australian colonies are unsurpassed for size and flavour, and the same may be said of currants. In South Australia of late years the price paid for grapes for crushing has been for Tokays and Madeiras, 4*l.* per ton, and for Frontignacs, Verdeilhos, and Muscats from 4*l.* 10*s.* to 5*l.*

As many vineyards will yield 3 tons of grapes to the acre, it can be readily seen that vine growing is a really profitable investment. On comparison of the various figures, it will be found that the colonies of South Australia and Victoria far outstrip the older colony of New South Wales, which was the first to commence the culture of the vine. South Australia stands first and foremost as the fosterer of the vine and wine making, as the following figures show:

	Acres under Vine.		Acres under Vine.
1850	282	1860	3180
1854	408	1865	6364
1858	1055	1871	6131

In 1860 there were 1,871,751 vines in bearing, and 1,948,510 non-bearing, from which 182,087 gallons of wine were produced and 23,398 cwts. of grapes sold. In 1861 the planting of the vine proceeded vigorously in the colony.

In 1864–65 there were 6,586,009 vines bearing, and 2,831,971 not bearing; 798,647 gallons of wine were produced, and 30,627 cwts. of grapes sold for table use. In this year one-tenth more land had been planted with vines.

In 1871 the vines were 5,783,674 productive, and 385,084 not bearing; the wine made was 801,694 gallons, and the grapes sold 85,847 cwts.*

In South Australia the production of Zante currants, and Sultana and other raisins, is satisfactorily progressing; and many of the growers are grafting their inferior vines with these valuable varieties. The first sample of South Australian grown Zante currants sent to Melbourne were pronounced of better quality than those imported from Europe; and when we bear in mind the fact that more than 120,000*l.* of dried fruit are annually imported into the Australian colonies, a large opening presents itself for the development of this industry.

New South Wales.—The introduction of the vine into Australia is due to the efforts of the late Sir W. Macarthur, who in 1840 received cuttings from Europe and planted them on his estate at Camden Park about forty miles from Sydney.

The quantity of land laid out in vineyards in New South Wales in 1852 was but 1096 acres, from which 92,744 gallons of wine were produced, and 1581 gallons of brandy.

In 1872 the number of acres of vineyards had increased to 2466, and of these 1084 acres of vines were as yet unproductive. There were made 413,321 gallons of wine, 1765 gallons of brandy, and 508 tons of grapes were sold for table fruit, from vineyards exceeding one acre in extent.

New South Wales contains millions of acres of soil admirably adapted for the growth of the grape, of which nearly every European variety is rooted in the colony, and the produce of her vineyards compares well with those of the countries of southern Europe. The wines of the Albury district, on the Murray, are famous throughout Australia, and the produce of the Hunter River and New England country has been awarded many medals at the great International Exhibitions of London and Paris. All through the coast districts the grape flourishes, and generously rewards the grower. It is to be found in nearly every garden, and as an article of diet it is within the reach of the poorest in the land. The consumption of colonial wine increases year by year, and it is thought that the wines of New South Wales would compete successfully with the light wines of France in the English market, were they admitted at the same rate of duty. Wine-growing is a very profitable branch of agriculture in the colony, and may reasonably be expected, with the growth of population, to be more so. It does not confine its rewards to the large

* Mr. J. T. Fallon on "Australian Vines and Wines," 'Journal of the Society of Arts,' vol. xxii. p. 39.

capitalist, but will amply remunerate the man of small means who has the requisite skill and industry to enter upon it. One man can attend to 8 or 10 acres of vineyard by obtaining occasional assistance; and if he have any mechanical ability, he can, as many of the small growers, who are chiefly Germans, now do, make most of his plant himself. Should he have to buy the plant he will need a capital of from 50*l.* to 100*l.* A handy man who could do his own coopering would require less. A small grower could not reckon on more than 300 to 500 gallons of wine per acre. The largest manufacturer in the Hunter district has, in favourable seasons, and from certain kinds of grapes, obtained 1000 gallons per acre; but his average yield would not be more than from 600 to 700 gallons. Much depends upon the soil and the variety of grape. Five hundred gallons must be considered a good average yield. At 400 gallons to the acre, and 2*s.* per gallon for his wine-juice, the vigneron would get 40*l.* per acre, and 100 acres of vineyard would yield 4000*l.* a year, leaving ample margin for casualties. The labour in a vineyard may be reduced to a small percentage on the produce, by planting in such a manner that it can be ploughed in various directions, and by using suitable implements.

Victoria.—Following in the wake of New South Wales, and from cuttings obtained from Sir W. Macarthur's vineyards at Camden, the vine was introduced into Geelong, and as early as the year 1851 the Hon. D. Hope had fair vineyards there in full bearing, and producing a drinkable wine. The year 1855 showed 274 acres under culture in Victoria, producing 11,000 gallons of wine.

In 1865 there were 4078 acres in vineyards, with 8,199,618 vines, from which 176,959 gallons of wine were made, besides 18,063 cwts. of grapes sold.

The acreage under vines in Victoria in 1874 was 5222. The total weight of grapes gathered was 105,650 cwts., the wine produced 562,713 gallons, and the brandy 100 gallons. The brandy made is generally not sold, but used for the purpose of fortifying wine. On the 31st March, 1876, there were planted in the colony 12,060,685 vines, of which 11,071,813 were above three years old, 971,602 under three years, and 17,270 unspecified. The wine made in the year 1875 was 755,000 gallons, of brandy 256 gallons; 123,650 cwts. of grapes were made into wine, and 21,211 cwts. sold as table fruit.

Queensland.—There is a large quantity of wine made in this colony, some of which is very good after having the advantage of a year or two in bottle. It is almost all consumed in the neighbourhood where it is produced, and vine growers mostly look for profit to the sale of the fruit. From the great range of soil and climate, it may confidently be anticipated that some of the districts will yet acquire a reputation beyond the colony for their vintages.

PRODUCTS OF THE ORANGE FAMILY.

Next to the vine in commercial importance for its fruit comes the Orange family. For the production of oranges all the countries coming within the tropical and subtropical zones are well adapted. They abound in the East and West Indies and Pacific islands.

Formerly proximity to this country was an essential in the production of the orange and lemon, for commercial purposes, and hence we derived our supplies almost exclusively from Spain and Portugal; but the facilities afforded by steamers now enable us to obtain oranges and lemons in a good condition from more distant quarters. They now reach us from Malta and Sicily, West Africa, Brazil, the West India islands, and the Azores.

The following figures give the imports of oranges and lemons into the United Kingdom in the last twelve years:

Year.	Quantity.	Value.
	bushels.	
1865	1,566,745	..
1866	1,711,857	..
1867	1,453,566	744,732
1868	1,806,372	876,197
1869	1,939,363	927,804
1870	1,933,421	648,056
1871	2,376,831	1,008,954
1872	2,385,160	1,154,270
1873	2,308,208	1,120,309
1874	2,403,338	1,158,480
1875	2,861,719	1,336,247
1876	2,995,323	1,258,565

The official return for 1870 is the latest which gives specific details showing the countries from which we received our supplies. It includes lemons as well as oranges:

	Quantity.	Value.
	bushels.	£
Portugal	273,296	92,313
Azores	826,760	281,502
Spain	514,676	180,687
Sicily	287,909	83,823
Other countries	30,780	9,731
Total	1,933,421	648,056

The Spanish and Azores oranges are considered the best. Prices fluctuate a good deal. In 1870 they were, wholesale: for Portuguese, 6*s.* 9*d.* a bushel, Spanish 7*s.*, Italian 5*s.* 10*d.*

The ORANGE, in the widest sense of the term (*Citrus Aurantium*, Lin.), is a native of Southern Asia. It is a tree of great longevity, having been known to attain an age of 600 years and more. Any specific differences to distinguish *C. aurantium* from *C. medica*, if they ever existed, are obliterated now through hybridization, at least in the cultivated forms.

Four varieties of citrons are described which are cultivated in Sicily, and fourteen varieties of the orange, and there are several kinds of lemons and limes both with sweet and sour juice.

The limit of the culture of the orange is almost about the same as the olive, except that, according to Schouw, it extends a little farther to the north. It crosses the northern part of Spain, the extreme south of Provence, traverses Italy a little above Florence, descends nearly to Greece, and, passing by the Isle of Cyprus, enters Asia. In France the limit traversed is the country where the mean temperature is 14°, the spring temperature 12°·5, the summer temperature about 21°, and the autumn temperature 14°.

The orange, lemon, lime, citron, shaddock, and forbidden fruit, all belong to one genus, the *Citrus* of Linnæus. According to Lindley, there are fifteen distinct species, with a few varieties; Steudel* enumerates, however, twenty-five, besides numberless varieties. They are thought to be natives of the East, where they are found growing wild, and are not considered to be indigenous to America, although one native species is attributed to French Guiana. Six or seven of the choicest species are natives of China and Japan, and the rest of India, and other parts of Asia.

Risso, of Nice, in his large work, enumerates 43 species and varieties of the sweet orange, 32 of the bitter and sour, 5 of bergamots, 8 of limes, 6 of shaddocks, 46 of lemons, and 17 of citrons.

In Central India a peculiar variety of *Citrus Aurantium* is under culture, producing two crops a year. The blossoms of February and March yield their ripe fruit in November and December, whereas from the flowers of July mature fruits are obtained in March and April. To prevent exhaustion, only alternate fruiting is allowed.

As a prominent variety of *Citrus Aurantium* may be distinguished the bitter orange (*C. Bigaradia*, Loisl.). This furnishes from its flowers the Neroli oil, so delicious and costly as a scent. The French are endeavouring to promote the manufacture of the essential oils of lemon and orange in their inter-tropical colonies. A machine or apparatus has been sent to Guiana, one to Tahiti, and another to Martinique. The French settlements in the Pacific send millions of oranges to California, although 5,000,000 or 6,000,000 are produced there. The annual requirements of the San Francisco market are over 12,000,000, of which 5,000,000 are imported from Tahiti and Mexico. A part of the crop is made into an excellent spirit, and the rest are wasted. In Martinique many houses make large quantities of orange wine, which finds a ready sale in Turkey and Russia. The oranges employed for these diverse uses might be first made to yield their essential oil from the rind. Oil of oranges sells at about 7*s.* per lb., and oil of citron or bergamot at 10*s.* to 25*s.* per lb. These high prices are likely to stimulate an industry which has hitherto been monopolized by Sicily. It is stated that orange flowers

* 'Nomenclatur Botanicum.'

to the value of 50*l.* might be gathered from the plants on an acre within a year. The rind of the fruit is used for candied lemon peel. It contains a bitter principle, hesperidin, and limonin, in the seed.

Of the sweet orange (*C. dulcis*, Volkamur), many kinds occur. The St. Michael's orange has been known to bear in the Azores, in sheltered places, 20,000 fruit on one tree in a year. Neroli oil is also obtained from the flowers of this and allied varieties. An infusion of the leaves of the orange, in the form of tea, is considered efficacious in fevers; and when amalgamated with the flowers, it acts as a stimulant, and is given as a tincture when its effects are required to be energetic. The seeds contain a fixed oil, of an amber colour, which is highly valued for reducing swellings, and as an excellent oil for the hair. It may also be used for the table. From the flowers an odoriferous perfume is extracted, and they constitute an excellent stomachic. In the mandarin orange (*C. nobilis*, Loureiro), the thin part separates most readily from the deliciously flavoured sweet pulp. There are large and small fruited mandarin oranges; the Tangerine variety is one of them.

The shaddock, or pumpelmos (*C. decumana*, Lin.). This fruit will exceptionally attain a weight of 20 lbs. The pulp and thick rind can both be used for preserves. *Citrus Bergamium*, Risso. From the fruit rind of this variety bergamot oil is obtained, and also oil from the flowers. The Mellarosa variety furnishes superior oil, and exquisite confitures. All the varieties of the orange tribe may be raised from seed. Those thus raised will produce fine fruit, and if not suffered to grow to trees, may be used as stocks for budding. The bitter orange and the citron are, however, considered the best stocks for the sweet orange. Once fairly in growth, it requires only to be attended to, and plentifully watered in dry weather, with a supply of manure from the cowhouse. The orange may also be propagated by layers.

The Citron, in the widest sense of the word (*C. Medica*, Lin.), is indigenous to southern Asia, but is widely diffused. As prominent varieties may be distinguished: the real citron (*C. cedra*, Gallesio). From the acid tubercular fruit essential oil and citric acid can be obtained, irrespective of the ordinary culinary use of the fruit. A large variety, with thick rind, furnishes the candied citron peel or succade of Italy. Five hundred or six hundred tons of candied peel are said to be used in this country. The cedrat oil comes from a particular variety.

The real Lemon (*C. Limomum*, Risso). From the fruit of this is largely pressed the lemon juice, while the thin, smooth, aromatic peel serves for the production of volatile oil, or for condiments. The sweet lemon (*C. lumea*, Risso), includes the pear lemon, with large pear-shaped fruit. The rind is thick and pale, the pulp not acid. This variety serves for particular condiments. The juice of this fruit is especially rich in citric acid. A large variety is the Rosaline lemon. Among the many cooling drinks for which American hotel-keepers have a *spécialité*, lemonade is not wholly forgotten. Their demands, indeed, give activity to a flourishing industry in the south of Europe. The lemon growers of Mentone depend greatly on American custom, which they almost entirely monopolize, as the lemons produced in the districts surrounding this port, being of a very superior quality, have the merit of bearing a long voyage uninjured, provided they are carefully packed previous to their embarkation. The lemons cannot bear the shock of removal in a cart, and are carried in baskets to the packing shed, where they are severally wrapped in silver paper, and laid in rows in the packing cases, care being taken to pack them loosely enough to avoid bruising the fruit, and yet tightly enough to prevent their becoming displaced during the voyage. The American steamers engaged in this trade carry 5000 cases; the case contains 500 lemons, and therefore each of these vessels conveys 2,500,000 of this useful fruit to the United States.

The real Lime (*C. Limetta*, Risso). The best lime juice is obtained from this variety. In several of our colonies attention is now given to the production of this article. From the island of Dominica, in 1874, 12,462 gallons, valued at 1600*l.*, were exported.

The requirements in the culture of the lime are very simple, and consist mainly in keeping the trees free from weeds, allowing them to spread freely, and irrigating during the dry months. No pruning is required, but merely the removal of exhausted and dry branches. Although the lime tree delights in a good soil, and is strengthened by a degree of moisture somewhat above the average, being a hardy plant it will thrive and be fruitful in soils and situations that may prove too poor and dry or exposed for coffee and cacao. Protracted drought is particularly fatal to the lime tree. The process of extracting and preparing the lime juice is most simple, consisting of submitting the fruits to the pressure of a mill of no great power, and boiling down the resulting juice (which may be kept a great length of time without deteriorating) to the required density, and putting it into casks for exportation. The density which has been found most satisfactory in Dominica, is reached by boiling down to one-eighth the original volume. In Jamaica, lime juice has been, of late years, concentrated and shipped to America, to be used in fixing certain dyes. The exports, in 1874, amounted to 107,558 gallons, of the value of 5378*l.*; 475 barrels of limes, worth 190*l.*, and nearly 5,000,000 oranges, were shipped from Jamaica in 1874. From Montserrat 400 to 500 puncheons of lime juice have been shipped in the year.

The quantity of oranges and lemons we receive in the United Kingdom has doubled in the last ten years. Our imports, in 1876, reached nearly 3,000,000 bushels, of the value, in round numbers, of 1,300,000*l.*

The imports of oranges, citrons, and lemons into France from Spain and Italy have increased fourfold since 1836, when only 5,943,022 kilos., valued at 111,660*l.*, were imported; in 1866 the quantity received had increased to 25,923,700 kilos., valued at 296,553*l.*

Marseilles receives the largest quantity. The imports there were, in

	Kilos.		Kilos.
1836	2,217,589	1856	9,214,537
1846	7,133,758	1866	9,592,120

Algeria.—The orange grows in all parts of this French colony which are not above 2000 feet elevation, especially in sheltered situations, and acquires an excellent flavour and aroma. Besides the orange proper, the citron and lemon, the cedrat and the pumpelmos, are grown. Among the oranges are numerous varieties, among which the best known are the Portugal, Chinese, and mandarin, the bigaradia, or bitter orange, useful for making orange-flower water, essence of bergamot, mellarosa, &c. The fruit of the orange tribe is becoming yearly an article of larger importance.

In 1865 there were 3095 planters, of whom 728 were European; there were 130,411 orange trees in bearing, and 72,447 young trees; 14,285,580 oranges were exported in the year. The province of Alger contains more orange groves than the other two. Blidah is the centre of production, and the orange groves in its vicinity form an evergreen circle of more than 500 acres. In 1873 there was exported from Morocco 1,577,700 oranges, valued at 927*l.*

The Azores.—Previously to the year 1842, from 20,000 to 30,000 boxes of oranges were annually exported from Fayal; but owing to the attacks of the insect *Coccus hesperidum*, which destroyed the trees, for several years no oranges were produced. The insects have, however, been gradually disappearing, and the exportation of oranges is augmenting.

The trees are planted at a distance of from 25 to 30 feet apart, and the ground sown with lupins, which are considered by the Portuguese to be a favourite food of the orange trees. Seven years elapse from the time of bearing before the orange trees come into full bearing, during which space of time, more especially among the poorer class of proprietors, the garden is sown with melons, water melons, and other vegetables. The trees are pruned every year, so that by thinning out their superfluous branches a free circulation of air is allowed, which is required for the proper ripening of the fruit. The orange grounds at the Azores vary in size from 1 to 60 acres, and they are rarely occupied only by orange trees. The Portugal and mandarin orange are those principally grown.

The exports from the Azores between 1851 and 1857 averaged about 130,000 boxes. The following shows the export since then in bushels:

	Bushels.		Bushels.
1858	495,426	1870	826,760
1860	627,709	1871	897,773
1867	471,304	1872	817,927
1868	727,923	1873	628,549
1869	625,434		

In 1861, 209,263 boxes of oranges, valued at 101,287*l.*, were shipped from St. Michael's, and in 1862, 182,723 boxes, valued at 59,696*l.* They pay an export duty in the island of 8½*d.* per box. The box may be said to hold about 3 bushels.

In 1869 there were shipped from St. Michael's 238,194 large boxes of oranges. Some shipments are made in what are termed Russia boxes, three of which are equal to two large or London market boxes. They are also shipped in half or flat boxes, third, and quarter boxes.

In 1870, 283,712 large, or London boxes, were shipped to Great Britain, and 6798 boxes to the United States. In the export of this fruit to Great Britain 243 sailing vessels and 30 steamers were employed. The value of the oranges shipped, taking each box at 5*s.* 4*d.*, was 77,814*l.* The shipping season extends from October to April. There is occasionally a considerable crop of what are called summer oranges (*redolta*), which are very inferior, and scarcely cover prime cost and freight when sold in the English market. The oranges which ripen in the summer months are not only deficient in sweetness and flavour, but are far more susceptible of damage in transport.

New South Wales.—Oranges and lemons are grown without difficulty in this colony where the soil is heavy; they do not thrive at Sydney on account of the sandy soil. In favourable situations they are as fine as can be wished. One man (according to Mr. Atkinson) has made as much as 1500*l.* per annum from 3 acres of orange garden.

The mandarin orange, a celebrated Chinese fruit, is said to be better at Sydney than it is at Canton. It is a very beautiful dark orange-coloured fruit, with a highly perfumed rind, scarcely thicker than brown paper, and not adhering to the pulp, which is exceedingly sweet, and of a different flavour to any other orange.

A considerable portion of land is devoted to the orange, particularly in Cumberland, where a fine market and an accommodating railway are to be found. Thousands of cases come down to Sydney annually from the Parramatta orangeries, and are shipped to Melbourne, South Australia, Tasmania, New Zealand, &c. The profits of orange-growing are, when the practical management of the tree is understood, very considerable; but in many cases the trees have been exhausted by being allowed to bear heavily year after year, without any attempt to recruit their jaded powers by the administration of manure. Most of the orangeries are new; but in some of the older ones the trees have attained a height of 35 feet, the diameter from the extremities of the branches being 33 feet. From trees of this size, of which there are few in the colony, 12,000 oranges are occasionally picked in the year, which, at 6*d.* a dozen wholesale, would give 25*l.* as the value of the yield of a single tree. The plantations are generally young, and the trade in oranges and lemons is likely to assume large proportions; but the growers will have to master the principles of drainage and manuring, and apply them, before they will be able to preserve their trees in a healthy state.

A paper by Dr. George Bennett, F.L.S., "On the Introduction and Cultivation of the Orange in New South Wales," published in the New South Wales Catalogue for the Paris Exhibition, 1867, and in the Intercolonial Exhibition Official Record, Victoria, 1866, may be consulted with advantage.

In the immediate vicinity of Sydney there exist orange groves as extensive and magnificent as any which have ever gladdened the eyes of travellers in Spain or the Azores; the orange and other members of the citron family grow luxuriantly in the valleys of the Hunter and the Clarence; and, indeed, all along the coast districts of New South Wales, over a belt of country 300 miles in extent. Some of the trees in the Parramatta orangeries, half a century old, have attained a height of 35 feet, and their branches a circumference of nearly 100 feet. Sometimes a single tree will produce as many as 12,000 oranges in a year; and the small variety known as the mandarin has borne 4200 upon one tree during the season. During the month of October, oranges of every kind come into the Sydney market in enormous quantities; and at that season 6000 dozen per week are often exported to Melbourne alone. Lemon trees grow in the same orchards with the orange, and are so loaded with fruit as to require support. In this congenial climate every species of *Citrus* flourishes, the seedless St. Michael's, the large and luscious "navel" orange, the little cumquat from China, and, equally well, the citron and the shaddock. From 50*l.* to 1800*l.* are realized by the proprietors annually, as the incomes from the produce of their orange plantations, according to the extent of fruit-bearing trees. One grower, in the vicinity of Sydney, sold in a year for exportation 40,000 dozen, leaving 20,000 dozen for home consumption. The price paid by the dealers on the ground for the fruit varies from 4*d.* to 2*s.* per dozen, according to the kind and quality.

Few persons visit Sydney without seeing, or at least without a desire to see, the Parramatta orangeries. The location is some 16 miles from Sydney, and about the same distance from the sea in a westerly direction. As soon as a landing is effected there one finds that he is in a fruit country. Oranges abound everywhere. The goods traffic of Parramatta is made up largely of oranges. Orange boxes, full and empty, meet the eye in all directions. Every second man, woman, and child, are eating oranges.

The orange is a surface-feeding plant. Where old trees are growing, the surface of the soil is an absolute network of fine rootlets. These rootlets should not be injured in cultivation; hence the use of the Dutch hoe. To keep up the fertility guano is extensively used. As soon as a tree shows signs of languishing it gets a dose of guano-mixture, say a couple of pounds. This is spread around the tree on the surface of the land, and is then touched in with the hoe. Both trees and fruit, by this treatment, are beautifully clean.

Concerning the varieties of oranges cultivated, seedlings are most in favour. Next to them are grafts upon the bitter orange stock. The lemon, as a stock, is considered the cause of deterioration in the orange, and the source of scale and other diseases. In selecting seed for sowing, the planter chooses the fullest and finest oranges; he will have nothing to do with refuse fruit for such purposes. The seed is sown wide apart, that the young plants may have space. The system of raising seedlings in close rows is found to cramp their growing capabilities. All through there is a desire to get large, vigorous, perfect trees, and to that end it is not considered desirable to force them into early bearing. Seedlings take many years (five or six) to come into bearing, but they make the finest trees, and that is considered all-sufficient for the Parramatta growers.

