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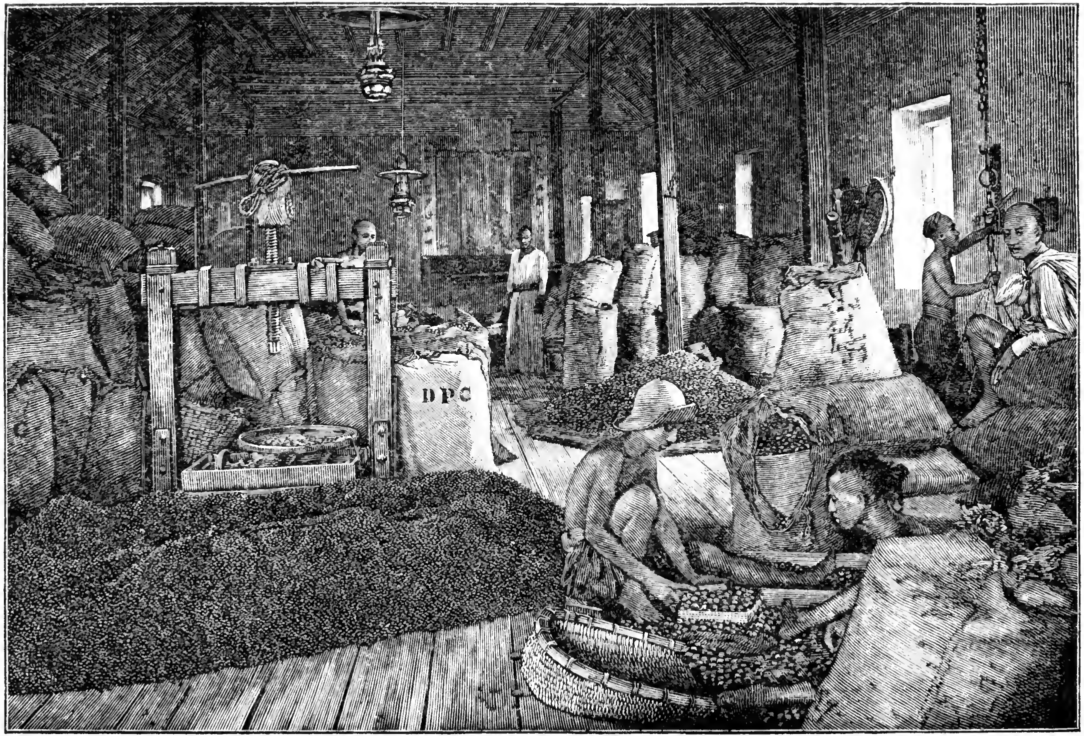

SORTING SPICES.

SPICES

BY

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INTRODUCTION

The history of the cultivation and use of spices is perhaps the most romantic story of any vegetable product. From the earliest known eras of civilisation spices were eagerly sought in all parts of the world. The earliest explorers in their search after gold paid almost as much attention to drugs and spices, and it was the pursuit of these as much as anything which led to the first rounding of the Cape of Good Hope, and the colonisation of the East Indies. Later, the greed of the Dutch in maintaining the monopoly of the Eastern spice-trade led to the founding of the Straits Settlement colony, while the pepper gardens of southern India, the vanilla of Mauritius and the Seychelles, the cinnamon and cardamoms of Ceylon all played important parts in the opening up of these countries to Western civilisation and Western trade.

It must be noticed that the greater part of the spices that have been valued by man are derived from the Asiatic tropics, while the other quarters of the globe have produced comparatively few. Thus we have the following distribution.

From Asia are derived pepper, cardamoms, cinnamon (natives of southern India and Ceylon), nutmegs, and mace; cloves, clove-bark, turmeric, ginger, greater galangal, from the Malay Archipelago; cassia-bark and lesser galangal from China. Africa gave us grains of Paradise, Madagascar *Ravensara aromatica*, while the

American tropics gave us only vanilla, capsicums, and pimento.

The colder climates of northern Europe and Asia produced but few—coriander, cumin, caraway seed, and mustard and calamus root.

Of the East Asiatic tropical spices most are not really known in the wild state, and it is in many cases actually doubtful as to where was their place of origin.

The appreciation of spices as flavouring for the simple rice food of the oriental, extending over unknown ages, has perhaps caused the oriental to cultivate forms of the aromatic trees and shrubs they met with in the forests into the forms we now know them in, but it must be admitted that in most cases the well-known nutmegs, cloves, ginger, and others do not bear any close resemblance botanically to anything we have since met with in the forests. The cause of this disappearance of the original plant may be perhaps due to the removal to or enclosure in gardens of the plant when found in a wild state. In the case of trees of which the fruit is valuable, the native, on finding it in the forest, may form a garden round them, or he may transfer all the seedlings he can find to his garden, or by steadily collecting the crop of seed annually, may practically in time exterminate the plant in the forest, while later selections of the most productive and valuable forms may modify the fruit so much that we can hardly now recognise it.