South Australia.—In this colony the orange thrives wonderfully well. Whole acres of healthy trees, laden to the very ground with golden fruit, may be observed around Adelaide, and in many parts of the country to the north and south of the capital. In the month of June the market price of oranges in Adelaide is 3*d.* a dozen. Every year somewhere about 50,000*l.* worth of oranges are exported from New South Wales and South Australia to Victoria and those of the other colonies where the cultivation of this agreeable fruit does not appear to be attended with much success.

It is a good many years since the first orange trees were planted in South Australia, and although now there are considerable plantations, and every year numbers of young trees are coming into bearing, some time will elapse before the colonists are able to supply our own consumption of that most delicious of fruits. Thousands of pounds are sent away every year for Sydney oranges, without which not more than half the local demand that exists could be supplied. In regard to quality, the fruit produced by the local growers bears favourable comparison with that received from the sister colony, and this will be even more the case as the trees get older and our horticulturists become better acquainted with the proper methods of orange culture. Lieutenant Field, R.N., is said to have introduced the orange tree here early in 1837; others state that the first trees were planted by the late Mr. George Stevenson in the year 1840, or thereabout, at North Adelaide, and they are, therefore, now about 35 years old. One of them has been known to yield 190 dozen of oranges, which is the largest authenticated yield taken from one tree in the colony, although several of those at Ashford are computed to bear 150 dozen and upwards. When the success of Mr. Stevenson's experimental planting became known, several other colonists, without much delay, set to work to secure themselves more or less extended plantations of a tree of such high European reputation as the orange, so that there are now a good many hundreds of trees in bearing; but, for a variety of reasons, comparatively few have attained anything like the productiveness for which the tree is credited in Spain and other parts of southern Europe, where trees are spoken of that yield some thousands of dozen of fruit in a year.

United States.—Oranges are cultivated in Florida as easily and produce as quickly as the apple, and yield in full bearing from 1000 to 2500 per cent. per acre to the owner on the ground at current prices, and with but trifling labour. The superior ripe fruit must end ere long in supplanting the half-ripe foreign fruit of which now there are nearly 1,000,000,000 of oranges and lemons imported into the United States annually, to New York alone 500,000,000, or half of the entire amount. On one property on the St. John's River, the Sanford Grant, of 25 square miles, which was purchased in 1868 at about $1 per acre, lands for orange culture have been sold of late years at an average of $50 per acre, and up to $150 per acre. Land purchased at $250 an acre and planted in orange trees, has been sold three years after at $1000 per acre.

Green peas, strawberries, tomatoes, &c., can be grown the winter through in the open air, in profitable union with the orange culture. The banana, guava, and breadfruit also thrive there.

Thirty or forty vessels are constantly engaged in carrying fruit to New York from the West India islands. They draw their supplies from Jamaica, Trinidad, Cuba, and the Bahamas. West Indian oranges are preferred for their flavour to those brought from Europe. They begin to arrive in October, and are most abundant in January and February; Mediterranean oranges are not received extensively until April or May.

California.—Oranges and lemons, with more or less protection, grow luxuriantly along and near the line of coast for 500 miles.

In 1874 the State of Los Angelos had 90,057 orange trees, which furnish from 1000 to 3000 fruit each, and these sell readily at 2*d.* a piece. The tree takes 12 years to come to maturity, and the lemon 16 years. Many of the latter trees yield 20*l.* profit yearly to their owners. There are in the State of California 13,606 lemon trees.

Bahamas.—The quantity of oranges shipped from the island of New Providence to the United States, in the season of 1875, was about 2,000,000, in 20 vessels, 6 of which took 150,000 or more per load. The largest cargo was 320,000 (equal to 1280 barrels). The trade is conducted in schooners, with the exception of the generally smaller quantities that are carried away by the steamers which call at the port. Eight of the 20 vessels carrying oranges were steamers. As a barrel is stated to hold, on an average, 250 oranges, the number shipped to the States from Nassau is equivalent to 7594 barrels. The 'Nassau Times' states 2,000,000 were also shipped to the States direct from Abaco, Andros, Eleuthera, and other of the islands, and the total shipped from the group was about 4,000,000 fruit (equal to 16,000 barrels), estimating the average price at 30*s.* per 1000, worth 6000*l.* to the growers. Adding the smaller shipments to London, along with grape fruit and shaddocks, it believes the crop of the season would realize 7000*l.* Extensive orange orchards having been lately planted in the islands, the trade is expected to soon double itself in quantity, increasing further by the greater productiveness of the trees as they approach full bearing; but with such increase a decrease in price is considered possible.

In *Tahiti* there were, in 1874, 48,927 orange trees, which produced 11,260,000 oranges, valued at 281,200 francs.

The progress of the exports of oranges from the island is shown by the following figures:

1849	151,000	1864	5,000,000
1850	373,000	1873	4,500,000
1851	3,043,000	1874	5,000,000
1852	6,670,000		

The orange trade between Tahiti and San Francisco is declining in consequence of the progress making in the culture, and the abundance of the produce, of Los Angelos, and the south of California. The price of Tahiti oranges has fallen from $60 to $15 the 1000.

Italy.—A large trade is carried on between New York and Italy in green fruit. In 1869 nearly 500,000 boxes of oranges, containing about 113,000,000, were received from Palermo and Naples. The steamers employed make the voyage in about 28 days, and carry from 13,000 to 15,000 boxes. In the same year (1869), 243,790 boxes of lemons, in all 85,664,000 were received. The box of oranges contains on an average 226 fruit; the chest, which is a box and a half, would have 340.

A full-grown orange tree yields from 500 to 2000 fruit annually, and arrives at the bearing state in three or five years, as does the lemon tree; both grow luxuriantly in most soils. The plantations (in the Mediterranean countries) are called gardens, and vary in size, the smallest containing only a small number of trees, and the largest many thousands. The fruit is gathered in baskets lined with canvas, the basket being held by a strap attached, and passed around the neck or shoulders. From the garden the fruit goes to the packing magazine, where it is removed from the boxes in which it was placed in the gardens, and repacked for shipment by experienced female packers, after having been carefully assorted by women, and wrapped in separate papers by young girls. As many as 500 persons (mostly women and children) are employed by some of the fruit growers in their gardens and magazines, in gathering, sorting, and packing for shipment, the wages paid them varying from 9 to 16 cents a day. In sorting, every fruit that wants a stem is rejected. The boxes are then securely covered, strapped, and marked with the brand of the grower, when they are ready for shipment. Twenty years ago, this trade was trivial in its commercial characteristics, or the inducements it offered to capitalists. Now it is progressing with giant strides into prominence, and is a considerable source of revenue to the Italian government.

Sicilian lemons, which were formerly very plentiful, have been getting scarce of late years, and the island can with difficulty supply the demand for the United States, which is always large. The consequence is that prices have risen considerably, and essence of lemon, which used to be 8*s.* per lb., is now 19*s.*; while boiled lemon-juice is nearly double its former price. Leghorn was the great seat of the candied citron trade, about 5000 boxes (1000 to 1100 tons) being exported in good seasons. But the trade has declined, as more sugar is lost in making the citron than the government allows drawback on.

In the province of Salerno, Italy, there were gathered, in 1874, 100 cwts. of citrons, 150 cwts. of mandarin oranges, at Pagani; Monticorrini possesses 500 orange trees, which yield from 25 lbs. to 1 cwt. of fruit. Most of this fruit is sent to Rome, Naples, and Sorrento.

The exports of oranges, bergamots, and lemons, are given in the Italian returns in kilogrammes of $2\frac{1}{5}$ lbs. The following will serve to indicate the course of trade:

	Kilos.		Kilos.
1862	45,829,894	1869	88,098,468
1863	68,807,140	1870	77,701,673
1864	64,414,125	1871	88,784,000
1865	69,223,276	1872	87,526,000
1866	90,151,696	1873	83,241,000
1867	67,219,463	1874	70,403,000
1868	71,460,936	1875	94,236,000

Spain.—The export of fruit forms an important branch of Spanish commerce; Malaga is the centre of the dried fruit trade; Seville, Valencia, and the Balearic islands, for oranges and citrons. The orange crop in the Balearic islands is beginning to show some signs of improvement, and it is hoped by the growers that the worst of the fatal disease which destroyed the trees is over, but it must be some years before the exports in this fruit return to their former figures.

Citrons are exported from Malaga in their green state, in cases weighing 80 kilogrammes, half cases, and quarter cases, each fruit being carefully wrapped in paper. The shipments were in 1871 39,027 cases. They are chiefly shipped to the United States. The localities of production are Pizarra, Alora, and Coin, in the neighbourhood of Malaga. 7,876 cases of oranges were shipped from Malaga in 1871, and 267,628 kilos. of orange-peel, which is largely consumed in Holland, France, and Germany, chiefly for making liqueurs and syrups.

The export of oranges from Spain is shown in the following return in thousands of oranges :

1863	156,722	1870	228,640
1864	101,397	1871	445,220
1865	133,897	1872	581,610
1866	189,333	1873	699,956
1867	298,431	1874	877,000
1868	188,512	1875	574,000
1869	272,052		

At Antwerp, in 1874, 39,639 boxes of oranges were received, and 4058 boxes of citrons, chiefly from Valencia, Seville, and Palermo.

Greece.—The Isle of Naxos, in Greece, ships to England more than half a million citrons annually, but could easily export several millions. They are collected and shipped as they ripen, the want of labour alone prevents their being preserved on the spot. The culture of citrons has been abandoned for cedrats. The gross export of oranges and lemons from Greece has rather fallen off of late years. In 1870, 47,111,000 were shipped, and, in the next three years, an average of 36,600,000; but in 1874 a little over 16,000,000 were shipped.

THE PINE-APPLE.

The Pine-apple (*Ananassa sativa*, Lindley) is one of the most esteemed of tropical fruits. Formerly great attention was given to forcing this fruit in England; but the large importations now made at certain seasons of the year have increased the foreign supplies, and somewhat reduced the price of home-grown fruit, still it is brought to great perfection by our gardeners.

The pine-apple is indigenous to South America and some of the West India islands, but has become so perfectly naturalized in many parts of the hot regions of Africa and Asia, that it has been thought to be likewise a native of those countries. It is now found in an almost wild state in most parts of India and Ceylon, and is abundant also in the Malay Peninsula, the Straits Settlements, China, and the islands of the Eastern Archipelago.

The varieties cultivated are very numerous. In the Transactions of the Horticultural Society of London, for 1835, Mr. D. Munro gives a list of 52 kinds, which fruited in the Society's garden at Chiswick; of these the following may be enumerated: the queen, the sort generally grown by gardeners for the London market; the Moscow queen an excellent variety; the black Jamaica; the brown sugar-loaf, Ripley, St. Vincent, and black Antigua, excellent and highly flavoured pines; Enville, a handsome fruit, lemon queen, and white Providence, a handsome showy kind. The Trinidad or La Brea pine, is a very fine large fruit, some reaching at times to 28 lbs. weight.

Bahamas.—The pine-apple is grown for export in the Bahamas in fields of large size, and of considerable extent. The cultivation of this fruit is carried on chiefly at Eleuthera, Abacos, and San Salvador, but the plants are also grown on some of the other islands. They are of two kinds, the sugar-loaf, which is the best, and the Spanish or red pine, an inferior fruit. They are cut in a green state in order to keep during the voyage; arriving in a sound state, they pay very handsome profits. In 1872, 590,665 dozens of pine-apples, valued at about 42,000*l.*, were exported. In 1874 the quantity shipped was valued at 40,066*l.*, the sale of one cargo in London being as high as 1000*l.*, by one of 14 vessels engaged in the trade.

The cultivation of the pine-apple for export was formerly confined almost exclusively to the island of Eleuthera and its keys or islets, it being erroneously supposed that the soil there was alone adapted to the growth of the fruit; but of late years the culture has been extended to many of the other islands, as well as New Providence, where large quantities are grown and annually exported to various quarters, and, meeting with a remunerative sale, afford both grower and shippers very handsome returns.

The simple mode of testing the capability of the soil for growing the pine-apple in the Bahamas is by running a knife down it in dry weather, and if any portion of the earth adheres to the knife, it is considered by the planter an evidence of the suitability of the soil.

In the island of San Salvador there are fields of pine-apples, containing 25 to 60 acres in a block. In good seasons the yield is about 800 dozen per acre.

The season for shipments of pine-apples is from June 1 to July 15. The average passage to London is 31 to 35 days. When ripe, they are liable to decomposition on the passage, and are, therefore, shipped in a green state, and ripen on board. Sometimes on arrival, if not sufficiently ripe, they are placed in warming rooms. Rainy and damp weather is very injurious to pine-apples, and if combined with a long passage, will render them worthless. The sugar-loaf pines are those chiefly shipped to London; the scarlet pine, which is heavier, to New York, where, the passage being shorter, they are shipped in bulk.

The number of cargoes usually arriving each season is nine to eleven, and the vessels bring about 48,000 pine-apples each; 1300 pines weigh about a ton. The hold of each vessel is fitted with three or four racks or battens of wood, supported by upright posts, thus forming three or four shelves or platforms, the entire length and depth of the hold, with the exception of the centre, where a passage is left from stem to stern for admission. The fruit is then placed, with a portion of its foliage on, to protect it from bruising, in layers of about four pines deep, upon racks, which are built to prevent the great pressure that would otherwise be upon the lower portion of the fruit.

Within the last three or four years a steam factory for preserving pine-apples has been started at Nassau, New Providence. In 1872, 494,213 cans of pine-apples, valued at 8190*l*., were preserved and exported, chiefly to the United States. In 1873 the value of the canned fruit shipped was 14,700*l*.

There is a large local demand for tinning it, and 113,000 dozen fruit were bought by one firm at Nassau, filling more than 1,000,000 cans with sliced pine-apples. For canning, the pines are required fully ripe, and to average 15 inches in circumference, none to be less than the usual shipping sizes, 13 inches and 12 inches for first and second cutting scarlet, and 12 inches and 11 inches for sugar-loaf.

The operation of peeling and slicing is performed on tables in the yards of the waterside premises, over which an awning is placed to protect the operators from the influence of the sun. About 20,000 pine-apples are peeled and 12,675 cans filled in a day. The cans are carried to the warehouse on wooden trays (each containing 15), to be immersed in syrup. The tops of the cans are soldered on, and they are lowered in an iron framework, 400 and 500 at a time, into the steam boiling vats. After boiling, the cans are perforated at the top to allow the steam to escape. They are then hermetically sealed, and spread over the yard to cool. Each can of fruit, before the syrup is added, weighs 2 lbs.

Mr. H. Spruyt, Professor of Agriculture at the School of Vilvorde, gives, in his 'Jardin Potager,' some very useful instructions as to the cultivation and selection of pine-apples in Europe. These will be found reprinted in the well-known periodical, 'Belgique Horticole,' for 1871, pp. 324-339.

As it does not seed, this plant is propagated by suckers. Occasionally the crown of the fruit (the small aggregated mass of leaves) is planted; but as this requires three years to arrive at fruit-bearing, and the suckers only take 12 or 18 months, the suckers are preferred for propagation. They should be planted in rich red soil, about 18 inches apart, and weeded every three months. Careful cultivation greatly improves the size and flavour of the fruit. In the Botanical Gardens of Singapore the enormous golden yellow fruit measure often 4 feet long by 9 inches wide, forming a remarkable contrast to the puny pine-apples which appear on the London fruit-stalls. A field of wild pine-apples, such as cover many of the islands in the Straits of Malacca, is almost as inaccessible as a field of cacti, and the leaves, with their sharp points, are a formidable obstacle to the naked legs of the marauders who desire to obtain the fruit.

New York now almost monopolises the trade in pine-apples from the West Indies. In 1854, 20 cargoes, averaging 80,000 dozen per ship, were imported there from Cuba, 20,000 dozen from St. Bartholomew, and 200,000 dozen from the Bahamas. The shipments from the Bahamas in the three years ending 1870 averaged 290,000 dozen, the great bulk of which went to the United States. In 1871 there was a much larger shipment, amounting to 449,418 dozen, valued at 41,876*l.*

The prices for pine-apples range from 3*s.* to 4*s.* per dozen, plantains and bananas, 2*s.* to 3*s.* the bunch, oranges 4*s.* 2*d.* the 100. In 1872 pine-apples in New York fetched 15 to 17 dollars the hundred.

There are numerous varieties of pine-apples; one of the best is said to come from Guayaquil. Nichau, one of the Sandwich Islands group, produces an exquisite fruit, such as is rarely met with either in the East or the Pacific. In Europe some of the varieties cultivated are the Montserrat, Cayenne, Enville, and others.

Although the culture of the fruit for export was at first restricted to the Bahamas, now Jamaica, St. Bartholomew, Trinidad, the Azores, and other quarters, have entered into the trade. The first shipments were made in 1842 to Liverpool from the Bahamas.

The Jamaica Colonial Botanist, writing in 1875, reported that five acres of this valuable fruit were being planted, and two acres of this plantation would consist of the fine variety known as the Ripley. About sixty plants of the fine new varieties, viz.: Enville, prickly Cayenne, smooth Cayenne, Providence, and Charlotte Rothschild, introduced several years ago at Castleton, have been transferred to Hope; and the stock plants, numbering as many more, were to be removed from the same place shortly, as the climate of Castleton was found far too damp for the successful growth of this plant. It is remarkable that the Hope, and the locality immediately surrounding it, to the extent of a few square miles only, is the best adapted spot in Jamaica for their culture. This is attributable in a great measure to the peculiar conditions of climate, which are exactly suited to the development of the plant, and also in some measure to the suitability of the soil. On the extension of the plain to the south of Hope the climate is too arid.

Notwithstanding the advantages indicated for the production of this fruit, as well as the existence of a fortnightly line of steamers plying between Kingston and America, where the demand for this and other fruits is unlimited, it is a matter of notoriety that the largest plantation of pines, as far as I am aware, is in extent not more than about a quarter of an acre, and probably the five-acre plantation will comprise an area equal to the whole extent under cultivation in the locality. Choice pines from this district are sold in Kingston at from 9*s.* to 12*s.* a dozen. The price realized in New York for the best Jamaica pines is upwards of 1*s.* each. It will, therefore, be a moderate estimate if each pine is valued at 6*d.* In the Bahamas 20,000 suckers are usually planted to the acre; but this appears excessive overcrowding, and as a consequence the plants and fruit must receive a constitutional check in their maturation. The distances apart, at which they are planted at Hope, are 3½ feet between the rows, and 2½ feet in the rows; this gives 4840 plants to the acre. Out of this number it may be safely computed that from the first crop, 16 or 18 months after planting, 4000 fruit will be obtained from each acre; considerably more would be procured from the second and third years' crops from the suckers produced around the parent plant, owing to sufficient space being provided for each plant. Now, estimating the return from each crop at 4000 pines, the result, at 6*d.* each, gives 100*l.* per acre. The pine fields ought to be cleaned five or six times a year, each cleaning costing say 1*l.* an acre, or 6*l.* for the year; and this constitutes the whole cultivation.

Azores.—The pine-apple is now being cultivated with energy in St. Michael's. The produce of the recent cultivation having realized very considerable profits in the English market, and the quality being recognized as superior to those of foreign growth generally, conservatories on a large scale have been constructed. The pine-apple of large size and of first quality now returns the grower from 16*s.* to 20*s.* each, which is a remuneration of 35 to 40 per cent.; and some choice specimens have been sold for as much as 60*s.* each.

They attain to a greater size than those received from the West Indies, some weighing 12 to 13 lbs. having come to hand. Great care is taken in packing them, to secure their arriving in England in sound condition. The stalk is cut several inches below the fruit; an ordinary large-sized flower-pot is then filled with mould, into which the stalk is inserted in such a manner that a casual observer would almost take it to be the way it was grown. Each pine is then put into a skeleton wooden case made just large enough to hold it, so that it can be safely handled without the risk of being bruised or injured, the pine itself being frequently wrapped round with paper as a further protection.

India.—The pine-apple is said to have been introduced into India by the Portuguese in 1594, and now grows abundantly at the foot of the Himalayas and in Assam. It grows in thickets near Rangoon, while in the Tenasserim provinces the plant has become so naturalized as to appear indigenous. A bag made on the Khasia hills, in Assam, of pine-apple fibre, was presented by Dr. Wallich, as far back as 1836, to the local Agri-horticultural Society. He mentions the enormous quantity of pines grown on that range, and that the plant appears as if it were quite a natural production. In the Tenasserim provinces the fruit is so abundant as to be sold in the months of June and July at 2*s.* the boat-load. The natives do not seem to be acquainted with the fibre yielded by its leaves. Some attention is being given to the culture of this fruit in Queensland, as there were 86 acres returned under culture with it in 1876.

Pine-apple Fibre.—The plant affords fine foliaceous fibres of practical utility from the leaves, which are about 3 feet long by 1½ inches to 2 inches wide, strongly edged with spines. These may all be worked when the fruit is cut, the plant being perpetuated by shoots from its base. Two skeins of the pine-apple fibre were sent by the Court of Directors of the East India Company to the Society of Arts, for a report on their properties, so far back as January 1836, but the specimens were too small for a trial of their tenacity.

From some tests on the strength of this fibre when made into cordage, conducted at the arsenal of Fort William, on a rope of 3¼ inches in circumference, it appears to be remarkably strong. The Government proof is, that a rope of this size should bear a weight of 42 cwts.; but it bore no less than 15 cwts. more, that is, it broke with a weight of 57 cwts., proving incontestably that pine-apple fibre possesses strength for cordage as well as fineness for textile fabrics.

The pine-apple grows in great abundance in the Philippine Islands, but produces only a small dry fruit. We require, however, more precise information to enable us to determine whether this is actually the plant escaped from cultivation. Mr. Perrotet, of Pondicherry, considers it a distinct species, and has named it *Bromelia pigna*, from the Spanish name pigna, or pina, signifying a cone.

In preparing the fibre for weaving, the fruit is not allowed to ripen early; its removal causes the leaves to increase considerably both in length and in breadth. A woman places a board on the ground, and upon it a leaf with the hollow side upwards. Sitting at one end of the board, she holds the leaf firmly with her toes, and scrapes its outer surface with a potsherd, not with the sharp fractured edge, but with the blunt side of the rim; and thus the leaf is reduced to rags. In this manner a stratum of coarse longitudinal fibre is disclosed, and the operator, placing her thumb-nail beneath it, lifts it up and draws it away in a compact strip; after which she scrapes again until a second fine layer of fibre is laid bare. Then turning the leaf round, she scrapes its back, which now lies upwards, down to the layer of fibre, which she seizes with her hand and draws at once, to its full length, away from the back of the leaf. When the fibre has been washed, it is dried in the sun. It is afterwards combed with a suitable comb, like women's hair, sorted into four classes, tied together, and treated like the fibre of the *lupi*. In this crude manner are obtained the threads for the celebrated web *nipis de pina*, which is considered by experts the finest in the world.

In the Philippines, where the fineness of the work is best understood and appreciated, richly embroidered costumes of this description have fetched about 200*l*. each.

This fine muslin-like fabric is embroidered by the nuns of the convents in Manila with great skill and taste. Beautiful specimens of this pina muslin were sent to the first London International Exhibition, and to subsequent Exhibitions. It is sometimes, but erroneously, called grass-cloth. With a magnifier the fibres may be seen to be very numerous and fine, but not twisted at all, as in grass-cloth or the finest muslins and cambrics. One of the coarser fibres may be subdivided into threads of such fineness as to be barely perceptible, and yet sufficiently strong for any purpose.

The manufacture of the pina fabric is carried on in the metropolitan province of Tondo. From the extraordinary facility with which the pine-apple is grown in the vicinity of the equator, it seems almost certain that by the application of European skill to the process of separating the fibre from the pulpy matter of the leaf, a valuable raw material composed of it might be obtained for the factories of Europe. The fibre by the hackling process could be rendered fit for the finest fabrics. The leaf consists of two different structures: the upper side, being of a soft or pulpy character, easy of removal; and the under side, of a harder or more ligneous nature, and more difficult to separate. These two external bodies hold the fibre between them.

In the Straits Settlements the Chinese labourers have taken kindly to this new and promising branch of industry. The process they adopt in preparing the fibre appears to be much the same as that pursued in the Philippines, and is thus described in a Singapore paper:

"The process of extracting and bleaching the fibre is exceedingly simple. The first step is to remove the fleshy or succulent side of the leaf. A Chinese, astride on a narrow stool, extends on it in front of him a pine-apple leaf, one end of which is kept firm by being placed beneath a small bundle of cloth on which he sits. He then, with a kind of two-handled plane made of bamboo, removes the succulent matter. Another man receives the leaves as they are planed, and with his thumb-nail loosens and gathers the fibres about the middle of the leaf, which enables him by one effort to detach the whole of them from the outer skin. The fibres are next steeped in water for some time, after which they are washed, in order to free them from the matter that still adheres and binds them together. They are now laid out to dry and bleach on rude frames of split bamboo. The process of steeping, washing, and exposing to the sun is repeated for some days, until the fibres are considered properly bleached. Without further preparation they are sent into town for exportation to China. Nearly all the islands near Singapore are more or less planted with pine-apples, which, at a rough estimate, cover an extent of 2000 acres. The enormous quantity of leaves that are annually suffered to putrify on the ground, would supply fibre for a large manufactory of valuable pine cloth. The fibres should be cleaned on the spot. Fortunately the pine-apple planters are not Malays, but industrious and thrifty Bugis, most of whom have families. These men could be readily induced to prepare the fibres. Let any merchant offer an adequate price, and a steady annual supply will soon be obtained."

The wild brother of the pine-apple has a larger leaf and longer fibre. This is the *Bromelia sylvestris*, or the *B. pinguin* of the West Indies. It is known as *istle*, or *ixtle*, in Mexico, and *pita* and *pinuella* in Central America and Panama. These are probably two distinct species; and there is a third, *B. karatas*, which is hardly to be distinguished from them.

B. karatas is very common in the Antilles, growing in the most arid spots. It makes excellent mats, hammocks, and ropes. Almost all the fishing tackle of the American mercantile marine is made of it.

The leaves are 5 to 8 feet long, and from 1½ to 3 inches wide, thin, and lined with a fine tough fibre. The plant is self-propagating, and left to itself in an open field will soon cover the ground. In Central America, but particularly in Nicaragua, it is so abundant in the forests as to be a serious obstruction to man or beast. It is largely cultivated in the district of Coatzacoalcos, in Mexico. It is indifferent to soil, climate, and season, while the simplicity of its culture, and the facility of extracting and preparing its products, renders it of universal use. From it is fabricated thread and cordage, mats, bagging, and clothing, and the hammocks in which the natives are born, repose, and die. The fibre is sometimes employed for brushes, and in paper-making; its juice is used as caustic for wounds, and its thorns serve the Indians for needles and pins.

The *Bromelias* are widely diffused throughout the tropics, growing everywhere in all varieties of soil. The plant is extensively used for hedges, for which its strong, straight, and spiny leaves admirably adapt it, and may be cultivated with a minimum of labour and cost, and in unlimited quantities. It is closely allied to the pine-apple, but the fruit is different, the ovaries failing to combine in one mass, as in the case of the pine-apple, the formation of which they well illustrate.

The wild pine-apple grows in abundance at Gaboon, Grand Bassam, Assinee, Porto Novo, Liberia, and other parts of the West Coast of Africa. It is employed for making nets, hammocks, superior cordage, and fabrics.

THE PLANTAIN AND BANANA.

Among the splendid, varied, and profuse vegetation, with which tropical countries abound in so infinite a degree, the magnificent, herbaceous plant, the Plantain, usually attracts particular notice; and, together with the cocoa and other palms, are the productions of the vegetable kingdom, which adorn the picture of the artist when depicting the scenery of the tropics. The broad leaves overhang gracefully the succulent huge stem of the plant; whilst just at their bases, huge clusters of fruit, of yellow, red, and other colours, contrast harmoniously with their shining, dark green foliage.

The size this splendid plant usually attains is 8 feet, but I have seen them reach an elevation of 12 and even 15 feet, with a diameter of stalk from 1 foot to 2 feet.

The plants of the *Musa* tribe, though they cannot, like the palms, be called the princes of the vegetable kingdom, rank first in the series of endogenous plants, and are without exception the grandest of the herbaceous vegetables, whether their gigantic size, the breadth and beauty of their foliage, the abundance and quality of their fruit, or the surpassing grandeur of their flowers, be considered. They are devoid of true stems, but form a spurious stem, often of considerable thickness, from the leaves as they rise from the root stocks, being sheathing at their base, encircling each other, and enveloping layer within layer the slender flower and fruit stalk. They are not confined to the tropics, but approach in many parts towards the cooler latitudes of either hemisphere. The plantain may be seen laden with its enormous masses of wholesome pleasant food in the mild climate of Madeira; but its yield of fruit is dependent on, and varies with, the temperature of the climate in which it is grown. In this respect it is a striking instance of the increasing bounteousness of nature as we recede from the poles and approach the Equator, and is a manifestation of the beneficence of the Creator.

The plantain is universal. It is as the *Penates*—the household god of the labourer's cottage. It grows everywhere on the mountain sides, and might be cultivated to any extent. Hitherto its value has been unknown. Its fruit has been consumed as a substitute for bread, but for all other purposes it has been valueless.

The plantain is, to many thousands of people, what rice is to the Hindoos, rye flour to the Muscovite, and wheaten bread to the Englishman; it is their main dependence (in more senses than one), their staff of life, grown everywhere in small quantities throughout the tropics.

Those who have never lived in tropical countries are unable to fully appreciate its value. Some look even with indifference upon the gigantic clusters of this fruit, as they are unloaded from the steamers and sailing vessels; and yet they deserve special attention and admiration, for they are to the inhabitants of the torrid zone what bread and potatoes are to those of the north temperate zone.

The plantain is one of the most striking illustrations of tropical fertility and exuberance. A plant which, in a northern climate, would require many years to gain strength and size, is there the production of ten or twelve months, The native of the south plants a shoot or sucker, taken from an old tree, in a moist and sandy soil, along some river or lake; it develops with the greatest rapidity, and at the end of ten months the first crop may be gathered, though the cluster and bananas are yet small; but the following year one cluster alone will weigh some sixty or more pounds. Even in the tropics they are always cut down when green, as they lose much of their flavour when left to ripen or soften on the tree.

It is remarkable that the plantain and banana should be indigenous, or at all events cultivated for ages both in the Old and the New World. Numerous South American travellers describe some one of these plants as being apparently indigenous articles of food among the natives; thus showing (if the plantain be a hybrid) a communication between the tropics of America, Asia, and Africa, long before the time of Columbus. (A hybrid, or mule plant, is obtained by impregnating the stigma of one *species* with the pollen of another *species*, but of the same genus, and what is called a cross breed is the impregnation of one variety with the pollen of another variety of the same species.) The older writers on the colony of Guiana, as Hartsinck, Bellin, and others consider the plantain to be a native. It is worthy of remark that Sir R. Schomburgk, during his travels found a species of large edible plantain far in the interior. The plantain is said to have been transported from Guinea to the Canary Isles, and from thence to the West Indies. It seems to have migrated with mankind from Asia into the numerous islands in the Southern Pacific Ocean, where it is universal in those which are inhabited, and has degenerated into numerous varieties. It spreads from the Islands of the Pacific and of the Indian Archipelago, northward to China and Japan, and along the Malayan Peninsula to Chittagong. From Chittagong northward, along the jungly base of the Himalayas, there is a suitable climate as far as 30° N., for the *Musa nepalensis* is found in Nepaul. The most northern latitudes where the plantain is cultivated are Japan, Madeira, the north of Africa, Syria as far as 34°, and parts of the south of Europe. The edible plantain bears at an elevation of 4590 feet in a temperature of 61° Fahr., and requires 15 months to mature, but its cultivation is little benefit in so high an altitude. It is the same with the cassava root. The cane at 3480 feet altitude gives no sugar, and indigo at 4860 feet affords no colouring matter. We may here remark that it was on these and similar facts that Boussingault based his theory, which is that the time required by a plant to arrive at maturity is as the inverse ratio of the temperature; therefore knowing the mean temperature of any place, and the number of days which a plant takes to ripen, the time required at any other point, more or less elevated, can be ascertained.

Finlayson gives the following interesting information respecting the wild plantain tree, found on the island of Pulo Ubi, off the southern extremity of Cambodia.

"We had," he says, "the good fortune to find that splendid herbaceous plant in flower: unlike, however, that luscious and most delicious fruit raised by the hand of man, the fruit of the wild plantain contains scarce any pulp whatever. Its leathery sheath encloses numerous series of large black seeds, attached to a pithy, central stem, and immersed in a gummy substance resembling bird-lime.

"It appeared, by our systematic works, that the seeds of this most useful plant have been but rarely seen by botanists; hence doubts had been expressed upon the subject. In none of the cultivated varieties are there any seeds discoverable; though, at times, we may observe minute black points in the pulp, disposed in longitudinal rows. These are, probably, the feeble traces of seeds not yet quite extinguished by cultivation, the black perisperm being the last to disappear. The seeds were numerous, covered with a thick, black, brittle shell, and as large as those of the custard apple, but of a more irregular shape.

"There is no necessity to refer, as Willdenow does, the origin of all the cultivated varieties, and of all the species enumerated by botanists to the *Musa Troglodytarum*, a native of the Molucca islands, as the parent stock. Our specimens accorded with the descriptions given of *Musa sapientum*. The seeds were in all respects perfect, and apparently capable of propagating the plant. Indeed its existence on these islands, so rarely frequented by man, and altogether unfit for cultivation, can be accounted for on no other principle than the fertility of the seeds."—(*Journal of a Mission to Siam, &c.*)

The banana is like the plantain, but its stalk is marked with purple spots, and its fruit is shorter and rounder. There are 20 varieties of plantain in Tenasserim, 10 in Ceylon, and 30 in Burmah. From Asia it has been introduced into the West Indies and South America, and into England in 1680. It is more productive than wheat. In South America the fruit is dried and preserved, while the flour is separated and made into biscuits. The fruit can be kept for 20 or 30 years owing to the sugar in it; 100 parts of the fresh fruit contains 27 of dry nutritive matter; the potato gives 25. In the plantain fruit out of 100 parts there are of—

Water	14 parts.	Sugar	2 parts.
Starch	$67\frac{1}{2}$,,	Oil	$\frac{1}{2}$,,
Gum	$4\frac{1}{2}$,,	Albumen ..	$4\frac{1}{2}$,,
Cellular fibre ..	$4\frac{3}{4}$,,	Ash	$4\frac{1}{2}$,,

A sucker attains maturity in a year; each produces a bunch of fruit weighing from 25 to 90 lbs. One tree gives 4 lbs. of fibre; 600 lbs. weight of fibre might be produced annually from each acre of plantains. The plantain is used as a nurse or shade to the betel vine and other plants. The top of the stem yields a juice good for making ink. The fibre can furnish material for paper and canvas; thus the plantain gives food for body and mind. The Chinese use the young shoots for paper-making; 1607 square feet of ground yield 4000 lbs. of nutritive substance from plantains, which will support 50 persons; the same space planted with wheat will support only 2.

It is in season all the year round. The Dacca plantain is 9 inches long; in Madagascar the plantains are as large as a man's forearm. In the mountains of the Philippines a single fruit or two is said to be a load for a man. All the large ones require, like potatoes, to be roasted.

Twelve months after planting 70 lbs. of fruit are often obtained from a single plant. The south of Spain is the only part of Europe in which the banana is cultivated in the open air.*

There are 17,000 acres under plantain gardens in the Madras Presidency, chiefly in Tinnevelly.

The name of plantain and banana is very indiscriminately applied in many countries where they are grown, but, properly speaking, the term plantain is restricted to the larger plants, the fruits of which are usually eaten cooked, while those of the banana, when ripe, being more saccharine, can be eaten raw as fruit. The French call the plantain "banane," and the bananas "bacoves" or fig bananas. Generally the pulp contains no seeds, but in Akyab and the Arracan coast there exists a species which is full of seed. These are large, black, and not unlike the cotton seed. The flavour, also, is very inferior.

The Poyat, or Martinique banana, grows to a very large size in some districts, and would possibly yield more fibre than the common plantain.

I notice in a recent Trinidad paper the fact stated that, in former years, 7½ million plantains were annually imported from the Spanish Main to supply the capital, 9 millions being required in Port of Spain alone. Although the foreign imports are now less, yet the increased extension of the cultivation is recommended.

The establishment of plantain walks for the annual production of 9 or 10 millions fruit will necessarily be a work of time, as plants for any great number of stools require time and outlay to collect and carry. A thousand plantain suckers take some gathering, and are not as easily carried as tobacco seed, of which one can put as much as will sow several acres in an envelope. It must take years to establish any extensive plantain cultivation. A bunch of plantains of the kind commonest here and on the Main (commonly called horse plantain) does not consist of more than 20 to 25 fruit, and as it might not be safe to reckon on more than 3 bunches fit to gather from the stool in a year (generally stated at 4 during the 12 months), one cannot reckon on an acre, with the stools planted at 10 feet apart, producing

* Long's 'Plants of Bengal.'

more than 30,000 to 40,000 plantains per annum, as at such distance the acre will hold but 430 or 440 stools.

It will be seen that it would not require more than 220 acres to yield the 7 million plantains wanted, nor more than 310 acres, in full yield, to give the 10 millions that could be disposed of for ordinary consumption. We say *ordinary* consumption, because there are other applications of the plantain, by which it could be converted into an article of commerce commanding a sale abroad, the amount of which is entirely uncertain, but might easily exceed the local demand for the raw article if it fell in with the popular taste in northern countries. These applications have not yet been tested, so far as we are aware, on a commercial scale, but they undoubtedly open a great possible future for what old Dampier called "the King of Fruit."

With regard to its geographical distributions, the plantain is an object of cultivation over an immense zone, which extends, although not continuously, from 38° N. to almost 35° S. latitude. A mean temperature of from 18° to 20° Cent. suits it best, provided, however, the winters are not too rigorous. In Cuba the small species are cultivated in situations where the thermometer falls to 7° Cent., and even sometimes almost to zero. The *Musa sapientum* is satisfied with 18° of mean heat, but *Musa paradisiaca* requires at least 20° to 22°, and that, too, only in the climates of equatorial regions. It produces the best crops in a temperature of 24° to 28°, and yields no fruit at 20°, nor at an altitude of more than 3000 feet in the southern latitudes from 0 to 10° (Humboldt).

In the Cordilleras of New Granada the banana is productive at an altitude of nearly 6000 feet, but according to Boussingault, the fruit never ripens at an elevation of 7000 feet. Schomburgk has seen the *Musa* bearing fruit in British Guiana at 3000 feet above the level of the sea; the fruit was magnificent, and would have borne comparison with the finest from Porto Rico. In Hindostan the *Musa* is cultivated at an elevation of 3700 to 5000 feet, at Kumaon and Gurhwal, in the middle of the Himalaya chain. Major Munro found a wild species at Khondah (Neilgherries), nearly 7000 feet above the level of the sea. Dr. Madden also discovered an indigenous *Musa* in the Himalaya range, to the north of the province of Assam.

Asia is, as we have seen, the native country of the banana plant; many varieties are also found in the Indian Archipelago, China, Cochin China, and Hindostan. On one side of the continent they are spread over Polynesia, and, lately, in Australia; and on the other, in Persia, in Beloochistan, in Asia Minor, as far as Mount Taurus, and in Arabia. In Africa the banana has not the same importance as in Asia and America, except sometimes in Guinea and Madagascar, where many indigenous *Musas* are cultivated. It is not to be found on the eastern coast, but only in gardens higher up the country, in Abyssinia, Nubia, and Egypt. The northern part of Africa also possesses the plant, which has been carried thither by the victorious Arabs, but no great attention has ever been paid to it in that region. When we pass into Europe, we see the banana appear in some gardens in Greece, in Sicily, and especially in the southern provinces of Spain. It was introduced into the last-named country by the Moors, who cultivated it extensively in the neighbourhood of Armenia. The eastern parts of Portugal, whose marine and equal climate is singularly favourable to the naturalisation of tropical plants, enumerate even the *Musa sapientum* among their garden productions. The *Musa Cavendishii* and *Musa sinensis* have also been successfully introduced into that country. Equatorial America has immense resources in the banana; Mexico, Central America, Colombia, Upper and Lower Peru, Brazil, the Guianas, and the Antilles, more especially Haiti and Cuba, cultivate this plant on a vast scale. The banana exists still in Louisiana, Florida, and the other Southern States, where efforts have been made for some time to extend its cultivation.

A warm and rather moist soil is best suited to the propagation of the banana, that is to say, a soil in which there is a plentiful admixture of clay, as in the immense valleys of America and Asia, and in the grassy plains of Malaysia. It seems to like the neighbourhood of the sea, and an atmosphere impregnated with salt, for it is in that kind of situation that it appears to prosper best. In Egypt it grows well in the nitrous plains of Rosetta. In the majority of countries where the plantain is grown no manure is necessary, owing to the decomposition of the stems and the alluvial nature of the soil. But in other less favourable soils manure may be requisite to maintain a vigorous and constant production. A plantain walk is usually established a little before the rainy season commences. The soil is loosened to a foot or less, so as to receive the young plants. It is thoroughly cleansed of all weeds and stones which may be there. Then shoots or suckers are taken from the parent stem, of from two to three feet high, their bulbs being divided from the principal bulb by means of a mattock. These slips are cut about eight inches above the neck, and placed in a slanting direction in the prepared holes, and covered with earth, leaving in sight only about two inches. The length of time which elapses between the planting of the slips and their fruiting depends on climate, situation, and variety of species. Thus *Musa sapientum* fruits in the fifth and sixth month, whilst the *Musa paradisiaca* requires ten months, and sometimes even a longer time than that. Two varieties of the fig banana, the *canaya* and *gengi*, produce their fruit in five months. In mountain districts, the fruit of the large banana ripens only at the end of eighteen or twenty months of cultivation; some varieties indeed, in such position, take three years to produce fruit. The leaves of the banana afford a useful shelter, and it is therefore of great service in tropical agriculture to young plants, which would otherwise suffer severely from the excessive heat of the sun.

In British Guiana, the plantains are set six yards apart, and yams, maize, cocos or canes planted in the intervals.

The cultivation of the plantain is one of the easiest to undertake, and at the same time one of the most profitable; when once it has been planted, there is nothing more to do except realize the harvest, for the trifle of manure bestowed upon the soil two or three times a year is nothing in comparison with the labour necessary in Europe to bring crops to perfection. As these plants renew themselves with offshoots at different degrees of development, it follows that each plantation offers at the same time rows whose branches are laden with ripe fruit; rows whose branches are full of blossom, and young offsets, which give promise of future plenty. In the best situation, three rows are counted to each cluster of bananas, sometimes four; in general they obtain five rows in two years. "There is no culture that can be undertaken with more confidence than that of the banana," says M. Boussingault, "for if climatic influences should sometimes have a prejudicial effect on the crop, they could never completely destroy the prospect of a harvest, as the certainty would always remain of that to be obtained from the surviving and stronger growing offshots or suckers. No other vegetable production presents similar advantages—not even the maize, that crop so precious in the warmer regions of the globe.

"The enormous return from this plant assures to the inhabitants of tropical countries an abundant means of sustenance, and one that can be obtained at a low price, as it is acquired without difficulty. But in consequence of the facility with which, thanks to the banana, the means of sustenance can be obtained, as the proverb runs, 'Personne ne meurt de besoin en Amèrique,' the inhabitants have a great excuse for being indolent, which they are already inclined to be on account of the climate."

The large banana is gathered at three different stages. At a fourth part of its maturity, it is rather milky and contains much starch. If it is roasted in ashes, or boiled in water, it forms a very nourishing food, capable of being substituted for bread. If cut at three-fourths of its growth, it is less nourishing, but contains more sugar; in this state, it is eaten as an accompaniment to meat. Lastly, when the fruit is perfectly ripe, all the starch is changed into gum or sugar; it then developes an acid principle: in this state it is eaten either raw or in the form of fritters. The banana fig, which is eaten when perfectly ripe, is rather a fruit than a nutritive substance; it is soft, full of sugar, melting, possesses a powerful perfume, and forms a principal dish for dessert in tropical regions. In some countries they cut them while they are green, and hang the bunches in their houses to ripen. To hasten their ripening in China they are covered with rice, or even with lime. The Chinese also eat the flowers of the banana pickled with vinegar.

The banana when plucked keeps fresh for a week; at the end of that time it becomes yellowish and more sugary; in twelve or fifteen days it begins to decompose and ferment. In America there are two methods of preserving the banana; the first, used when the fruit is green, produces banana farina; the other, when the fruit is completely ripe produces the *platano-pasado* of the Mexicans, or the *platano curado* of the province of Neyba, New Granada.

There is a method of utilizing this plant, made use of in South America, but it is defective in a great many points as compared with that already noticed. They grate the fruits, having first peeled them, squeeze the moisture out in a press, bake them, like manioc, in an oven, and by this means obtain a coarse kind of flour. But the nutritive property of this is inferior to that prepared from the dried slices, for no doubt the pressure which extracts the moisture expels also the soluble albumen, and other nutritious qualities.

The next method of preserving the banana very closely resembles that commonly used in the preparation of dried fruits, such as figs, prunes, &c. The time chosen is when the fruit is quite ripe, and its skin has become of a yellow colour, shaded with black. In Mexico in the "terras culientes," and particularly in Méchoacan and Xafisco, bananas are dried simply by exposure to the atmosphere. According to Colonel Colquhoun, they proceed in this manner: the fruits are exposed to the sun in bundles, and when they begin to wrinkle they are peeled, for the skin, if left on, causes a disagreeable flavour. They are kept for some time, until an efflorescence of sugar appears on their surface, as on dried figs and prunes. They are then pressed in masses of about 25 lbs. each, and wrapped in leaves of the banana plant, or else kept in boxes. Of course, these methods can only be adopted in countries where the climate is very dry. In others, recourse must be had to artificial means, which are unfortunately more costly.

There are three distinct ways in which the ripe banana may be dried. 1st, exposing the fruit to an atmosphere of sulphuric acid gas before the dessication is begun. 2nd, boiling rapidly very ripe fruit in water which contains sulphate of lime. 3rd, by boiling it in syrup. By either of these, the albumen and caseine of the fruit coagulates, and the tendency of the banana to decay and ferment is stopped at a period favourable for dessication. Experience shows that the second method is the best to employ; in moist climates, without this precaution, the fruit, instead of drying, becomes damp. To expose the fruit to the sun's rays after boiling, trays of bamboo, as in Mexico, or of anything which permits the free action of the air and light on the fruit, may be used. If rain falls, they are dried in a furnace, which must be left open, otherwise the bananas bake instead of drying. The heat, also, must be moderate. The bananas, when dry, are pressed and packed in boxes. The fruit thus prepared is a very good article of food, resembling figs, and its abundance and easy preparation would render it a cheap one.

Some of the fruit of the plantain was exhibited at the Great Exhibition of 1851, that had been in this country for sixteen years. It was still in an eatable state, and had much the taste of dried figs. The quality of the fibre is finest before the ripening of the fruit. The cost of keeping up a plantain estate in Demerara would be about 6*l.* per acre; and the produce of the stem alone for fibre, if cut every eight months, would be 1400 or 1500 good stems every cutting, or 4500 stems in two years. The average quantity of fibre per stem may be put at 4 lbs., or 9000 lbs. per annum per acre, at a cost of 6*l.*; and add 4*l.* for the preparation for market, the cost would not exceed ½*d.* per lb. In this way (by the succession of suckers) the production of the plantain is enormous; and Humboldt's statement, once thought exaggerated, that an acre of good land in the tropics, covered with the plantain, would yield as much nutritious food as 144 acres of wheat, is no longer denied or doubted.

The plantain is noted for the abundance and excellence of the nutritive food which it yields. The fruit is served up both raw and stewed; slices fried are also considered a delicacy. Plantains are sometimes boiled and eaten with salt meat, and pounded and made into puddings, and used in various other ways. In their ripe state these fruits contain much starchy matter.

A few bananas are occasionally imported to England, but they are seldom received in such perfection as to form an estimate of their flavour; nor are they at the best of times much appreciated. A considerable trade is, however, carried on in bananas between New York and Aspinwall, the Atlantic seaport of the Panama railway. Not a steamer leaves without taking from 5000 to 8000 bunches, and during the year something like 200,000 bunches (or 800 tons) of bananas are exported to New York. They are grown in plantations or walks, seven or eight miles from the town. After the small bush is cut down, fire is run over the land, and the suckers are planted irregularly all through, six or seven feet apart. The kinds principally cultivated are the doubloon, the China, and the fig. The last most resembles the honey banana of Jamaica. The plantain is not exported, but is only used for home consumption. The Indians manufacture a kind of spirit from the plantain. When the fruit is fully ripe, the Indian gathers it, peels off the skin and throws the fruit into a dish, where it remains for some days. After fermenting, he draws off the liquor and puts it in his home-made bottle for future use. The liquor, or as the Indian terms it, "rum," is said to be strong and very intoxicating. When drunk to excess the effects remain for two or three days.

In Jamaica, the banana seldom comes to maturity in less than twelve or fourteen months; but in Aspinwall, six or eight months are sufficient. In Jamaica, when a sucker is planted, it only comes up single and bears but one bunch of fruit; but in Aspinwall a sucker comes up with several shoots, and these bear in succession one after another. The bunch of fruit is cut with as long a stalk as possible, for the convenience of carrying, and it is always cut green before it ever begins to ripen, or the fruit would rot before they arrived at New York. They pay a duty of 10 per cent. in America.

Plantain Meal.—The flour of the plantain, known in many parts of the West Indies as conquintay, is highly esteemed, and extensively used as a food for invalids and children. It is decidedly superior in these respects to arrowroot, in consequence of its nourishing and strengthening qualities. But it is scarcely known at all in Europe, where I believe it would be greatly prized. It is prepared by stripping off the husk of the plantain, slicing the core, and drying it in the sun. When thoroughly dry it is powdered and sifted. It has a fragrant odour, acquired in drying, somewhat resembling fresh hay or tea. It is largely employed as the food of infants and invalids. As food for children and convalescents it would, probably, be much esteemed in Europe; and it deserves a trial on account of its fragrance, and its being exceedingly easy of digestion. In respect of nutritiveness it should have a preference over all the pure starches on account of the proteine compounds it contains. The plantain meal would, probably, be best and freshest were the sliced and dried plantain cores exported, leaving the grinding and sifting to be done in Europe. The flavour of the meal depends a good deal on the rapidity with which the slices are dried; hence the operation is only fitted for dry weather, unless, indeed, when there was occasion for it, recourse were had to a kiln or stove.

Plantain starch cannot enter into commercial competition with other starches. The difficulty of separating it from the rest of the constituents of the fruit, its unusual colour, and the high value of the fruit in its other applications, will, probably, prevent its being considered but as a curiosity. The colour resists the free application of chlorine water. A few particles of the starch under the microscope show irregularly oval corpuscles, and some oblong, varying from $\frac{1}{475}$ to the $\frac{1}{950}$ of an inch in diameter, and, in most cases, the $\frac{1}{425}$ of an inch in breadth. A few globules, almost spherical, are observed, measuring the $\frac{1}{3800}$ of an inch. As the colour, however, is sufficient to identify this starch, no aid from measurements or shape of its globules is required.

Vinegar from the plantain is obtained by a very simple process. When there is a temporary glut in the market, the surplus, when yellow, is thrown into baskets, supported on open barrels. The fruit liquifies and drops into the receiver, where the juice ferments and speedily becomes vinegar. No water is used in the process.

Let us now glance at some of the uses of the stalk. The stem is filled with an abundant pith, enveloped in fibrous cases, and containing much starch. This boiled might serve as human food; animals like it very much. Cattle, and especially the pig, relish this kind of sustenance.

A curious fact connected with the banana plant is that the sap is so abundant that it escapes whenever an incision is made into the outer coating. The sap has been examined and analysed by Fourcroy, Vauquelin, and Boussingault. According to the last writer it contains tannin, gallic acid, acetic acid, chloride of sodium, salts of lime, potass, and aluminium. If cotton, linen, or flax, are dipped into it whilst perfectly fresh, it deposits a colouring matter of a yellowish grey, which adheres to the fibre. When exposed to the air it becomes agitated, and precipitates floccules of a dirty rose colour. This phenomenon is produced by the oxygen contained in the atmosphere. The banana plant is used in Annam, or Cochin China, and the Philippines, in the process of refining sugar. Masses of raw sugar are placed in layers 1 inch thick and 10 wide, which are covered by a layer of stalk of this plant, cut into small pieces. According to Grosie, however, it is the ashes of the *Musa paradisiaca*, which they use in this process. The aqueous liquor that flows from the stalks filtrates through the sugar, carrying away with it all impurities, and leaving the sugar in a crystallized state. The sap is also of great value as a mordant in dyeing; the Malays, by means of it, fix the green colour of the *Dolichos Lablab.* When employed alone the sap of the cochon banana communicates to fabrics a purple tint, which is durable. The sap has also medicinal properties. It is used in St. Domingo to stop internal and external hœmorrhage, as tannin is in other countries; and at the Philippines, to heal a species of venereal disease very common in the province of Bisayas.

In Cuba, Mr. Russell tells us, " The plantain, or banana, is seen growing over the whole island, affording shade and shelter to every cabin, however small or mean. Though it wants the grace and beauty of the cocoanut palm, its form is peculiarly tropical, none more so. In good soil it grows to the height of 20 feet. It is about 9 inches in diameter at the base, tapering towards the top, when it sends out long broad leaves, and also a short stalk bearing a heavy cluster of fruit (which, in Jamaica, I have known to weigh as much as 70 lbs.) The plantain requires to be renewed on good soil only once in 40 years. Little care is bestowed upon its culture, being planted in check rows 12 feet apart. The ground usually receives two ploughings during the season. It is not unfrequently seen growing, however, on the shallow soils of the coral formation, where there is little for it to fix its roots, except the crevices of the rock. It is largely used by all classes, and commonly pulled when green, and cooked with grease or oil. In Jamaica it is roasted in the wood ashes of the kitchen fire, and used as a substitute for bread, and it is also boiled and used as a potato. In this form it is seen on the tables of both rich and poor. For, although the plantain cannot support the strength of the overworked labourer, it furnishes, when the work is light, a most wholesome and delicious food. . . . I rode through a field of plantains attached to an estate, of 60 acres in extent."

The plantain, or banana, is generally admitted to be a better developed plant in the West than in the East Indies. All hot climates seem equally congenial to its growth. It is considered by the best authorities to be a native of the East Indies, and other parts of the Asiatic continent, and probably of Africa. Baron Humboldt has, however, suggested that several of the species of *Musa* may, possibly, be confounded under the names of plantain and banana, and that some of these may be indigenous to America. Linnæus conjectured that the Bihai (*Heliconia humilis*), a native of Caraccas, which produces fertile seeds, is the stock of the plantain.

Dr. Royle, whose opinion is more reliable on the subject, agrees with Mr. Brown in thinking " nothing has been advanced to prevent all the cultivated varieties being derived from one species, *Musa sapientum* (also called *Musa parasidiaca*, the banana), of which the original is the wild *Musa* described by Dr. Roxburgh as grown from seed received from Chittagong."

The banana and plantain form a large portion of the food of the natives in New Caledonia. Before the French occupation they had but four species—*M. fehi*, Bert; *M. paradisiaca*, Linn.; *M. discolor*, Hort; and *M. oleracea*, Nob. *Musa sinensis* and *sapientum*, introduced only a few years, have begun to be extensively cultivated among the tribes.

The plantain loves moist situations, and requires, for perfect development, a rich soil. The labourers plant it much too closely; it should be allowed, from root to root, a space of 14 feet good. The first year's crop thereby may be reduced, but the cultivator will have his reward in the subsequent yield. Besides, in wide planting, the better opportunity is afforded of self-reimbursement to the planter in the shape of inter-culture of other minor articles, such as Indian corn, peas, &c.

Plantain Fibre.—When the fruit has arrived at maturity the stem that bore it is felled and left to rot on the ground, but this might be turned to advantage for its fibre. It is stated officially that the yield of fibre from thousands of acres of the plantain is lost annually in the colony of British Guiana alone for want of simple and inexpensive means for separating it. Could an efficient and cheap machine be invented the fibre would be almost entire profit to the planter. The banana yields less fibre than the plantain, and it is generally somewhat discoloured or tinted.

The next point for consideration is the machinery necessary for cleaning and preparing the fibre; it is recommended that the stalk be cut into lengths of about 4 feet, and also divided into 4, so as to be able to separate the different qualities of fibre before passing through the mill, formed of horizontal rollers, by which means the water and a portion of feculæ or pulp would be pressed out. There would still remain a portion closely adhering to the fibre to be got rid of, which would require a scraping operation, which there is no doubt could be performed by means of a scraper of wood or metal attached to the mill, and put in motion by the same motive power; it would, then, require the application of water the more effectually to loosen the remaining matter; exposure to the sun would dry and bleach it after being passed through a heckle, which would separate the threads. The difference in value of each description and quality of fibre must depend upon its strength, and its fitness for the various purposes for which it would be found applicable in the manufacture of cloth, cordage, paper, &c. Practical experience would soon prove the most effectual methods of performing the several operations; and, if fitted to the purposes for which they are required; the most suitable localities for these plantations would, no doubt, be in the mountain districts, or in the plains, if well supplied with streams of water running through them. Experience will soon determine which variety of *Musa* is most valuable for producing fibre for manufacturing purposes. The best plant for this purpose is that which will produce the greatest return in the shortest period, requiring but little knowledge and expense in cultivation.

The one pre-eminently fitted to answer all these requirements, is the Martinique banana (*Musa sapientum*), requiring but little or no skill and energy in its general management; for quantity, colour, and texture of fibre, it surpasses by far all varieties of the common plantain (*Musa paradisiaca*), which is a delicate plant, and frequently requires to be renewed or re-planted. The production of suckers and weight of stem are at least one-third less than the banana, and the fibre by no means so strong. I would also recommend two other species of *Musa* to the cultivators of this genus for their valuable fibre. One is the *Musa violacea*, an exotic from the Philippines, and in no respect inferior to the banana, except in the absence of edible fruit. The plant is exceedingly prolific and hardy. The other is the one producing the well-known Manila hemp (*Musa textilis*), and no expense or trouble ought to be spared by the Colonial Governments to introduce suckers and seeds of this most valuable plant in quantity in the West Indies, as it takes a long time to obtain stock from the produce of one plant.

The following is the mode of preparing plantain fibre in Jamaica:—

The plantain is cut when ripe, and the outside layer is split in longitudinal slices and put through a mill, and afterwards boiled in a copper, with a small quantity of potash, soda, or quick-lime, to take off the mucilage. This layer is the *coarsest*, and requires a longer time to boil, therefore is to be done separately. The next layer is to be done the same way, and being finer and more valuable, should be kept by itself. The following layer ditto. The centre part of the plantain ditto.

As the inner part is the finest fibre, requires the shortest time to boil, and commands the highest price, that is the reason why these boilings require to be performed separately.

After boiling, the fibre is hung up on ropes to dry, and it can then be carried down and sold to the merchants, or shipped direct.

Several modes have been recommended for the preparation of the fibre.

1st. Beating, washing, and drying.

2nd. Simply cutting and drying.

3rd. Scraping.

If we look at the structure of the plant itself we shall be able to form an estimate of those processes.

The plant is composed of at least two very visible rows of cells, an inner and outer, along its whole extent upwards and downwards, and through every layer, there being several layers.

The cells are formed of fibre, for "uprights" and "sills" and "plates," and tissue, as it were for "plastering;" the former useful for ropes, fabrics, &c., the latter for paper.

Of the processes named above, the last is the only one that produces fibre in its pure state; but, whether we scrape from the inner or outer surface, we must lose all the tissue, and probably more than half the fibre.

The first process will produce the material of the plantain stalk in a fit state for shipment with partially clean fibre, but nearly all the tissue will be lost. The washing, also, should be simple rinsing, for allowing the tissue to remain in water tends to discolour it greatly.

The second process, I imagine, would be very slow, in consequence of the abundant water of the stalks. I apprehend also the discolouration which would ensue from the process would render the material all but unfit for market, except at a very low rate.

It seems desirable that three or four objects should be kept in view in any process.

1st. Saving of the cellular tissue for paper.

2nd. Preserving the fibre of an agreeable appearance.

3rd. Ultimate freeing the fibre from the tissue.

4th. Preserving all the fibre.

And, with relation to these, the processes and mechanical arrangement are to be considered.

By no process of the hand can clean fibre be profitably procured. For this resort must be had to machinery.

The fibrous material, that is to say, the stalk after it has undergone the squeezing process without separation of the tissue or pulp, may be prepared either by hand or machine, the latter being, of course, the most economical.

Squeezing, rinsing, partial separation, or "teazing" with the hand, after being hung up on rails of bamboo, or other cheap article, and rapid drying, may be recommended as a simple and efficacious process for obtaining the fibrous material in a favourable state, and with the several objects referred to in view.

Machinery for performing this, and effecting the final separation of the fibre from the pulp or tissue, must be a desideratum. In the absence of such machinery parties can only hope to prepare advantageously the fibrous material by hand.

It has been supposed that boiling of the material would render the separation of the fibre at a future time more easy; but this seems unnecessary. Simple saturation in water for some few hours renders it fit for further process.

Much objection is felt by the labourers, from whom alone are the stalks at present to be procured in abundance, to cutting the stalks, from the fear of injury to young shoots by loss of manure. It would be well if fear on this head could be shown groundless.

The Rev. W. J. Pearson, of St. Thomas's, Jamaica, thus speaks, after much practical experience in the preparation of the fibre:

Provided the tissue remain on till it reaches England, the fibrous material ought to be more valuable than the clean fibre, for the worth of the pulp should exceed the cost of separation. In the preparation of the material, also, it seems unnecessary to preserve more than two qualities, that of outer and inner, and this not from any great difference in the fibres, but from the colour of the tissue, the outer being darker than the inner; coarse and fine fibres will be found in every layer, and the former are, for the most part, but assemblages of the latter.

In trying the strength of the fibrous material it will be well to ascertain *whether you have a thin or stout fibre* overlaid with tissue, otherwise the result would be deceptive.

The process of preparation, both of the material and of the fibre being tedious, it is very probable that difficulty will be experienced in inducing the labourers to engage in it on their own account, at any rate until the returns become certain and profitable.

The quantity of material or fibre yielded by a sucker is, at present, so small, that until results prove remunerative, they will not have sufficient inducement to enter on the new source of industry. From my experience stalks do not average more than $1\frac{1}{2}$ lb. of fibrous material, consequently of clean fibre much less. The fibrous material seems almost fit for the manufacture of small cordage, even as it is.

It must not be supposed that the work of preparing the "material" is either easy or pleasant. To bring up the suckers from the deep valleys in which they sometimes grow, is a difficult task, and to carry them on the head up hill and down dale, as has often to be done, is very laborious. While some suckers are small, there are others frequently heavier than can be borne by one man, and until the work can be carried on by cart, there is no help but to divide such for long distances. The process by hand, of expressing the watery parts, is also very tedious, and drying and baling require much care and attention.

Manila hemp takes its name from the chief city of the Philippines. It is not hemp, however, but the fibre of a species of plantain (*M. textilis*), which does not differ greatly from the edible banana, and is probably a variety of the same species. Thus far, according to Dr. Jagor, the serviceable fibre has been exclusively obtained from the southern portion of the Philippines, all attempts to make its cultivation profitable in the western and northern provinces having failed. A species of banana grows in great luxuriance in Western Java, but it has not been utilized as a fibre plant to any great extent. Great efforts were made in Celebes to cultivate this fibre, but it has been abandoned in favour of coffee, which is found to be far more profitable. For domestic purposes, the plantain fibre, known to commerce also as abaca, is made use of in many tropical countries, and in time will doubtless be largely supplied; but for the present the supply comes, as already stated, from the Philippines.

There is some dispute as to the true scientific name of the species of *Musa* from which the Manila hemp of commerce, the *abaca* of the Portuguese and Spaniards, is obtained. It is now usually assigned to *M. textilis*, Nees, but probably some may be obtained from *M. Troglodytarum*, Lin., a native of the same locality. Some ascribe it also to *M. sylvestris* and *M. Balbisiana*. There are several species of *Musa* wild and indigenous to the Amboyna, Moluccas, and the Philippines.

The plant thrives best on the shaded forest-covered slopes of volcanic mountains, such as abound in Albay and Camarines; on level ground not so well, and on marshy land not at all. The plant requires, on an average, three years to produce its fibre in a proper condition. For the first crop only one stalk is cut from each bunch; later on, the new suckers grow so quickly that they can be cut every two months. In full growth the yield is 30 cwts. to the acre, whereas from an acre of flax not more than 4 cwts. is obtained. After the plantation is once established, the plants flourish without any care or attention, the only trouble being to collect the fibre. One plant may yield as much as 2 lbs. of fibre, but the average is not more than 1 lb.; on indifferent soil much less.

Several grades of fibre are derived from different parts of the stem, the edges yielding the finest. The fibre, which lies next the surface, is stripped off by hand in broad bands, and then softened by being drawn backwards and forwards between a broad-bladed knife and a block of wood. One worker cuts up the stalks, strips off the leaves, and attends to the supply; the second, frequently a boy, spreads out the strips of fibre; the third draws them under the knife. The coarse fibre is called *bandala;* the finer, *lupis*. The former is chiefly used for ships' rigging, the latter is employed in weaving. The three finer grades of lupis are further softened before weaving by being pounded in a rice mortar. Generally the first or finest sort is worked as woof with the second as warp, and the third as warp with the second as woof. The fabrics so woven are nearly as fine as the *nipis de pina* (pine-apple fibre). For purity, flexibility, and colour, the finest of these plantain fabrics are said to compare with cambric as cardboard does to tissue paper. According to Jagor, the finest stuffs require so great an amount of dexterity, patience, and time in their preparation, and are consequently so expensive, that they cannot compete with the cheap machine-made goods of Europe. Their fine warm yellowish colour also is objected to by European women accustomed to linen and muslin strongly blued in the washing. By the rich half-castes, however, who understand the real goodness of their qualities, they are highly appreciated. In the regions where abaca is cultivated, the entire dress of both sexes is made of this coarse cloth, called guimára. For foreign markets, still coarser and stronger fabrics are prepared, such as crinoline and stiff muslin, used by dressmakers.

It is as an article for export, however, that the cleaned fibre is of the most importance commercially. Nearly three-fourths of the produce go to America. It is very largely used in the manufacture of paper.

From the fibre of this plant, cordage, mats, and wearing apparel are made in the Philippines.

Leyte and Saniar in 1856 had a combined export of 5000 tons; Négros, 800 tons. South Camarines and Albay produce the largest part of the existing export of hemp, and yield a considerable quantity of remarkably good hemp.

Large supplies are derived from Leyte, Saniar, Bohol, and the east coast of Negros (Dumaguete) in its more immediate vicinity. While from the great island of Mindanao a further supply is obtained, from the fine province of Misamis, and from the small island of Carneguin, which produces nearly 1000 tons of good hemp, all of which goes to Cebu.

The plantain from which it is obtained is propagated with great rapidity, being planted in the rainy season. One hundred plants occupy about 1000 square yards of land. The rude method of preparing the fibre is as follows. The stem, after having attained the age of between two and three years, is cut down and stripped of its layers or folds; these are then divided into sections of three or four inches wide, and the pulpy or fleshy part separated by the process of drawing them under a knife fixed for the purpose; the fibre thus laid bare is then placed in the sun to dry. If the plant be left on the ground for any length of time after it has been cut down, the hemp made from it assumes a reddish tinge, unfitted for commerce, the tannin in the sap colouring the fibre. Fifty tons produce about 25 lbs. of hemp or fibre.

The difference that exists between the fibres of the species of plantain appears to be attributable to the fact that some fibres of wild plants, and especially those of the banana, are more or less modified by cultivation. The abaca is found in the volcanic islands of the Philippines, and in the neighbouring archipelago; still it is principally in the pueblos of Donsol, Sorsogon, Tabaco, Cameli, and Quipa, that the cultivation is carried on, and from whence the best material is obtained. The only difference between the abaca and other species of the *Musa* genus is the rich dark-green hue that pervades every part of the former. The abaca has very little care bestowed on its cultivation, being grown only for its stalks, and it is an advantage rather than otherwise that its fibres should retain their natural coarseness and tenacity. Nor does it require so rich a soil as the edible varieties: it is usually planted on the slopes of mountains, where the land has been newly broken up. The ground is carefully and frequently cleared of all obnoxious weeds during the growth of the young plant, and the stalk is cut when the fruits first make their appearance. At the end of the first crop, they have, monthly, good suckers springing up, and that, too, during the whole time that the plantation lasts, which is from five to seven years. The duration of course varies with the nature of the soil, the fertilizing properties of which this crop exhausts very rapidly, especially as no manure is applied. The textile material is obtained in the following manner: The stems are cut down and stripped of their leaves. It is next divided into long strips of two fingers in breadth, then passed between a thick plank, placed in a horizontal position, with a knife resting edgewise. The material is then drawn through with one hand, whilst the other presses heavily on the back of the knife, and in this manner the pulpy matter is scraped and cleared off, leaving the textile fibres bare. These are put to dry in the sun, care being taken to protect them from rain and moisture. They are then beaten lightly with sticks, again exposed to the sun, and lastly the filaments are separated according to their degrees of fineness. In this manner three sorts of fibre, of varying quality, are obtained: the first, called *bandala*, from the outer sheaths of the stem, which is the strongest and coarsest, and from which ropes, &c., are made. The second, known by the name of *lupis*, which is the finest, is procured from the inner layers; whilst the third, the *tupoz*, comes from the intermediate layers of the tissue, and from this last fabrics and gauzes are manufactured. Two men employed at this work, one in separating the outer coats, the other using the knife, can prepare from 24 lbs. to 26 lbs. avoirdupois a day. Fifty feet of land covered with plaintain trees will furnish from 24 lbs. to 26 lbs. of abaca fibre, or 143 lbs. to 145 lbs. to every 2½ acres. It is cut at least ten times a year, which gives a mean return of 1760 lbs. of bruised abaca, worth from 5*l.* to 10*l.* If the process be properly conducted, at least 1 lb. of thread, or, taking the produce of 2¼ acres for a whole year, 3520 lbs. of abaca will be obtained, worth at Manila about 20*l.* The abaca intended for weaving is bruised in a mortar, and thus reduced into a kind of ball about the size of a child's head. This operation has the effect of rendering the threads more flexible and resistant. These threads, having been joined together by women or children, are woven after the manner of cotton, and the texture is immersed in water with a little shell lime for a day and a night. Afterwards they are cleaned in fresh water and left to dry. If mixed with silk or cotton, a beautiful texture is produced, very fine and valuable, and applicable to a variety of purposes.

Roping and cordage made from abaca are employed in the mercantile marine of India, and in the navy of the United States, and are well known under the name of white rope or Manila rope.

Machines have been invented to remove the fibre from the pulp, but few are used. One was exhibited at Manila, about three years ago, very simple in its construction and apparently producing results vastly superior to the ordinary mode I have described of manual labour. The exhibition of this machine produced a great excitement, and it was proposed and countenanced by the Captain-general to give a large premium to the inventor. The subject died away, however, and the machine disappeared from public view. It is probable that the criticisms of experienced people formed some drawbacks to the perfection generally ascribed to the invention; but, without possessing the slightest mechanical knowledge, the impression which its structure and effect made on persons capable of judging, was extremely favourable. There was no intricacy in its machinery; wood was its only material and a buffalo its moving power; a village carpenter could make one from its model, and its results were tenfold or more greater than by the ordinary course. It may suggest itself, why has it then not become of general use? I cannot affirm that the model has not been applied; but there are circumstances or influences in regard to the natives here, and the culture of this production, and indeed of all others, unfavourable to the extensive adoption of machinery.

Exports of Manila hemp from the Philippines :—

	Piculs.		Piculs.
1850	124,367	1874	616,122
1872	613,240	1875	519,392
1873	628,066		

From Cebu the exports were in

	Piculs.		Piculs.
1874	234,361	1875	154,922

The best fibre comes from the latitudes south of Manila, and from several islands as far as the tenth degree.

Of the 250,000 bales received at Manila in 1864, about 129,000 were shipped to the United States and California, 114,000 to Great Britain, and the remainder to the British possessions and settlements in Australia, India, China, &c.

The exports from the port of Cebu in 1874 were 154,922 piculs, of which upwards of 91,000 went to America. The total exported from the Philippines was 616,122 piculs against 628,066 piculs in 1873. Great Britain takes about one-third, 233,000 piculs.

The manufacture of cloth and rope from the fibre of the plantain is not a new discovery, for the Indian natives of South America have long been in the habit of using it for these purposes. Dampier notices the process as common in the Indian archipelago in the early part of the last century, as follows: " They take the body of the tree, clear it of its outward bark and leaves, cut it into four quarters, which, put into the sun, the moisture exhales; they then take hold of the threads and draw them out; they are as big as brown thread. Of this they make cloth in Mindanao, called saggera, which is stubborn when new, wears out soon, and when wet it is slimy."

Our direct imports of Manila hemp into the United Kingdom from the Philippines have been as follows :—

	Cwts.		Cwts.
1862	173,478	1870	129,345
1863	312,871	1871	206,678
1864	183,944	1872	153,746
1865	194,851	1873	259,962
1866	87,873	1874	276,640
1867	88,033	1875	324,792
1868	175,118	1876	300,798
1869	92,642		

SECTION VII.

THE SPICES OF COMMERCE.

PEPPER is one of the most wholesome and useful of the spices. With persons in ordinary health it has the effect of stimulating the stomach greatly to the performance of its functions, and is peculiarly serviceable to persons who are of cold habit, or who suffer from a weak digestion. Used in moderation, pepper decidedly promotes the appetite and digestion; but its excessive use tends to vitiate the gastric juice and injure the stomach, besides provoking inordinate thirst; and this remark applies generally to all spices.

Many of the natives of India esteem pepper as a stomachic, and drink a strong infusion of it in water by way of creating an appetite. They have also a method of making a fiery spirit of fermented fresh pepper with water which they use for the same purpose.

The varieties of pepper which enter into commerce are Pinang and Singapore, Tellicherry, Sumatra, Malabar, Trang, Siam, and Cochin.

The empire of Acheen is the chief producing country for pepper. It is, however, cultivated in various parts of the island of Sumatra and at Bantam. The Malay Peninsula, where the pepper vine was introduced from Java, and which produced at one time about 4,000,000 lbs., now grows none. The culture, as far as quantity is concerned, may be said to be almost restricted, at present, to the east and west coasts of Sumatra; the production, which used to reach nearly 40,000,000 lbs. annually, has, however, greatly declined of late years, but it is probable that when the civil wars are suppressed it will again recover.

It is impossible to arrive at any precise data with regard to the crops. In 1872, 142,000 piculs were shipped to Pinang; in 1873, 105,000; and in 1874, 96,000. The blockade of the Acheen ports by the Dutch cannot alone have been the cause of this decrease, else the quantity shipped in 1874 would have been larger than in 1873. Besides the shipments to Pinang, there used to be sent, before the war, about 2,000,000 lbs. direct to Mediterranean ports. In estimating the entire produce now at about 22,600,000 lbs. we are not far wrong, which is more than 17,000,000 lbs. below the former production.

The pepper that comes to the Batavia market is received from the Lampong islands off the Sumatra shores; the quantity produced there is estimated at about 23,000 piculs annually. The crop is plucked in September and following months, therefore up to the end of January about 2000 piculs reach the Batavia market monthly, while from February to August the monthly receipts hardly reach 500 piculs. The exports of pepper from Java in 1870 were 21,039 piculs.

The pepper produced in the Lampong district in 1871 was 14,000 piculs; in 1872, 20,537 piculs. In 1872 the shipments consisted of 24,256 piculs of white and 30,695 of black pepper.

The imports of pepper into China were, in

	Piculs.		Piculs.
1868	40,169½	1871	25,683¾
1869	42,866¾	1872	41,011½
1870	24,485		

In 1867 the export of pepper from Siam, all to China, was 18,947 piculs, valued at 22,500*l.* This was not more than half the usual crop, owing to severe drought in the pepper districts on the east coast of the Gulf of Siam. In 1870 the export was 25,544 piculs, valued at $17,4881. Pepper is also grown to some extent in Cochin China, as 4308 piculs were shipped from thence in 1871. An export trade in this article was early fostered by the French authorities; the home administration, patriarchal ever towards its offshoots, determined to aid the development of its promising eastern colony, and, among other things, to induce a greater effort to be made in the production of pepper. For this purpose the duties levied in French ports upon the importation of pepper were entirely remitted in the case of Cochin China produce, or what was the same thing, so far as the home authorities could judge, Saigon exported produce. The differential duties thus created were very great, so considerable that it was found much more profitable to send pepper up to Saigon, to be there shipped to France as of Cochin China growth, than to send it on at much less expense and much smaller freight direct from the Straits. Now, however, a change has been made, and certificates of origin are required upon all pepper allowed to be exported to France, and none but such as is declared on shipment to be of Cochin China origin, is admitted duty free on arrival in France.

The importation of pepper into the port of Marseilles has been as follows, in tons, from

Year.	British India.	Dutch India.	Other Countries.
1872	240	849	393
1873	753	87	336
1874	1,357	1,139	375
1875	1,928	297	899

Of this there was taken for consumption in 1874, 416,975 kilogrammes, and in 1875, 647,228 kilogrammes.

In 1855 there were reported to be in Singapore 1,054,715 pepper vines in bearing, and 553,571 young vines. The exports were about 68,000 piculs annually; of this 50,000 piculs were produced in Singapore, and the balance imported from the Johore territory and Sumatra, &c. From Pinang, between 1855 and 1860 there were shipped on the average 50,000 piculs annually. In 1867 there was exported from the Straits Settlements 4,831,375 lbs., valued at 285,145*l.* Our direct imports of pepper from Singapore in the last five years have been as follows:—

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	lbs.	£		lbs.	£
1871	21,820,600	478,965	1874	17,503,343	507,790
1872	25,009,813	681,569	1875	27,677,719	622,865
1873	24,629,444	769,191			

The pepper vine (*Piper nigrum*) is indigenous to the forests of Malabar and Travancore. For centuries pepper has been an article of exportation to European countries from the western coast of India. Although a product of many countries in the east, that which comes from Malabar is acknowledged to be the best. In 1874 there were 23,179 pepper vines scattered over the territory of French India.

Its cultivation is very simple, and is effected by cuttings or suckers put down before the commencement of the rains in June, in a rich and tolerably moist soil. In three years it begins to bear, each plant yielding on an average 2 lbs. of pepper per annum up to fifteen or twenty years, after which they begin to decline. The crop is gathered in March or April; the fruit is plucked when not quite ripe, and usually dried on mats in the open air. White pepper differs from black only in being deprived of the outer skin by a short maceration in pure water and subsequent gentle rubbing; it is somewhat smaller, of a greyish white colour, and with a less aromatic taste.

The small round berry-like fruit grows somewhat loosely, to the number of twenty to thirty, on a common pendulous fruit-stalk. They are at first green, then become red, and if allowed to ripen, yellow; but they are gathered before complete maturity, and by drying in that state turn blackish-grey or brown. When one or two berries at the base of the spike begin to turn red the whole spike is pinched off. Next day the berries are rubbed off with the hands, picked clean and dried for three days in the sun, or in bamboo baskets near a gentle fire.

The plant is capable of growing to a height of 20 or 30 feet, but for the sake of convenience it is usually kept low, and is often trained on poles. In places where no vines occur naturally, the plant is propagated by setting slips near the roots of the trees on which it is to climb. An acre of land will bear 2500 plants, and as they require but little care, the cost of cultivating and bringing into bearing one acre does not exceed 4*l.* at the most, and as the annual yield when the plants come into bearing is worth upwards of 80*l.*, the investment is a very profitable one.

The pepper vine is hardy and easily cultivated, and as its produce is of such great commercial importance, it may be well worth trying whether it could not be successfully grown in other localities under congenial conditions of climate and soil. The choice of a proper site for the plantation is a consideration of the first importance. Level ground lying along the banks of rivers and rivulets is to be preferred, both on account of the vegetable mould commonly found in soil so situated, as well as on account of the facilities of water-carriage which such a situation generally affords. But the land should never be so low as to be liable to inundation. Declivities, unless very gentle, are to be avoided, because the soil loosened by culture is liable to be washed away by heavy rain. Plains, whether naked or covered with long grass, will not answer, unless broken up well with the plough and enriched by manure. Above all, the pepper-vine loves a moist climate.

In Malabar the pepper-vine is often raised from seed, and experienced men have been known to express a decided preference for this mode of propagation, because the vine so raised bears for fourteen years. On the other hand, though the cuttings yield for only seven years, or just half the period, the crops they give are greater, and the berries are both of larger size and of superior quality. It is for this reason, therefore, that in Malabar the cultivation is practised with cuttings or suckers, which are put down into the ground before the rain sets in, in June. The soil must be rich, but it should also be free from any accumulation of moisture below, or the young plants are apt to rot. The cuttings are usually planted at the foot of trees with rough bark, on which the vine as it grows finds a support. The creeper will climb up about 20 or 30 feet, but it is purposely kept lower for facility of collecting the berry. During its growth every sucker is removed, and it is pruned, thinned, and kept clear of weeds. In three years the vine begins to bear. After the berries have been gathered, they are dried on mats by exposure to the sun, when they change colour from red to black. Much experience is required as to the proper time for gathering. The trees which are generally selected in Malabar to support and shade the pepper-vine are the jack, the mango, the cashew-nut, and other similar trees; so that the pepper is an additional crop which the cultivator gathers from his orchard lands, even while they also are bearing.

Although the quality of the pepper grown in Malabar is considered to be better, the largest quantity of the spice is produced in Sumatra, where the method of cultivation is somewhat different. In that island the pepper-vine is raised in plantations regularly laid out. The ground is previously cleared of wood, ploughed up, and sown with rice, among which the cuttings are put down at a distance of five feet from each other in every direction, with the green sapling of some tree of quick growth and rough or prickly bark, which soon takes root and affords support and shade to the vine as it grows. It grows most luxuriously in moist, rich soils, provided it obtains good shade. Like most other vegetable productions in hot climates, it requires but little trouble or attention after it has once been planted, other than watching the proper season for collecting the berry. In Sumatra, the layers or cuttings are put down in September. The plant is afterwards left to itself for twelve or eighteen months, it is then buried with all its branches, so as to leave only a small arch of the stem above ground. From this arch new shoots sprout out, three or four of which are allowed to climb up the tree, and are expected to produce flowers and fruit in a year after. It is inferred that, by this practice, the strength and vigour of the plant are so much increased by the multiplication of its organs of nourishment, namely, the roots, that it will not only yield a larger crop of flowers, but also bring out its fruit in the greatest perfection. The neglect of this precaution might seriously affect the out-turn of a crop, both in quantity and quality.

The vine produces fruit in two seasons of the year. The flowers of the principal crop appear in September, with the rains of the first monsoon. In the latter end of December the berries begin to ripen, and are gathered in January, as they get to maturity. The finest berries in the second stage towards maturity are selected for making white pepper. The process in Sumatra consists in steeping these berries for three or four days in running water, and then drying them well in the sun. The flowers of the second crop appear in March and April with the rains of the little monsoon; and the fruit ripens and is gathered about July and August; it is probably to the want of moisture at the time the fruit is setting, that the inferior quality and scantier out-turn of this crop is to be attributed. One thousand vines are estimated to yield about $10\frac{1}{2}$ cwt. of pepper in the course of a year; so that each vine may be reckoned upon as producing $1\frac{1}{2}$ lb. of the spice.

The black berries of *Embelia Ribes*, Burm., are often used to adulterate it in parts of India, as they so much resemble pepper as to render it impossible to distinguish them by sight or by any other means, and they are, withal, somewhat spicy. Although there is a very heavy penalty on adulteration in this country, ground pepper is frequently sold sophisticated with starch, mustard husks, linseed and capsicum.

From 1811 to 1824 the duty imposed ranged from 2*s.* to 2*s.* 6*d.* per pound. Up to 1836 it was 1*s.*; it was then reduced to 6*d.*, and finally abolished.

The following have been the imports of pepper into the United Kingdom since the year 1840 as given in the Board of Trade returns:—

	Lbs.		Lbs.
1840	5,927,959	1859	8,719,266
1841	15,034,466	1860	12,810,040
1842	6,021,290	1861	14,684,389
1843	4,083,160	1862	18,115,975
1844	8,087,099	1863	16,810,469
1845	9,852,983	1864	18,536,795
1846	5,906,586	1865	18,343,592
1847	4,669,930	1866	14,612,161
1848	8,125,545	1867	13,913,924
1849	4,796,042	1868	16,990,144
1850	8,082,319	1869	18,144,284
1851	3,996,295	1870	19,339,491
1852	6,631,700	1871	23,669,727
1853	5,496,885	1872	27,576,710
1854	9,428,882	1873	26,324,828
1855	6,489,005	1874	19,648,118
1856	10,810,398	1875	29,399,020
1857	5,463,738	1876	26,059,030
1858	12,357,508		

The value of the pepper imported in 1875 was stated at 670,175*l.*

There would seem to be extraordinary fluctuations in the quantity of pepper taken for consumption here and stocks held, for if we take the last five years, deducting the re-exports from the imports, the following were apparently the quantities taken for consumption and held in stock in the United Kingdom:—

	Lbs.		Lbs.
1871	4,193,510	1874	3,320,468
1872	9,685,090	1875	9,187,571
1873	13,938,350		

The average consumption of pepper in the United Kingdom from 1848 to 1862, when there was a duty levied, was from 3,500,000 lbs. to 4,000,000 lbs. per annum.

A pepperwort, the small red carpels of which inclose black shining seeds of an aromatic odour, and a peculiar pungent flavour, with an acrid after-taste, being stimulant, stomachic, and astringent, are used for seasoning purposes in China. They are brought from the Szechuan province to Ning-po, and are worth 50 $ a picul.

Chillies and Cayenne Pepper.—The Cayenne pepper of commerce is obtained chiefly from the pulverised chillies or fruit pods of one or two species of capsicum (*Capsicum annuum*, Lin., and *C. fastigiatum*, Blume). But a very large number of species and varieties of capsicum are grown and used as condiments in all tropical countries, where there appears to be a greater necessity for pungent seasonings.

The generic botanical name of Capsicum is derived from "kapto," to bite, on account of the hot pungent qualities of the pericarp.

Among the principal species grown may be named the following:—the cherry pepper or round chilli, (*Capsicum cerasiforme*, Willd.); the bonnet pepper (*C. tetragonum*, Mill.); the bell pepper (*C. grossum*, Lin.); the spice or goat pepper (*C. frutescens*, Lin.) and the bird pepper (*C. baccatum*, Lin.). The last named two are more acrimonious than the others. The fruits of these several species are of various forms—round, oblong, cordate or horned, and either scarlet or yellow; in some varieties they are so little pungent as to be used sliced in salad, in others they are intolerably biting till the mouth becomes accustomed to them by habit. The acrid resin (*capsicine*) in the fruit renders them hot, pungent and stimulating. Contrary to general opinion it has been found on analysis that the seeds after removal of the pericarp, and thoroughly washing and drying them, are entirely devoid of acridity and pungency.

Red pepper may be termed one of the most useful condiments in hygiene. As a stimulant and auxiliary in digestion it has been considered invaluable, especially in warm countries. There are always a few of these shrubby plants grown about the dwellings in the tropics to supply the daily wants of the table, as they are generally gathered and eaten just before fully ripe.

Unfortunately Cayenne pepper is very frequently adulterated, and hence reliance can only be placed on purchasing from respectable wholesale houses, which have a reputation and character for probity and the sale of genuine articles. Venetian red, red ochre and cinnabar are often added to darken the colour, although this is no sign of its excellence, for the Nepaul and many other Cayenne peppers are extremely light coloured as they will naturally be if made with the ground seeds alone unmixed with the redder husks of the fruit capsule. As Cayenne pepper when obtained pure and used in moderation promotes digestion and so prevents flatulence, and is hence undoubtedly serviceable to persons of languid digestion, so if adulterated with poisonous substances it is calculated to be highly injurious.

The French names for capsicums are "piment," "poivrons," "pevrots," and "corail of the gardens." The Spanish name for this spice is "agi:" it was formerly known under the name of Calicut pepper, and in Gerarde's time, nearly three centuries ago, it was sold here under the name of Ginnie pepper, and it still bears the name of Guinea pepper in France.

The natives of Brazil consume great quantities of these peppers, preferring the small red ones, which are of excessive pungency. When they have no fish they boil several pounds of these peppers in a little water, and dip their mandioca bread into the fiery soup thus formed.

There is an enormous consumption of chillies in India, as both rich and poor daily use them, and they form an important ingredient in the curries and chutneys in general use, when ground into a paste between two stones, with a little mustard, lard, oil, ginger and salt, this forms the only seasoning which the millions of poor in the East can obtain to flavour their insipid rice.

In 1870 there were more than 70,000 acres under culture with capsicums in the Madras Presidency, the largest portion being in Kistna. The exports from Madras in the four years ending 1855 were 81,042 cwt. Bombay imported in 1873, 5567 cwt. principally from the Madras Presidency, and exported 3323 cwt. In 1871 Singapore imported 1071 cwt., chiefly from Pinang and Pegu. The spice is largely consumed by the Chinese. 409½ piculs of dried chillies were shipped from Chefoo in 1871 to other Chinese ports. *C. annuum* is extensively cultivated in Bengal; there is a variety growing in Nepaul (*C. Nepalensis*) the taste of which is far more pungent and acrid than any of the preceding named species.

Chillies or pod peppers are much used for flavouring pickles. By pouring hot vinegar upon the fruits all the essential qualities are procured, which cannot be effected by drying them, owing to their oleaginous properties; hence chilli vinegar is in repute as a flavouring substance. In Bengal the natives make an extract from the chillies, which is about the consistence and colour of treacle. A form of soluble Cayenne was sent from British Guiana in 1867 in the collection forwarded to the Paris Exhibition.

Chillies are imported here from the West Indies, Western Africa, Zanzibar and Natal, but there are no reliable statistics as to the quantity we receive, although it has been estimated at as much as 80 tons annually; Sierra Leone shipped in 1871, 7258 lbs., and Natal 9072 lbs.

Ginger.—After pepper, ginger probably ranks next in importance for the quantity produced and consumed, and the aggregate value of that which we receive. The declared value of all the spices we import averages about 1,200,000*l*., of which pepper stands for nearly one half. Cinnamon is valued at about 125,000*l*., whilst ground ginger has now reached beyond 169,000*l*., besides about 20,000*l*. more for preserved ginger, and this is all consumed here. According to Hanbury, ginger must have been tolerably well known in England even prior to the Norman Conquest. The plant affording it was known to Marco Polo, who speaks of observing it both in China and India.

The root-like stem of *Zingiber officinale*, Rosc., is cultivated in very many of the warmer parts of the world for local use, but only in a few localities on an extensive scale for shipment to supply European wants. Of this well-known flavouring condiment several varieties are known in trade, distinguished by their quality, place of growth, &c. Gingers are either "coated" with the shrivelled rind, or "scraped" by having it run over. Ginger is sometimes bleached by chloride of lime, or whitewashed with lime and water. This spice is but little used on the Continent compared with England.

The varieties of ginger which enter into commerce are Jamaica, Cochin, Brazil and Africa. The first three are scraped gingers, the last-named is coated ginger—that is to say, it still retains its epidermis. Jamaica ginger is the sort most esteemed, and next to it the Cochin.

The following shows our sources of supply in 1875:—

From—	Quantity.	Value.
	cwts.	£
British West Africa	9,900	19,887
Bombay	10,459	31,418
Madras	11,553	37,898
Bengal	8,295	16,068
British West India Isles	15,215	54,955
Other countries	1,481	3,586
Total	56,903	163,812

Ginger is received chiefly from three quarters, the East and West Indies (Cochin and Jamaica) and the Western Coast of Africa—Sierra Leone. Our imports of ginger into the United Kingdom have been as follows:—

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	cwts.	£		cwts.	£
1867	42,834	95,398	1872	32,174	72,139
1868	52,194	101,456	1873	36,363	97,548
1869	34,535	59,982	1874	38,750	117,987
1870	33,854	60,973	1875	56,880	163,951
1871	32,723	70,884	1876	62,164	169,252

Several of the West Indian islands used to grow ginger, especially Barbados, Hayti and Jamaica, but the cultivation for export is chiefly now confined to Jamaica.

In Jamaica it is propagated by division of the root, the smaller pieces or protuberances being set, each of which throws up two different stems. The first bears the leaves, and rises sometimes to the height of three feet or more, though its usual growth seldom exceeds 16 or 18 inches; when this spreads its leaves and grows to full perfection, the second stalk springs up, which is also simple and furnished only with a few scales below, but at the top is adorned with a roundish squamose flower-spike, and seldom rises above two-thirds of the height of the others. The land having been well cleared and trenched, the ginger is planted about March or April. It rises to its height and flowers about September, and fades again towards the end of the year. When the stalks are wholly withered, the root is thought to be full-grown, and fit to dry, which is generally done in January and February following. When these are dug up, they are picked and cleaned, and scalded gradually in boiling water. After this, they are spread out in the sun to dry, from day to day, until sufficiently aired for packing. The larger spreading roots are generally called "hands" in Jamaica, and will occasionally weigh half-a-pound; they are also termed "races."

In 1874 there were 185 acres under culture with ginger in Jamaica. The crop seems to vary a good deal, since we find over 18,000 cwt. shipped in 1868, and not much more than 5000 cwt. in 1872, recovering again to 10,551 cwt. in 1874, valued at 21,100*l*., but the average for many years may be taken at 1,000,000 lbs. to 1,500,000 lbs. The following have been the exports of ginger from Jamaica of late years:—

	Lbs.		Lbs.
1866	1,550,166	1871	632,031
1867	1,728,075	1872	599,766
1868	2,036,921	1873	815,659
1869	1,261,873	1874	1,181,789
1870	680,492		

The ginger plant is extensively cultivated in India, from the Himalayas to Cape Comorin. It is not exactly known to what country the plant is indigenous, though Ainslie states it to be a native of China, while Joebel asserts that it is a native of Guinea. In the Himalayas it is successfully reared at elevations of 4000, or 5000 feet, requiring a moist soil. The Malabar ginger, exported from Calicut, is the produce of the district of Shernaad, situated to the south of Calicut.

In the Dacca district the natives cleanse the roots in boiling lime water, which probably injures much of the fragrant pungency; whereas in the West Indies, they use simply plain water. The leaves and shoots of the broad-leaved ginger (*Z. Zerumbet*) are used as greens in Bengal. It grows wild in the Concan, and in the woods about Calcutta. The underground stem of this species resembles that of ginger, but is bitter as well as aromatic. The root-stocks of *Alpinia*

Galanga, *A. racemosa*, *A. Allughas*, have somewhat similar aromatic and pungent properties, and are frequently used as substitutes for ginger.

In India the cultivation is carried on in the Hill States as follows. The best "races" of the previous year's crops are selected and placed in a corner of the house, and smeared over and covered with cow dung to prevent them becoming dry.

When the first rain falls, the land is ploughed two or three times, and then divided off into beds with a little raised edge round each bed, taking care to make openings to let superfluous water run off; for if water lodges on the crop, the roots will rot. Little pieces of the roots are then buried 3 inches deep in the soil at intervals of 9 inches. The field is covered with the leaves of trees to keep the soil moist, and over these manure is spread to the depth of half an inch. When it rains, the water, impregnated with manure, filters through the leaves to the roots. Artificial irrigation is given after the rains. When the plants are about 2 feet high, to every shoot there will be found about eight rhizomes, or parts of the root. These are dug up, and buried in another place for a month, then taken up, exposed to the sun for a day, and are fit for use. A beegah of land requires eight maunds of ginger to plant, and yields thirty-two maunds for a first-rate crop. Ginger, fit for planting, sells at 8 to 10 seers for the rupee; that for use, 24 to 32 seers the rupee. In order to dry ginger into "sonth," or for keeping, the fresh roots are put into a basket, which is suspended by a rope, and then two men, one on each side, pull it to and fro between them by a cord attached, and thus shake the roots in the basket; this process is carried on for two hours every day for three days. After this the roots are dried in the sun for eight days, and again shaken in the basket. The object of the shaking is to take off the outer scales and skin of the roots. Two days' further drying completes the process, and the "sonth" sells for 3 to 4 seers the rupee. Turmeric is cultivated in the same manner; when ready it is dug up, steeped in hot water a day and a night, and then dried.

The following have been the exports from India:—

Year.	Ginger.		Other sorts of Spices.	
	Quantity.	Value.	Quantity.	Value.
	cwts.	£	lbs.	£
1869	11,835	20,017	..	..
1870	15,313	27,647	..	..
1871	13,014	28,199	1,215,438	32,135
1872	13,310	28,217	701,869	19,781
1873	14,959	39,830	737,562	20,807
1874	16,004	47,410	1,209,133	50,413
1875	30,307	85,384	1,208,662	47,766

The African ginger is grown in Sierra Leone; about half that produced comes to England, and the other half goes to America. In 1868 the value of the ginger exported from Sierra Leone was 18,917*l.*, and in 1869, 14,008*l*. Our direct imports from Sierra Leone have been as follows:—

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	cwts.	£		cwts.	£
1869	9,566	11,380	1873	7,655	16,383
1870	6,855	8,999	1874	8,813	20,908
1871	5,948	5,540	1875	9,843	19,752
1872	6,167	9,980			

Ginger is a good deal grown in China, and largely used in its fresh state as a condiment, and in medicine. Some small quantity is exported dried, but it is black and hard, and not much appreciated in commerce.

Ginger also appears in European commerce as a succade, the young shoots of the rhizome being peeled and preserved in syrup. For this purpose the rhizomes are lifted while they are yet tender and full of sap, befere they have become hard or woody; the roots are carefully picked and washed, and afterwards scalded till they become tender enough for the purpose; they are then put into cold water, and scraped and peeled gradually. This operation may last three or four days, the water on the roots being changed frequently. When thus prepared, they are put into jars and covered with the syrup, and this is changed two or three times, when they are ready for shipment. The imports of preserved ginger are principally from China, from whence we have received of late years the following quantities:—

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	cwts.	£		cwts.	£
1867	4,249	23,799	1872	9,372	25,722
1868	4,972	21,177	1873	4,327	16,319
1869	2,677	9,753	1874	7,681	21,949
1870	3,791	12,731	1875	6,996	19,894
1871	3,366	13,465			

Nutmegs and Mace.—The tree which produces these spices is the *Myristica moschata*, Thunberg; *M. fragrans*, Houttuyn; *M. aromatica*, Lam.; *M. officinalis*, Lin.; a native of the Moluccas. The tree attains a height of 20 to 30 feet and greatly resembles our pear tree. The fruit, which is singularly beautiful, is pear-shaped, about the size of an apricot. As it ripens, the pulp, which is nearly half-an-inch thick, and of a whitish colour, opens and displays the nutmeg in its black and shining shell, encircled by a network of mace.

The tree begins to bear when ten years old, and goes on improving during the space of a century. The fruit is gathered two or three times a year. Three sorts of nutmegs are distinguished, namely, the male or barren, the royal, and the queen. The last, which are small and round, are preferred to the others, which are large and oval.

In 1830 the duty on nutmegs was 2*s.* 6*d.* per lb. on British grown, and 3*s.* 6*d.* on foreign, and the consumption was 121,260 lbs., which had increased in 1837 to 134,115 lbs. In 1836, wild nutmegs were admitted at 1*s.* duty. In 1846, the rates for British and foreign were equalized to 2*s.* 6*d.*, and for wild lowered to 3*d.* per lb. In 1847, a distinction was made between wild in the shell and wild "not in the shell," the former being charged 3*d.* and the latter 5*d.* per lb. The home consumption in 1859 was 265,783 lbs. The duty on all spices has long since been abolished. The following figures give the Imports of nutmegs into the United Kingdom for a series of years; but they have not been separately specified in the Board of Trade returns for the last six years:—

	Lbs.		Lbs.
1840	113,193	1848	336,420
1841	135,198	1849	224,021
1842	169,241	1850	315,126
1843	209,602	1851	358,320
1844	152,110	1852	357,939
1845	444,706	1853	300,563
1846	405,679	1854	438,312
1847	367,936	1855	335,623

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	lbs.	£		lbs.	£
1856	462,600	54,602	1864	809,095	48,864
1857	462,972	51,738	1865	771,971	42,621
1858	421,785	39,695	1866	563,785	31,788
1859	451,561	39,176	1867	370,193	23,417
1860	532,208	42,157	1868	682,139	43,245
1861	574,164	33,440	1869	809,589	57,818
1862	511,023	32,223	1870	537,978	32,513
1863	551,577	27,160			

The nutmeg is propagated from fresh seeds (nutmegs) and these vary greatly in size and shape, just as apples and pears do raised from seeds. There can hardly be a more profitable crop than the nutmeg at present prices. The annual yield of a good tree of sixteen or eighteen years' growth, and covering about 600 square feet surface, is about 10 lbs., which, at an average of 2*s.* per lb., gives a value of produce per acre, per annum, of over 70*l.*, exclusive of the yield of mace, 1 lb. each tree, which at 4*s.* is equal to 10*l.* more. The fruit of the nutmeg takes nine months to mature.

In the year 1619, the Dutch took possession of the Spice Islands, and while encouraging to the utmost of their power the culture of the nutmeg tree in a few of them, ruthlessly destroyed all the trees in the surrounding islands. Two years after the occupation of the Moluccas by the British in 1796, the nutmeg tree was planted at Bencoolen, in Sumatra, and shortly afterwards the culture was undertaken in the Straits Settlements.

The Banda islands, where nutmeg culture is carried on by the Dutch, are Great Banda or Lonthoir, Neira and Ay. The annual production there in the fifteen years ending 1854, was 579,321 lbs. of nutmegs, and 137,392 lbs. of mace. There are about thirty-four nutmeg gardens there. These differ in size, the number of trees varying from 4000 to 28,000, and the produce is from 5000 to 32,000 of nutmegs. These are classed into medium, inferior, and broken nuts, and the mace into good and chips. As the consumption would seem to be increasing, and the production does not keep pace, the value is likely to rise, although the price has doubled in the last two years. In 1863, the combined shipments of nutmegs and mace from Java were 900,000 lbs. In 1870 the shipment of nutmegs alone was 5931 piculs; and in 1871, 8107 piculs, of which more than a fourth went to the United States.

The British production in the Straits Settlements twenty years ago exceeded the Dutch crop, the total yield of the Bandas in 1855, being but 4032 piculs of nutmegs and 1000 of mace. The production of Pinang alone (exclusive of Singapore) was as follows, for ten years:—

Year.	Nutmegs.	Mace.	Total.
	piculs.	piculs.	piculs.
1846–47	1,519	477	1,996
1847–48	2,077	661	2,738
1848–49	2,178	666	2,844
1849–50	2,086	656	2,742
1850–51	2,564	751	3,315
1851–52	2,625	886	3,511
1852–53	3,020	781	3,801
1853–54	2,768	887	3,655
1854–55	3,294	898	4,192
1855–56	4,624	1,340	5,964
Total	26,755	8,003	34,758

The following shows the decennial progress of the exports from Pinang, in piculs:—

Year.	Nutmegs.	Mace.
	piculs.	piculs.
1840	598	159
1850	2,086	656
1860	6,421	2,094

There were, in 1860, 14,502 acres under culture with spices of all kinds, namely, 13,153 in Pinang, and 1349 in Province Wellesley. Pinang nutmegs are always shipped in the natural state, and not limed.

In 1848, there were 1190 acres under nutmeg trees in Singapore, containing 71,400 trees, which produced 624 cwts. of nutmegs and 156 cwts. of mace. In 1855, there were 2639 nutmeg trees bearing, and 34,000 young trees. The production was but 89,379 nutmegs, which were then valued at 3½ dollars per 1000.

The island plantations in Singapore and Pinang have never recovered the severe blight which, in 1857, destroyed nearly every nutmeg tree then in existence. The plantations at that time were yielding at the rate of 30*l.* to 40*l.* per acre. The lands formerly in nutmeg cultivation are now planted with cocoa-nut and other fruit trees, which, although not so valuable as the nutmeg, yield a fair return for the capital and labour expended. The Chinese have, however, lately commenced to replant the nutmeg tree, and with every prospect of success.

In 1867, 485,123 cwts. of nutmegs valued at 50,559*l.*, and 5416 cwts. of mace, valued at 7354*l.*, were shipped from the Straits Settlements.

Our imports of unenumerated spices from Singapore in the last five years (exclusive of pepper) are stated below; Singapore is, however, the entrepôt of the Eastern Archipelago, and receives large quantities from Sumatra and Borneo:

Year.	Quantity.	Value.
	lbs.	£
1871	640,544	45,821
1872	1,282,066	112,242
1873	552,719	48,867
1874	336,882	45,327
1875	432,992	54,656

From the west coast of Sumatra there was shipped in 1872, 1953 piculs of nutmegs, and 403 piculs of mace; in 1873, 2237 piculs of nutmegs and 568 of mace. In 1874, from the southern division of Padang alone, 284 piculs of nutmegs and 28 of mace; 130 piculs of the nutmegs were sent to Pinang.

The cultivation of nutmegs is much in favour in Jamaica just now, and 2000 plants are under propagation in the Government Botanic Garden for distribution. A fine nutmeg tree there is stated to have had upwards of 4000 unusually large fruit upon it. The value, calculating ninety nuts to the pound, would be 44 lbs., worth at least 3*s.*, or in all 6*l.* 12*s.*

The Island Botanist reports as follows on the culture of the nutmeg:—

"This plant, I consider, is the most generally prized, as it is undoubtedly the most frequently applied for of all that are under cultivation. Notwithstanding this, and that the plant has been introduced into this island some forty or fifty years, and has yielded thousands of fruits annually during the greater part of that time, there are, as nearly as I am enabled to judge, not more than probably fifty bearing trees in the whole island; and this, too, in a country where the tree yields fruit of the finest quality, and in the utmost profusion. The great majority of the bearing trees are in the immediate vicinity of Bath. In my recent tour throughout a great part of the island I found that nutmegs were unknown to cultivation, although large tracts through which I passed are admirably adapted for their growth. I consider that the cultivation of this tree deserves the utmost encouragement, especially amongst the peasantry, as I am strongly inclined to think that as a remunerative industry even coffee would find in it a very formidable rival.

"The nutmeg trees at Castleton are now beginning to bear, and about 150 plants have been recently planted, and this number will soon be augmented. I expect that one acre of plants will be shortly set out. I have also made arrangements at the Bath Garden for bedding all the seeds obtainable there, and these will probably amount to 3000 plants a year, which I purpose offering for sale at a moderate rate per hundred. This tree succeeds best in a rich, deep, friable soil, over a gravelly subsoil forming a natural drainage.

"The form of the ground ought to be undulating, to assist the running off of all superfluous water, as there is no one thing more injurious to the plant than water lodging around its roots; although, in order to thrive well, it requires an atmosphere of the most humid kind. This tree begins to bear about the seventh year; and a few years after the average annual yield from each tree may be calculated at from 1000 to 5000 fruit."

Nutmegs are valued a good deal according to size, the largest being the best; thus, those of 68 to the lb. will fetch 4*s.* 8*d.*; while very small, 120 to the lb., will be worth but only half that price.

The shape of the nutmeg varies a good deal, being spherical, oblong and egg-shaped, but the nearer they approach sphericity of figure the more highly are they prized. Those of good quality ought to be nearly round, and the largest and finest weigh on the average about a quarter of an ounce each. They should have an agreeable flavour, but rather bitter, and when pierced exude an oily juice.

It was at one time thought, for a few years, that the culture would receive a great development in French Guiana, but at last, either from want of proper care, or public infatuation giving way to complete indifference, the nutmeg plantations were gradually given up. Notwithstanding repeated trials in various colonies in the Indian Ocean, West Indies, and America, the nutmeg does not seem to thrive well, and succeeds only in the localities of the Indian Archipelago.

In 1864, there was a small export of 5000 lbs. of nutmegs and 900 lbs. of mace from Reunion, and in 1871 the shipments were rather larger, but the production has declined altogether.

A fraud is often practised in disguising worm-eaten nuts by filling up the holes with mastic. They are also often first deprived of their essential oil by distillation, or steeping in alcohol. Nutmegs yield when distilled with water a volatile or essential oil of nutmegs, in the proportion of about 2¼ per cent., and mace an oil of nearly similar properties. A concrete oil, known as nutmeg butter, is also imported from the Moluccas; it is prepared by heating nutmegs and afterwards submitting them to pressure. The *Myristica sebifera*, of South America, also yields an oil by expression.

Wild nutmegs of a longer shape are the produce of *Myristica fatua*, or *tomentosa*, and are often imported. Lieut. Cameron states that in his explorations in Central Africa he met with large groves of wild nutmeg trees. A wild nutmeg is also yielded by a Brazilian tree, *Cryptocarya moschata*. A false nutmeg, called in Guiana the Ackawa nutmeg, is the fruit of *Acrodiclidium Camara*. Another kind has occasionally been imported on the Continent from Madagascar and Bourbon under the name of clove nutmegs, or ravensara nuts; they are the produce of *Agathophyllum aromaticum*.

There are several other kinds of nutmegs derived from different species of *Myristica*, which are in use in various parts of the world, but as they are much inferior in their qualities, and are not found in commerce, it is unnecessary to describe them here.

MACE is the reticulated scarlet arillus enveloping the thin, dark brown, glossy, oval shell which covers the nutmeg. When dry, the mace becomes yellow, brown and brittle. In preparing it, it is said to be first steeped in a weak salt solution, which renders it supple and preserves the aromatic principle.

In 1830, the duty on mace was higher than on nutmegs, being 3*s*. 6*d*. per lb. on British produce, and 4*s*. 6*d*. on foreign; the home consumption then was 12,600 lbs. In 1835, it had increased to 18,835 lbs. The duty was then fixed at 2*s*. 6*d*. for all descriptions, and in 1852 the consumption was 21,485 lbs. In 1853, the duty was lowered to 1*s*. per lb., and the consumption had increased in 1859 to 34,714 lbs.

The following figures show the imports of mace as far as they have been officially recorded by the Board of Trade :—

	Lbs.		Lbs.
1862	81,689	1867	26,269
1863	48,649	1868	88,966
1864	55,175	1869	75,922
1865	63,563	1870	60,869
1866	110,789		

The shipments of mace from Java in 1871 were 2101 piculs, and from Padang, in Sumatra, 457 piculs.

Nutmegs and mace are employed chiefly as condiments for ordinary purposes, for which they are admirably suited by their agreeable taste and stimulating properties. As remedial agents they owe their activity to the volatile oil which they contain, and when administered in moderate quantities, produce the usual effect of the other spices. Their use requires caution in those subject to apoplexy and other cerebral affections, as they possess narcotic properties. Taken in small quantities these spices assist digestion, dispel flatulency, strengthen the viscera, and stop dysentery.

CASSIA AND OTHER SPICE BARKS.—Many of the trees of the Laurel family, to which the Cinnamon and Cassia belong, contain an aromatic principle, which resides in many parts, such as the bark, leaves, and fruit. Of this we have instances in the berries and leaves of the bay (*Laurus nobilis*); the latter are used for flavouring custards, puddings, &c. Figs imported into this country are also packed in them.

Laurel leaves in Greece are more aromatic than in other localities. It seems as if in warmer climates the aromatic principles of plants are more profusely developed, like the bitter and astringent principles in the colder regions. In America the bark and wood of *Sassafras officinale* have a pleasant aromatic odour, which leads to a considerable commerce. In the United States the essential oil obtained from it is used to give a pleasant flavour to effervescing drinks, tobacco, and toilet soaps. The bark of a Brazilian tree, *Mespilodaphne pretiosa*, resembles the true sassafras in odour. There is a thick sassafras bark produced in Burmah, Martaban, and other parts of India. An eastern sassafras is obtained in Sumatra from *Sassafras Parthenoxylon*, and in

Nepal from *S. glanduliferum ;* while the bark of *Benzoin odoriferum* of North America is also highly aromatic. The bark of *Atherospermum moschatum* of Tasmania is pleasantly aromatic. The aromatic Malambo bark (*Croton Malambo*), of Central America, is said to be used in the United States for adulterating spices.

The spice bush (*Oreodaphne Californica*) a lofty tree, has leaves which are pungently aromatic, and the spice wood (*Lindera Benzoin*) found in Western Virginia has a highly aromatic wood. Sassafras nuts, the large separate cotyledons of two Lauraceous trees of Brazil, are also occasionally met with in commerce and used for flavouring. Another member of the Laurel family, *Daphnidium Cubeba* of Nees von Esenbeck, has berries which have an agreeable warm aromatic flavour, and are used as spice by the Chinese.

In ancient Italy the berries and flower buds of the myrtle were used as a kind of spice. The modern Tuscans and the people of Syria and Palestine still frequently substitute these for pepper or flavouring.

Cassia Bark.—Messrs. Hanbury and Fluckiger have furnished more ample details respecting this bark than had previously been published, and they state that various species of *Cinnamomum* occurring in the warm countries of Asia from India eastward, afford what is termed in commerce Cassia bark. The trees are extremely variable in foliage, and inflorescence, and aromatic properties, and the distinctness of several of the species laid down even in recent works is still uncertain. At present, neither botanists, pharmacologists, or spice dealers are able to point out characteristics by which to distinguish the barks of this group, or even to give definite names to those found in our warehouses.

The bark which bears *par excellence* the name of cassia, or cassia lignea, and which is distinguished on the Continent as Chinese cinnamon, is a production of the provices of Kwang-se and Kweichan in Southern China. Cassia lignea is also produced in the Khasyo mountains in Eastern Bengal, whence it is brought down to Calcutta for shipment. In this region there are three species of cinnamon, growing at 1000 to 4000 feet above the sea-level, and all have bark with the flavour of cinnamon, more or less pure; they are *Cinnamomum obtusifolium*, Nees; *C. pauciflorum*, Nees; and *C. Tamala*, Nees. *C. iners*, Reinw. a very valuable species occurring in Continental India, Ceylon, Tavoy, Java, Sumatra, and other islands of the Indian Archipelago, and possibly, in the opinion of Thwaites, a mere variety of *C. Zeylanicum*, but, according to Meissner, well distinguished by its paler, thinner leaves, its nervation and the character of its aroma, would appear to yield the Cassia bark or wild cinnamon of Southern India. *C. Tamala*, Fr. Nees et Eberm, which, besides growing in Khasya, is found in the contiguous regions of Silhet, Sikkim, Nepal, and Kumaon, and even reaches Australia, probably affords some Cassia bark in Northern India. Large quantities of a thick sort of cassia have at times been imported from Singapore and Batavia, much of which is produced in Sumatra. In the absence of any very reliable information as to its botanical sources, we may suggest as mother plants *C. cassia*, Bl. and *C. Burmanni*, Bl. var. *a. Chinense*, both stated by Teijsman and Binnendijk to be cultivated in Java. The latter species growing also in the Philippines, probably affords the cassia bark which is shipped from Manila (*Pharmacographia*).

The bark is stripped off by running a knife along the branch on both sides, and then gradually loosening it, and after it is taken off it is suffered to lie for twenty-four hours, during which it undergoes a kind of fermentation, and the epidermis is easily scraped off. The bark soon dries into the quilted shape in which it is brought to market. In China it ranges in price from 8 to 25 dollars per picul. It is there used to flavour medicine, and for making incense. The extreme tender ends of the branches of the tree are also used as a spice.

Of late years no separate account has been taken by the Board of Trade of Cassia bark, but we can get at some details of the special commerce by referring back to the official returns of a few years past. The imports and value of this spice bark were as follows in the years specified :—

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	lbs.	£		lbs.	£
1856	1,408,021	46,575	1864	885,936	34,096
1857	454,538	20,575	1865	1,117,909	43,481
1858	819,198	35,705	1866	349,349	12,346
1859	9[illegible]9,729	32,780	1867	521,852	23,579
1860	580,560	22,142	1868	568,212	29,518
1861	283,869	11,247	1869	530,537	25,072
1862	580,141	20,180	1870	875,991	40,612
1863	1,086,985	41,263			

If we trace the re-exports of cassia bark in the years for which the shipments have been enumerated, we find that there is but a small consumption of it in this country, not more than about 40,000 lbs. a year on the average. The bulk of the receipts go to the Continent, true cinnamon bark being preferred here.

The re-exports of Cassia bark were in

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	lbs.	£		lbs.	£
1866	538,672	25,963	1869	544,422	26,699
1867	534,735	24,361	1870	611,123	27,192
1868	362,329	18,693			

In 1872 the value of the Cassia lignea bark shipped from the fourteen Chinese ports open to commerce was 11,591,334 dollars; and in 1873, 14,007,924 dollars. Some Cassia bark is shipped from Padang to the United States.

There has been a very large and steady increase in the export of this product year by year from Canton, as will be seen by the following figures :—

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	piculs.	dollars.		piculs.	dollars.
1862	7,683	130,030	1867	24,660	440,885
1863	8,374	139,175	1868	36,055	721,098
1864	13,851	228,874	1869	40,686	860,486
1865	23,514	398,776	1871	61,220	..
1866	23,960	455,113	1872	76,464	..

The imports of spices of all kinds from China into this country have been as follows (the bulk of this is Cassia bark);

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	lbs.	£		lbs.	£
1870	888,913	32,695	1873	951,896	32,775
1871	597,101	17,080	1874	2,732,215	80,190
1872	1,363,507	65,683	1875	1,206,598	35,608

Cassia Buds are the immature fruits gathered and dried of several species of Cinnamon, chiefly the Chinese Cassia lignea. They are used in confectionery, having the flavour and pungency of cassia. The average quantity imported in each of the thirteen years ending with 1842 was 4023 lbs., and we consumed about 6700 lbs.

We received in

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	lbs.	£		lbs.	£
1867	7,355	467	1869	39,861	3,000
1868	50,676	3,565	1870	29,321	2,226

No more recent returns have been published of the imports. In Southern India the more matured fruits of one of the varieties of *Cinnamomum iners*, Reinw. are collected for use, but are very inferior to the Chinese cassia buds.

When gathered young, the receptacles completely envelope the embryo seed, which progressively protrudes, but continues firmly embraced by the receptacle. The buds are of various sizes, having the appearance of nails with roundish heads. If completely dried the receptacle is nearly black.

Cassia buds are shipped from Canton, but the exports have much declined. Rondot estimated them as averaging in 1848 53,333 lbs. a year. In 1866 only 31,066 lbs., and in 1867 but 22,000 lbs. were shipped from Canton.

Cinnamon.—The Cinnamon of commerce is the aromatic bark of a species of laurel, *Cinnamomum Zeylanicum*, Breyne. Its fruit is a small berry in the form of an olive, with a kernel. The bark is composed of thin layers which are separate, and which, cut in lengths, are exposed in the sun, and curl up in drying. Good cinnamon should be fine, thin, brittle, of a yellowish brown, and aromatic. It is one of the delicate spices of the table, and is also used in medicine.

In the "Feuille de la Guyane" for 1820, of Guisan, page 339, it is represented as a very hardy plant, growing well in all situations, soils, and aspects, on the summits of mountains, on the borders of streams which wash its roots; in alluvial soils, thoroughly or badly drained, it is stated to succeed well. This differs, however, from the opinions entertained in Ceylon, where cinnamon of a superior quality is restricted to sandy soils. Leblond remarks that every part of the tree is important, and can be applied to some useful purpose, the wood, leaves, fruit, and bark. The roots even yield, by distillation, a camphor of a better quality than that ordinarily used in medicine. The old trunks furnish resinous knots which have the odour of rose-wood, and can be advantageously employed for furniture; the leaves furnish an oil appreciated by perfumers; a distilled water from the flowers, besides the soft and pleasant odour, sweetens the worst breath, animates the spirits, and diffuses its pleasant perfume wherever it is used. A decoction of the fruit furnishes a useful wax.

The cinnamon is raised most readily from seeds, although the fine kinds are propagated in Ceylon by layers, and they differ in the degree of aromatic principle or flavour just as much as the nutmeg varies in respect of size, but the quality of the seedlings can always be ascertained in the seedling bud by tasting the leaves.

Cinnamon was held in high esteem in the most remote times of history. In the words of the learned Dr. Vincent, Dean of Westminster, it seems to have been the first spice sought after in all oriental voyages. Both cinnamon and cassia are mentioned as precious odoriferous substances in the Mosaic writings and the different Biblical works, also by many of the writers of antiquity; and from the accounts which have thus come down to us, there appears reason for believing that the spices referred to were nearly the same as those of the present day. That cinnamon and cassia were extremely analogous, is proved by the remark of Galen, that the finest cassia differs so little from the lowest quality of cinnamon that the first may be substituted for the second, provided a double weight of it be used (*Pharmacographia*). This bark was an article of export from India in the time of the author of the Periplus of the Erythræan sea, and even long before it was much used among the masters of the ancient world. Nero is reported to have burnt a quantity of cinnamon and cassia, at the funeral of Popposa, greater than the countries from which it was imported produced in one year. Marco Polo, the Venetian, incidentally mentions this spice in several places, but gives this name to wrong articles sometimes. Cæsar Frederick, a countryman of Marco Polo, who travelled in Asia about A.D. 1563, describes the process of gathering the spice in Ceylon.

The roots of the cinnamon tree are branchy and ligneous; the bark of these roots has the pungent smell of camphor, with the delicious odour of cinnamon, and yields camphor by distillation. The wood of the tree is light, fibrous, and inodorous. The trunk is from 12 to 18 inches in diameter, rising to the height of from 20 to 30 feet; it grows irregular and knotty; the external bark is thick, rough, and scabrous, and of an ash colour; the inner bark is reddish. The bark of the young shoot is often speckled with dark-green and light-orange colours. The branches are thick and spreading, and shoot forth horizontally or inclining downwards; they are covered with numerous oblong leaves growing in pairs opposite to each other. When first developed, these leaves are of a bright red hue, then of a pale yellow, and when arrived at maturity of a dark olive colour. At full growth they are from 6 to 9 inches long, and from 2 to 3 inches broad. The upper surface is smooth and shining, and of a darker green than the under side. The petiole has the odour and taste of cinnamon. The plants bloom in January and February, and the seed ripen in June, July, and August. Many white flowers grow on one peduncle. Their smell, though not strong, is exceedingly pleasant, resembling a mixture of the rose and lilac. The fruit is an oval berry, larger than black currants, and adheres in the manner of an acorn to the receptacle, which is thick, green, and hexangular. The leaves when full grown emit a strong aromatic odour on being bruised, and have the pungent taste of cloves.

The prepared bark of this tree is the cinnamon of commerce. Diversities in the quality of cinnamon do not appear to arise from any varieties of the plant, but from care and skill in the preparation, the soil and temperature of the country, the age and health of the plant. It is rarely found worth collecting except in the southern and western aspects of Ceylon. Beyond certain limits the bark is never of a good quality, as it is powerfully affected by local circumstances.

The Karuwa of the Malabar coast has been considered by many botanists as identical with the *Laurus Cassia*, but it is said that specific difference can be discovered between the cinnamon tree of Ceylon and the karuwa. The prepared bark of the karuwa is, according to good authority, inferior to the best Ceylon cinnamon. It is, however, allowed to be superior to the produce of the cinnamon tree which is found on the northern and eastern part of the island. Linnæus, deceived by the name of *Laurus Cassia*, was misled, and ascribes qualities to that tree which it does not possess.

The cinnamon plant delights in a silicious soil, with an admixture of vegetable mould, in which only it produces the sweet taste, aromatic smell, and the pale brown or russet colour which renders it so valuable as an article of commerce and useful as spice, for it has generally happened that plants, even of the genuine kind, when they grow in valleys or marshy ground, or on land subject to inundations, lose their characteristic properties; two-ninths of the plants growing in Batticolea and Chilaw, allowed to be of the genuine kind, are deficient in smell and taste, and consequently less useful or valuable; and the cinnamon grown in the valleys of Moronea Corle, the soil of which is marshy, yields a bark of inferior quality. Again, the plants which are raised in Bombay, from seeds and seedlings sent thither at an early period of the British rule in that island, although they grew luxuriantly, produced bark of an inferior quality, which was not valued as an article of commerce.

Besides the inferiority in smell, taste, and colour, which invariably marks plants grown in any other than a silicious soil, a disadvantage of no little importance to the grower has been observed to follow. Whilst the stumps of plants grown in silicious soil shoot forth rapidly, and are fit to be peeled a second time within a period of but four or five years, and produce bark superior in quality to that peeled at first, those grown on a hilly or marshy soil require not less than six years before they can undergo a second peeling, and yield bark less in quantity and inferior in quality to that peeled at first.

When the ground is prepared for planting cinnamon, the low brushwood and young trees are cut down, but lofty trees are allowed to remain at intervals, as it is found that the tender plants thrive better under shade than when exposed to the direct rays of the sun. The planting usually takes place when the seeds are ripe; for this purpose a line is stretched across the ground, and, guided by it, the planter turns up about a foot square of ground at intervals of six or seven feet. The brushwood and branches having been previously burnt, their ashes are then spread upon the newly dug spots, and into each of them four or five cinnamon berries are sown in holes made with a dibble; they are then covered with earth, and branches of trees are laid over the parts to prevent the earth from becoming parched, and to protect the young shoots as soon as they come forth. This takes place in about fifteen or twenty days; sometimes the berries are sown in nurseries, and the young plants are transplated in the months of October and November. In favourable situations shoots attain the height of 5 or 6 feet in about six or seven years, and a healthy bush will then afford two or three shoots for peeling. In a good soil every second year from four to seven shoots may be cut from one tree; thriving shoots of four years' growth are sometimes fit for cutting. As four or five seeds are usually sown in one spot, and in most seasons the greater part germinate, the plants grow in clusters not unlike a hazel bush. If the season be unusually dry many of the seeds fail, while the want of moisture is often fatal to the young shoots, so that it is sometimes necessary to plant a piece of ground several times successively. A plantation of cinnamon, even on good ground, cannot be expected to make much return until after the lapse of eight or nine years. This plant is sometimes propagated from shoots cut from large trees, by layers, or, lastly, by transplanting large stumps.

The method of culture by seeds is considered the least advantageous, as the trees are longer before they arrive at perfection.

If cultivated from shoots, the sprouts must be continually watered, or they will not thrive. Those selected for the purpose should be very young, not having more than three leaves; if older they die.

The third method, by layers, is recommended by Dr. Wight, since the numerous side branches which issue from the bottom of the trunk always furnish a plentiful supply well adapted for layering. The transplanting of the old roots is a plan of modern adoption, and the practice is much approved, since they yield shoots of the usual size twelve months after they have been placed in the ground. Great care is, however, necessary in their removal, for should any of the rootlets, even of one-tenth of an inch diameter, receive injury, the whole root will certainly perish. Thunberg mentions a fifth method of cultivation, or rather a manner of obtaining cinnamon of superior quality. When the tree is cut down and a fire kindled on the spot to consume the stumps, the roots afterwards throw out a number of long straight shoots, which yield incomparably fine cinnamon. From these are cut the cinnamon walking-sticks, which in appearance resemble those of the hazel tree, and retain the taste and smell of cinnamon. They have no scent, however, unless when the bark is rubbed.

The peeling process commences early in May, and continues until late in October. When a Chilaw perceives a shoot of a proper growth, he strikes an instrument which resembles a small bill-hook obliquely into the shoot. He then gently opens the gash to discover whether the bark separates freely from the wood; should this not be the case, he leaves the sucker for a future time. Some shoots never arrive at a fit state for decortication. Plants of several years' growth sometimes bear numerous marks of annual experiments made for the purpose of ascertaining whether the bark was in a favourable situation for removal.

The shoots which are cut are usually from a half to three-quarters of an inch in diameter, and from three to five feet long. Some travellers in former times asserted that the cinnamon was peeled from the tree while standing, and that nature provided the decorticated plant with a new bark. It is said that the experiment has been recently tried on several plants, all of which died in consequence. The shoots being cut are tied in bundles, and carried to sheds appropriated to the preparation of the cinnamon.

Being cleared of small shoots and leaves, two longitudinal slits are made in the bark, which is gradually loosened with the convex side of the knife, and then usually half the circumference of the bark comes off in one entire slip. When the bark adheres firmly to the wood, it is strongly rubbed with the handle of the peeling-knife until it is disengaged and stripped off. The sections of the bark thus obtained are carefully put one into the other, the outer side of one piece being placed in contact with the inner side of another; they are then collected into bundles, and firmly pressed or bound together.

In this state the bark is allowed to remain for twenty-four hours, or sometimes for a longer period, by which means a degree of fermentation is induced that facilitates the subsequent operations of removing the cuticle. After being subjected to this treatment, the interior side of each section of bark is placed on a convex piece of wood, and the epidermis, together with the greenish pulpy matter, immediately under it, is carefully scraped off with a curved knife. This is an operation requiring some nicety, for if any of the outer bark be allowed to remain, it gives an unpleasant bitterness to the cinnamon. In a few hours after the removal of the cuticle, the pieces are put one into the other, the bark dries, contracts, and gradually acquires the appearance of a quill or pipe, the whole forming a congeries of quills more than a foot in length. During the first day the cinnamon is suspended under shelter upon open flat forms; on the second day it is placed on wickerwork shelves, and exposed to the sun. When sufficiently dry it is made up into bundles of about 30 lbs. weight each; previous to preparing for shipment, they are subjected to the process of assortment.

The bark of large shoots or thick branches of trees produces coarse cinnamon. Occasionally the external pellicle of this kind is scraped off, which thins the cinnamon and improves its colour. It is, however, even then thicker and of a darker colour than that of good quality, while it is of a very inferior flavour, and is disagreeably pungent. This sort is always rejected by the Inspectors as unfit to be exported to Europe. The bark of very young and succulent shoots is likewise of an inferior quality, and is of no commercial value. It is very thin, and of a light straw colour, having little flavour, and that evanescent. Shoots exposed during growth to the direct rays of the sun, have their bark more acrid and spicy than the bark of those which grow under a shade. A marshy soil rarely produces good cinnamon, its texture under the circumstances being cross-grained and spongy, while it possesses but little aroma. It is hardly possible to discover the cause which produces the varieties in the quality of the bark, since shoots from the same tree are found to yield cinnamon of very different qualities.

The best Ceylon cinnamon is thin, smooth, and of a light yellow colour; it admits of a considerable degree of pressure, and bends before it breaks, the fracture is thin and splintry; it has an agreeable warm aromatic flavour, with a slight degree of sweetness. When masticated the pieces become soft, and seem to melt in the mouth.

From cinnamon which has been rejected for shipment, an essential oil is usually extracted. The best oil of cinnamon sinks in water, but when inferior, it is of smaller specific gravity. A very large quantity of bark is required for obtaining only a small portion of oil: it is reckoned that 80 lbs. of newly-prepared cinnamon yield about 6½ oz. of heavy oil, and 2½ oz. of light oil.

The total exports of cinnamon from Ceylon have been as follows:

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	lbs.	£		lbs.	£
1850	644,857	64,487	1863	734,038	36,702
1851	508,491	50,849	1864	776,675	38,833
1852	427,667	42,767	1865	850,973	42,549
1853	956,280	51,040	1866	890,484	44,524
1854	784,284	45,184	1867	1,017,750	50,888
1855	730,600	36,089	1868	2,056,509	102,825
1856	877,547	45,370	1869	2,685,395	134,270
1857	887,959	52,574	1870	2,071,679	103,584
1858	750,744	37,537	1871	1,359,327	67,966
1859	879,361	43,972	1872	1,267,953	64,748
1860	675,156	33,758	1873	1,160,754	58,038
1861	845,218	42,261	1874	1,132,191	53,077
1862	875,475	43,776	1875	1,407,010	70,352

There was long an export duty on cinnamon in Ceylon; this was first imposed in 1832 on the abolition of the Government monopoly, and fixed at the rate of 3*s.* per lb. on the best, and 2*s.* on the second quality. It was then reduced in 1837 to 2*s.* 6*d.*, and 2*s.* in 1841; on the 1st June, 1842, to 1*s.* per lb.; on the 1st September, 1848, to 4*d.* per lb., and a few years afterwards it was wholly abolished.

The duties on imports levied by the British Customs on cinnamon were, in 1830, 6*d.* per lb. on British grown, and 1*s.* on foreign. The home consumption then was 40,588 lbs. In 1841 the consumption had declined to 15,625 lbs.; the duty was then reduced 50 per cent., and in 1852 the consumption had recovered to 36,325 lbs. In the following year (4th June, 1853) the duty was lowered to 2*d.* per lb. alike on the British and foreign; the consumption of that year being 43,000 lbs., the consumption in 1859 had reached 50,789 lbs. In 1860 the duty was abolished, and, as has been already shown, the consumption was trebled in quantity.

Vanilla.—One of the most profitable and least troublesome cultures of humid tropical climates, is certainly that of the Vanilla orchid, of which there are several species, as the true vanilla (*Vanilla planifolia*, And., *V. sativa*, Scheede), *V. aromatica;* the wild or simaroma, (*V. sylvestris*,) a variety of *V. planifolia*, and the pompona (*V. Pompona*). This orchid is indigenous to the hot regions of Eastern Mexico, but grows from thence to Peru, on the American continent, and has been diffused by cultivation through the West Indies, the Indian and Pacific Islands. The plant, which is rather fleshy, and has large green inodorous flowers, grows in moist and shady forests, climbing the trees by means of its aerial roots.

Mexico.—The finest vanilla is the Mexican. The chief seats of production are the coast regions of the State of Vera Cruz, the centre of the culture being Jicaltepec, in the vicinity of Nantla. It is likewise obtained on the western declivity of the Cordilleras, in the State of Oaxaca, and in lesser quantity in those of Tabasco, Cheapas, and Yucatan. The eastern parts of Mexico exported in 1864, by way of Vera Cruz and Tampico, about 44,000 lbs. of vanilla, chiefly to Bordeaux. Since then the production seems to have much declined, the importation into France having been only 15,112 lbs. in 1871, and 4363 lbs. in 1872. Papautta, Vera Cruz, produces excellent vanilla. The value of the export of vanilla from Mexico in 1873 was 473,038\$.

The culture is very simple. Shoots about 3 feet long having been fastened to trees on the approach of the rainy season, and scarcely touching the ground, soon strike roots attached to the bark, and form plants which commence to fruit in three years, and remain productive for thirty or forty. The plantations are cleared once a year from weeds and undergrowth.

Several varieties are recognised by the growers. One, the "vanille de cochon," is so called from emitting an offensive smell whilst drying. The harvest begins about December, when the fruit becomes yellowish-green, as it is not allowed to arrive at maturity. There are two ways of preparing it for the market. In one method the fruit is allowed to dry until the pod loses its green colour. Straw mats covered with woollen blankets are spread on the ground, and when these are warmed through, the fruits are spread on them and exposed to the sun. After a time they are wrapped in blankets, and placed in boxes covered with cloth, after which they are again exposed. In about twelve hours the fruits should become of a coffee colour, but if they do not the process is repeated. After about two months' daily exposure they are tied up in bundles of fifty, and packed in tin boxes. Five qualities of vanilla pods are known: the best is the *primiera*, the pods of which are twenty-four centimetres long, and proportionally thick. The second quality is called *chica prima*, the pods are shorter, and two count as one; the third, *sacate*, and the fourth, *vesacate*, are still smaller, four of the latter being reckoned for one; they are gathered before they are ripe. The fifth and poorest quality is called *basura;* the fruit is very small, spotted, and much cut or broken about.

The following is another method of preparing vanilla for the market: About 12,000 of the pods are strung together by their lower end, as near as possible to the footstalk; "the whole are plunged for an instant into boiling water to blanch them; they are then hung up in the open air and exposed to the sun for a few hours. By some they are wrapped in woollen cloths to sweat. Next day they are lightly smeared with oil by means of a feather or the fingers, and are surrounded with oiled cotton to prevent the valves from opening. As they become dry, on inverting their upper end, they discharge a viscid liquor from it, and they are pressed several times with oiled fingers to promote its flow. The dried pods, like the berries of pepper, change colour under the drying operation, grow brown, wrinkled, soft, and shrink to one-fourth of their original size. In this state they are touched a second time with oil, but very sparingly, because with too much oil they would lose some of their delicious perfume."

In Guatemala the Indians of Vera Paz collect a good deal of vanilla growing wild in the woods along the banks of the river Polochia, and in the forests to the north-west of Coban, and this orchid is also found growing on the coast of Suchitepequez. In 1874, 431 lbs. were shipped from Guatemala.

It appears somewhat remarkable that the cultivation of vanilla in the British West Indies has not been largely undertaken, as it would be attended with little difficulty, and might be made a source of much profit to the inhabitants. But even in Caraccas and Guiana, where the plant grows profusely in a wild state, it is almost entirely neglected. It has been attempted in Jamaica.

Guadeloupe.—Some small attention has been given to the production in this French island. In 1869, 260 kilos. were gathered there; in 1871, 149 kilos. were shipped to France; in 1872, 1496 kilos. were raised; and in 1874, 598 kilos.

Brazil.—Vanilla is very badly prepared in Brazil; in fact, no attention is given to the culture—the wild pods are merely collected in the woods as they ripen. These vary in length in different districts. The Brazilian pods are in general much larger than those grown in Mexico. Those of the province of Sergipe are 8 to 10 inches long by

6 to 12 lines broad; those of Minaes are 6 to 9 inches long by 4 to 6 lines broad. The ordinary pods found in British commerce are from 3 to 8 inches long by a third to half an inch wide. The large Pompona pods are known as vanillons in France. The name vanilla is a diminutive of the Spanish *vaina*, a pod.

The imports of vanilla into the United Kingdom in the years when a record was kept by the Board of Trade, were as follows:

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	lbs.	£		lbs.	£
1867	8,178	2,864	1869	4,805	3,748
1868	6,846	2,164	1870	10,785	9,706

The chief use of vanilla is in flavouring perfumery, and confectionary, ices, creams, and especially chocolate. One pod is sufficient to flavour a pound and a half of chocolate, being ground with sugar for that purpose. The fragrance is said to act upon the system as an aromatic stimulant, exhilarating the mind, and increasing the energy of the animal system. It is occasionally employed on the Continent in cases of hysteria, and is used by the Spanish physicians in America as an antidote to poison and to the bite of venomous animals, as well as in other cases. A liquid used in Peru, where it is known as *Baume de vanille*, exudes from the open pods at perfect maturity. The fruits in time become covered with an efflorescence of fine needle-like crystals, which possess properties similar to those of benzoic acid; when viewed through a microscope with polarized light they are very beautiful objects.

In the 'Medical Flora,' it is stated that vanilla exercises a powerful action on the animal economy, and justifies the attributes of tonic, stimulant, and comforting, which are accorded to it. The truly active and strong impression which it makes on the nervous system by its fragrant aroma, and on the stomach when taken internally, is rapidly and sympathetically transmitted to all the organs, the functions of which it more or less accelerates. Hence, when the system is lowered, vanilla facilitates digestion and nutrition, augments the cutaneous transpiration or the secretion of urine, and acts as a tonic in various other ways. It is recommended in cases of dyspepsia, melancholy, hypochondria, and chlorosis, where the digestive functions are sluggish or torpid.

It is much employed by the Spaniards in South America to cure various maladies, being reckoned stimulant and stomachic.

Besides the large consumption of vanilla as a flavouring essence, it is also used to a small extent in scenting tobacco, snuff, and cigars, and as a perfume; and more recently a new demand for vanilla has arisen, especially in Germany, the pod having been found to yield a fine brown colour.

The quantitative determination of vanillin in vanilla shows that the per centage of this aromatic principle varies between 1·5 and 2·5 per cent. Mexican vanilla of prime quality was found to contain 1·69 per cent.; Bourbon vanilla, 1·91 and 2·48 per cent.; and Java vanilla, 2·75 per cent. The vanillin in the Bourbon and Java vanillas is associated with an unpleasantly odorous volatile oil, for which reason the Mexican variety, notwithstanding its inferiority in the quantity of the aromatic principle, is preferred, and commands a better price.

The pods as received in Europe are made up in packets containing fifty each, and should be fresh, unctuous and very aromatic. The gathering commences towards the end of September. The pods, after they have been plunged for a moment in a vessel of boiling water, to blanch them, are then hung up in an airy place, and at this stage there exudes from them a viscous liquid which must be removed. The removal is facilitated by light pressure repeated two or three times a day. This desiccation is a difficult operation, and must proceed slowly. The pods are frequently oiled with mahogany-oil to render them supple and preserve them from insects; they are also tied up with cotton thread to keep them from opening. These are delicate operations, and the rareness of complete success explains the high price of vanilla of the first quality. As soon as the pods are ready, no time is lost in wrapping them in oiled paper and packing them in tin boxes; exposed to air they would speedily lose their aroma. . . . The Vanilla, when covered with the brilliant silvery efflorescence, caused by the essential salt contained by the fruit working its way out, is called *vanille givrée*, and is preferred to all others. This efflorescence sometimes makes its appearance on a pod two or three years after its preparation for market; kept in a hermetically closed box it will retain its perfume for many years. Vanilla is despatched in tin boxes weighing generally from 17 to 18 kilogrammes (or about 37 to 39 lbs.). The buyer should assure himself that the packets in the box are entire, and that the pods are of the same length. Frauds are often practised in the retail sale of vanilla. Some unscrupulous persons impart a perfume by means of oil of benzoin to old dried-up pods, soak them in a mixture of oil of sweet almonds and balm of Peru to restore their softness, and dust them with salt to give them the desired crystalline efflorescence.

Reunion.—The introduction of the culture in this island dates from about a quarter of a century ago, having been taken up after the failure of the sugar-cane between 1850 and 1856. In 1857, 1917 kilos. were exported to France; in 1858, 2841 kilos.; and in 1861, nearly 40,000 lbs. were exported, amounting in value to nearly 100,000*l.* As the plant not only yields fine returns pecuniarily, but is an ornament to the garden, a very large proportion of the population are engaged in its cultivation—plants being found in every garden— and this fine industry is now with coffee the mainstay of the island.

A good deal of attention has been of late given to vanilla production here. In 1871, the number of hectares under culture with vanilla was 593, and the produce 56,203 lbs., of the approximate value of 153,282*l.*, raised at the cost of little more than 5100*l.* In 1874, the produce was 44,000 kilos., valued at 4,098,600 francs.

The gradual progress made is shown by the following figures:

Year.	Hectares.	Produce.	Year.	Hectares.	Produce.
		kilos.			kilos.
1864	..	13,412	1870	334	18,512
1866	223	15,494	1871	593	25,547
1867	218	16,162	1872	1,562	19,375
1868	230	15,041	1873	671	50,695
1869	303	19,063	1874	1,563	43,959

The hectare is nearly 1½ English acres, and the kilo. a little more than 2 lbs. avoirdupois.

In Reunion, vanilla is prepared in two ways with boiling water according to local practice, and by drying in a furnace in the Mexican style. Bourbon vanilla is generally shorter and less intense in colour than Mexican, and commands a lower price.

The British Consul at Reunion, in his report dated May 1, 1875, states, "The great demand for this perfume latterly in the markets of Europe has brought large profits to the planters of it, and the plantations have multiplied on all sides to such a degree that the next crop will double that exported this year, which amounted to 20,854 kilos., and the quantity which will appear in the market towards the month of August next is calculated at about 40,000 kilos. Unless circumstances arise which are at present unforeseen, and also by reason of the newness of some of the plantations, the colony can produce in two or three years from 50,000 to 60,000 kilos. of vanilla. I learn that this cultivation is also extensively carried on in Madagascar and Mauritius, and it is feared by persons interested that this extended cultivation will create a supply too great for the demand, or, in other words, that prices will go down."

Vanilla is cultivated more particularly by the small proprietors than by the great. Its produce assists a part of the population who are averse to work, and the small extent of whose lands has not allowed them hitherto to think of attempting a cultivation like that of the sugar-cane, maize, manioc, or coffee, which would require the assistance of labourers or field-hands. Provided the soil be fertile, moist, and shaded, it needs but a small space to accommodate thousands of vanilla plants, and the produce, being of considerable value, yields to the cultivator a profit which no other plant on the island can give. The crop of Reunion in 1864 sold at an average of 50*s.* the pound, therefore a sum of 74,000*l.* was circulated, principally among the small planters and coloured population. It would be rash to expect such prices in future, but even admitting a reduction to 30*s.* the pound, it would still be advantageous to continue this cultivation.

For exportation in good condition, vanilla should be packed in tins well soldered, in quantities of about 10 lbs.

In December, 1868, when the market was glutted, vanilla realised but 6*s.* a pound: subsequently it went up at a bound. It was 15*s.* per lb. in March, 1869; 28*s.* per lb. in August, 1871; 45*s.* in August, 1873; 57*s.* to 60*s.* in 1875; and now it is quoted at 20*s.* to 40*s.*

Mauritius.—It was from Reunion that the vanilla orchid was carried to Mauritius. I have not the returns of the exports for the last few years, but the shipments from that island up to 1874, with the declared values, were as follows:

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	lbs.	£		lbs.	£
1865	5,025	1,520	1870	4,986	2,860
1866	4,427	1,456	1871	4,919	3,345
1867	5,184	1,488	1872	7,563	10,560
1868	4,014	964	1873	5,546	12,216
1869	5,351	2,004	1874	13,435	33,061

A small quantity of that shipped is not raised in the island, but is imported produce.

There is a somewhat extensive cultivation of vanilla in Java. The culture on a systematic basis was introduced in 1841 by M. Teysmann, Director of the Botanic Gardens at Buitenzong. He introduced the artificial process of fecundation with beneficial results.

There were 26½ hectares under culture with vanilla in Tahiti in 1874, the produce being 2040 kilos., valued at 102,200 francs.

Among the vegetable odours assimilating somewhat to vanilla are the Faham leaves, of Mauritius, from another orchid, *Angrœcum fragrans*, which somewhat resembles the perfume of vanilla and Tonquin beans. The leaves of a few other orchids, such as *Orchis fusca*, dried carefully, also possess the odour of those of the Faham.

Pimento, or Allspice.—This spice, of large consumption, is a West Indian product, the fruit of a beautiful lofty evergreen tree, the *Pimenta officinalis*, Lindley, *Myrtus Pimenta*, Linn. *Eugenia Pimenta*, Dec. Jamaica enjoys the monopoly of supplying the markets of the world. Every attempt to carry the seeds to San Domingo and Cuba and to propagate it there has failed, and though the tree is found in Yucatan, the fruit is not exported thence.

The Pimento walks are situated in the mountains on the north side of the island, where the trees grow in hundreds. It is a white-trunked shapely tree, not unlike in form and growth an English apple tree, but with a thicker, richer foliage, and dark glistening leaves, aromatic like its fruit, and resembling those of the myrtle, to which family it belongs. The trunk is white, because every year the bark strips. Nature seems to have intended that some useful purpose should be served by the bark, but hitherto it has not been made available commercially. The tree blossoms twice, but only bears once a year. The blossom that holds and sets to fruit appears in April. The tree grows spontaneously, and seems to mock all the labours of man in his endeavours to extend or improve its growth; not one attempt in fifty to propagate the young plants or to raise them from the seeds, in parts of the country where it is not found growing spontaneously, having succeeded. The usual method of forming a new Pimento plantation (in Jamaica it is called a "walk") is nothing more than to appropriate a piece of woodland in the neighbourhood of a plantation already existing, or in a district where the scattered trees are found in a native state, the woods of which being felled, the trees are suffered to remain on the ground till they become rotten, and perish. In the course of twelve months after the first season, abundance of young Pimento plants will be found growing vigorously in all parts of the land, being, without doubt, produced from ripe berries scattered there by the birds, while the fallen trees, &c., afford them both shelter and shade. At the end of two years it will be proper to give the land a thorough cleaning, leaving such only of the Pimento trees as have a good appearance; these will then soon form groves, and, except for the first four or five years, require very little subsequent attention. In July and August, soon after the trees are in blossom, the berries become fit for gathering, the fruit not being suffered to ripen on the tree, as the pulp in that state, being moist and gelatinous, is difficult to cure, and when dry becomes black and tasteless. It is impossible, however, to prevent some of the ripe berries from mixing with the rest, and if the proportion of them be great, the price of the commodity is considerably injured. It is gathered by the hand. One labourer on the tree employed in gathering the small twigs bearing the branches, will give employment to three below (who are generally women and children) in picking the berries, and an industrious picker will fill a bag of 70 lbs. in the day. It is then spread on a terrace and exposed to the sun and air for some days, in the course of which it loses its green colour and becomes of a reddish-brown; when perfectly dry the stalks are removed, it is passed through a fanner, bagged, and is ready for shipment. The term sometimes used to denote the in-gathering of the crop is not picking, but "breaking," because, with each cluster of berries a portion of the branch is broken off, the tree thriving all the better for the spoliation. The returns from a Pimento walk in a favourable season are prodigious. A single tree has been known to yield 150 lbs. of the raw fruit, or 1 cwt. of the dried spice, there being commonly a loss in weight of one-third in curing; but this, like many other of the minor productions, is exceedingly uncertain, and perhaps a very plenteous crop occurs but once in five years.

Before the war with Russia, there was a large demand for Pimento in that country for use in spiced bread, but during the blockade it was found that a tree growing on the banks of the Amoor yielded a bark which, when grated, was pungent enough to yield a spice, and the Russian market was thus lost.

The acreage under Pimento seems to vary. In 1871 it was returned at 6902 acres, in 1874 it was only 1392 acres. Between 1830 and 1850 the crops ranged from 3,000,000 lbs. to 5,500,000 lbs. The following have been the exports from Jamaica:

	Lbs.		Lbs.
1866	4,866,239	1871	6,857,830
1867	7,595,800	1872	5,140,898
1868	4,373,259	1873	6,024,551
1869	6,575,249	1874	5,762,256
1870	5,243,109	1875	5,262,797

The United States takes about one-third of the Jamaica crop.

In 1789, Browne, in his 'History of Jamaica,' stated the export of Pimento to be 438,000 lbs., valued at 22,000*l.* In 1805, our imports were 2,257,000 lbs., the duty paid on which was 38,063*l*. In 1826, we imported 2,000,000 lbs. The crops and shipments fluctuate with the seasons, and according to the price obtainable. This has frequently fallen as low as 1½*d*. per pound, making it scarcely worth the expense of picking. In 1850, the imports into the United Kingdom were 1022 tons; in 1855, 2115 tons, of which 1200 tons were re-exported; in 1860, the imports were 1000 tons; in 1865, 1279 tons; and in 1875, 2350 tons. The following shows the imports more in detail for a series of years, as far as the Board of Trade returns officially particularise this spice:

	Cwts.		Cwts.
1862	30,018	1867	46,798
1863	29,268	1868	16,279
1864	42,340	1869	29,557
1865	25,454	1870	20,401
1866	19,864		

In 1870 there would seem to have been no re-exports. A quarter of a century ago we only consumed here about 400,000 lbs. of Pimento per annum; now about half the imports are used at home, and the remainder shipped to the Continent. The duty of 5*s*. per cwt. levied on this spice was repealed in 1860.

The berry of Allspice is globose, one-seeded, black, rather variable in size, but commonly the size of a pea, from two-tenths to three-tenths of an inch in diameter. All the plant, especially the unripe fruit, abounds in an essential oil (3 to 4 per cent.) which is a powerful irritant, and is often used, like oil of cloves, to allay toothache. The bruised berries are carminative, stimulating the stomach, promoting digestion, and relieving flatulency. The chief use of Pimento is as a culinary spice, for which it is largely employed both in Europe and America. It has an agreeable pungent spicy flavour, much resembling that of cloves, for which, when ground, it is often sold. The berries have a similarity in smell and taste to cloves, juniper berries, cinnamon and pepper, or rather a peculiar mixture of all combined, whence the name of Allspice or Jamaica pepper.

The Mexican spice called "Pimienta do Tabasco," coming from Tampico, is probably the "Piment Tabago" of Guibourt; it is somewhat larger and less aromatic than the Jamaica Allspice, and is believed to be derived from a variety of the Jamaica species (*P. officinalis*). The wild clove tree *Eugenia* (*Pimenta*) *acris*, Wight and Arnott, and *P. Pimento*, Griseb, afford analogous aromatic products, but do not appear much in commerce. A Pimento plantation was tried in Tobago, but it was abandoned for sugar cane.

Oil of Pimento has substantially the same composition as oil of cloves. Pimento is used in tanning, striking with a persalt of iron, an inky black, and a patent has recently been taken out in Jamaica for the employment of the leaves as a tanning material. The tree furnishes walking sticks and umbrella handles that are in great request in Europe.

Cloves are the dried calyces or flower-buds of the *Eugenia caryophyllata*, *Caryophyllus aromaticus*, Lin.

In British commerce they are chiefly distinguished by their places of growth, and rank in the following order, Penang, Bencoolen, Amboyna, and Zanzibar. There also enter into commerce as secondary products, clove stalks and mother cloves, or the dried unripe fruit. Clove stalks are largely shipped from Zanzibar and Reunion.

This elegant tree grows spontaneously in the Moluccas, and was from thence carried to Mauritius and Bourbon, French Guiana, and the West Indies. When the Dutch took possession of the Portuguese territories in the East Indies, they compelled the people to destroy the clove trees so as to concentrate the culture in the Amboyna Islands and Ternate.

After being gathered, the cloves are prepared for shipment by smoking them on hurdles, covered with matting, near a slow wood fire, to give them a brown colour, and they are further dried in the sun. They may then be cut off from the flower branches, and will be found to be purple-coloured within, and fit to be packed in bales for the European market. In some places they are scalded in hot water previously to being smoked, but it is not a practice very generally in vogue.

Cloves are produced in the islands of Zanzibar and Pemba. The total average quantity produced is about 7,000,000 lbs., valued at 85,000*l.* In 1863 the crop was a total failure. In the following year it was much above the average. Some three or four years ago a hurricane devastated Zanzibar, and the consequence of this disaster was to destroy nearly every clove tree in the island.

Cloves arrive sparingly from Amboyna, the shipments from Java in 1870 were 1226 piculs, 3200 piculs in 1872, and 5000 piculs in 1874. In 1874 there were 290,000 clove trees, of which 161,260 were in bearing. In Ternate the number of clove trees on the average of the three years ending 1874 was 8000.

In Brazil the cloves of *Dicypellium caryophyllatum*, which are remarkable for their fine aroma, are largely employed in domestic and medicinal use.

The following figures give the import of cloves into the United Kingdom:—

	Lbs.		Lbs.
1845	414,486	1860	981,308
1850	749,646	1865	3,339,184
1855	864,339	1870	1,089,667

In 1870, the last year for which there are distinct accounts, the following were our sources of supply:—

	Quantity.	Value.
	lbs.	£
Holland (Eastern Possessions) ..	83,623	1,918
Egypt	115,309	1,386
Zanzibar	757,390	9,845
British India	75,345	970
Straits Settlements	33,669	1,848
Other parts	24,331	407
	1,089,667	16,374

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THE NEW FORMULA FOR MEAN VELOCITY OF DISCHARGE OF RIVERS AND CANALS.

BY W. R. KUTTER.

Translated from Articles in the 'Cultur-Ingénieur,' by LOWIS D'A. JACKSON, A.I.C.E., Author of 'Hydraulic Manual and Statistics,' 'A Curve Book,' 'Simplified Weights and Measures,' &c.

NOTICES OF THE PRESS.

"About a year ago, when reviewing the very important investigations of Captain Cunningham, R.E., on the flow of water in the Ganges Canal, we referred to the above work of Herr Kutter, and expressed a wish that the Institution of Engineers should at least publish an abstract, if no translator or publisher could be found to present English engineers with the whole work.

"As a result of our suggestion the present translation has been made, and we welcome its appearance none the less that the duty of translation has been assumed by an engineer whose previous studies in the same field render him undeniably competent and trustworthy.

"We have frequently had occasion to ridicule the superstitious reverence with which too many of our so-called hydraulic engineers regard the nostrums of old authorities in their particular branch of science, and we may now the more properly take occasion to state that we consider the present work to be a specific against infection from these old sources of mischief. One minute's glance at the tables will dispel at once and for ever a host of illusions, and a careful reading of the whole work will prove most valuable to students, and interesting to all.

"The most convenient, and consequently the most generally employed, formulæ for the flow of water in open channels are of the form

$$v = c\sqrt{rs}$$

where v is the mean velocity, r the hydraulic mean depth, s the fall of the water in a length of unity, and c the experimental coefficient. Now, in a given channel, and within certain limits of variation in the depth and surface fall of the water, the value of c remains practically constant, and it has been but too commonly assumed that it will similarly remain constant when applied to other channels widely differing in section and fall. Thus in Beardmore's tables, one value of c does duty for all the cases tabulated, and the author has taken care to notify that the same value will apply to cases outside the limits of his tables, since he says the latter may be readily extended if it be remembered that to get double the discharge you require four times the fall, and so on. What years of laborious research have been wasted in the past, and would be spared in the future, were such an assumption only approximately true! But unhappily it is about as unwarranted an assumption to take a constant value for c as it would be to assume a constant length for a degree of longitude. The latter will vary but little within certain limits of latitude, and the former will similarly vary but little within certain limits as regards depth of water, fall of the channel, and condition of its surface.

"We are of opinion, therefore, that the present translation of Kutter's work has appeared none too soon, and that it will fill a long-standing void in the literature of hydraulic science."—*Engineering.*

"The fact that the erosion of the bed and destruction of the works of the Ganges Canal were due to the reliance placed by Colonel Cautley, R.E., in common with the majority of the English engineers of the day, on the velocity-formula of Dubuat, which proved, in this instance, mischievously misleading, is a proof of the great practical importance that attaches to a thorough knowledge of hydraulic law, in so far as it is at present ascertained. Considerable gratitude is therefore due to the enterprise, whether it be that of the author or that of the publisher, which has led to the publication of a book which must have been so costly to print as Kutter's 'Hydraulic Tables,' which are reproduced in a clear and intelligible form by the translation of Mr. Jackson. The public addressed by such a work is not large; but to that public it has an indispensable value. Herr Kutter has brought the new formulæ of D'Arcy and Bazin, and the new formula of the American engineers, Humphreys and Abbot, to the test of a tabulated series of experiments collected from very wide observation. From a comparison of eighty-five measurements of discharge in Swiss rivers, it appears that the formulæ of D'Arcy and Bazin give velocities within 4 per cent. of those actually observed; while the formula of Chezy-Eytelwein gives a velocity of 252, and that of Humphreys and Abbot a velocity of 46, against an observed velocity of 181, on the average of the experiments. The American formula is based on measurements of the flow of the Mississippi and its affluents, where the volume is immense and the inclination of the bed is very small. It appears, from what we have above stated, that the application of such a formula to the flow of water under other conditions is entirely out of the question. The subject is of too technical a nature for us further to pursue; but we are able thoroughly to recommend the book; and that the more so because, in spite of the extreme importance of the subject, both as relates to our own country and to India, hydraulic engineering is not a branch of the art and science of the engineer, as to which Great Britain can with any truth be said to occupy a leading, or even a satisfactory, position. Herr Kutter's work, which appeared in 1870, was immediately translated into French, Dutch, and Italian. English engineers are indebted to Mr. Jackson for the manner in which he has translated it into their own tongue."—*Athenæum.*

"This translation will be of interest to all engineers in India who are familiar with the large work, 'Hydraulic Manual and Statistics' of the translator, now translated into Russian. Hydraulic engineers of every description, from the engineer of experience down to the extra assistant commissioner, who tries to find out how much irrigation water may be conveyed in a small trench of supply, will be glad to learn something of the way in which the only trustworthy formula for calculating discharges of water in open channels of every size and inclination, and in any material, has been eventually arrived at. It has been deduced from experimental observations on rivers of all sizes, up to the Mississippi down to trenches a few inches wide, with inclinations from those scarcely appreciable down to the steep gradient of Swiss torrents; and allowance is made for every material of surface, from smooth curbstone, planed and unplaned timber, rubble, earth, and grass-covered and pebble-impeded mud. The tables given in this work enable the formula to be applied in practice in metrical measures, with the least amount of work: the diagram answers the same purpose, both for metrical and for English measures. The application of this formula and tables for English measures having been already fully carried out in Mr. Lowis Jackson's 'Hydraulic Manual,' this translation may be considered as a useful adjunct to it."—*Allen's Indian Mail.*

"'The New Formula for Mean Velocity of Discharge of Rivers and Canals' is an English translation by Mr. Lowis Jackson, A.I.C.E., from a German work by Herr Kutter, which has already circulated widely in many parts of Europe. Hydraulic science in England appears to have lagged far behind other branches of engineering, in which our countrymen have kept the lead of other nations for years past. Even the great field which India has offered to our engineers seems in this respect to have been but indifferently worked, owing, in great measure, to faulty theories and defective or mistaken methods. The new formula claims to point the way to more successful applications of hydraulic science in the future, and the claim is certainly supported by the good opinions of some experienced judges in this country, as well as others, not forgetting Madras."—*Home News.*

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"It is written in a plain unassuming style, entirely free from affectation and fine writing, which are the bane of so many productions of unpractised writers. His account of his own works is not damaged by undue assumption, and the narrative is enlivened by accounts of extensive travels made at various times, partly in localities seldom visited. In a word, although the autobiography bears a professional aspect, and contains much professional matter, it is a perfectly readable book for the general public, and that is saying a great deal in its favour."—*Academy*.

"The details of the construction of the piers of London Bridge, penned as they are by the designer, are of great professional interest, and the peculiar conditions under which the bridge was built render it of more than usual importance, while the successful way in which all the difficulties connected with the old bridge and the powerful scour at this part were overcome, proclaim Sir J. Rennie as the king of bridge builders."—*English Mechanic*, Nov. 19, 1875.

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