Spices can be arranged according to the parts of the plant which form the commercial product. Thus in cloves it is the flower bud which is used; in nutmegs, vanilla, capsicums, pepper, it is the fruit; ginger and turmeric the underground stems, cinnamon and cassia the bark. This is perhaps the most convenient way of sorting them, and I have adopted it.

Cultivations in general can be classified into groups in the following way:—

1. Plantation cultivations, which are generally effected on a large scale, and belong to the class of

permanent crops, lasting for a number of years. Such are nutmegs, cloves, cardamoms, cinnamon, vanilla.

2. Garden crops, which are done on a smaller scale, are less permanent and often cultivated as a subsidiary crop to other permanent crops. Such are ginger, capsicums, pepper.

3. Field crops, which are done on a large scale as a temporary crop, and often grown in rotation with other field crops. Such are coriander and cumin.

A certain number of commercial spices are hardly cultivated at all, but are derived from wild trees or plants, the demand for them not being greater at present than the forest can supply. Such are Malay cassia-bark and calamus root. Any of them may at any time, however, come into a greater demand, and it would then be necessary to develop the cultivation. It is therefore desirable to pay some attention to them, as it is not always easy to predict their future. Thus calamus root is grown all over the East, as well as in many other parts of the world, in small quantities, as a native medicine, and imported occasionally into European markets. Recently, however, a planter in the Malay states distilled the oil of it, and sent some of it with other oils to Europe for examination. It proved to be in great request by certain brewing firms as a beer flavouring, and was highly valued. The demand for this product was quite unknown to cultivators and distillers in the East.

The produce included under the name of spices comprises all aromatic vegetable products which are used in flavouring food and drinks, but almost all have other uses as well, for which they are in great request in commerce. Many are used in perfumery, or in soap-making, such as vanilla, cloves, and pepper, others in the manufacture of incense—cinnamon. A good number are utilised in medicine, either as a flavouring, or for their special therapeutic values—cardamoms, ginger, nutmegs, etc. Turmeric is used in dyeing, especially by natives; clove oil in microscopy, and others of the spices in various arts. All these uses add to the commercial demand, and are of considerable importance to the planter.

Of late years there can be no doubt that the use of spice as flavouring by European nations has considerably diminished. In the twelfth and later centuries the use of spice in every household was very large, and was only regulated by their cost. But the last few years have shown a certain amount of falling off in the demand for spiced foods, and the spice-box is not so important a household utensil as it was. Artificial flavourings, too, have made some amount of alteration in the demand. But if profits on spices are not as large as they were in the days when, next to gold, spices were considered most worth risking life and money for, there is still a good profit to be obtained by their cultivation. The trade is still large among European nations, and the demand by orientals, the greatest spice-lovers, is as large as ever it was.

TROPICAL REGIONS

The area included in this work as the area of the tropics lies between latitude 25° N. and 25° S., and this includes a considerable variation in regions and climates. A great portion is occupied by the tropical rain forest region, where the air is constantly moist and there is practically no dry season. This is the great spice-region, where almost every spice mentioned in this work can be cultivated with success. The rainfall is heavy and constant, that is to say, a little falls every day or two, and at the breaks of the monsoon there are generally some very heavy falls, continuing for a whole day or two with little or no break. The temperature is high, but not so great as a little farther north. In this area, beside the rain forest region, we have regions in which there is a distinct dry period, lasting for some months, and followed by heavy rains. During the dry weather the temperature is very high. Such trees as are not adapted especially for this region do not thrive here. Most of the trees of this region are leafless in the dry season, and trees like the nutmeg and clove, which are not deciduous, but evergreen, succumb at the first dry spell. In this region the annual field crop spices—coriander, cumin, chilies—are commonly grown, as well as the rhizomatous ginger and turmeric, which in this climate lose their leaves during the dry spell. Some of the tropical spices, such as capsicums and ginger, have a wider cultivation area than most of the others, and go almost outside the tropical area, but on the whole the areas of successful cultivation are limited.

It is rather remarkable that so large a proportion of the spices of the tropics are successfully grown on islands only, or in close propinquity to the sea. Among these are nutmegs, cloves, vanilla, clove barks, and perhaps we may add cinnamon and cardamoms as island plants.

SOILS

The various soils suited for the different spices are mentioned under their respective headings. There seems to be increasing evidence that with most plants the physical characteristics of the soil are more important than its chemical constituents. Its water capacity, permeability, and capillary conduction or power of absorbing water, are its most important characteristics. Different crops require different degrees of moisture or dryness. Most, however, of the plants described in this work require a greater average moisture in an accessible and utilisable form than the plants of colder climates, as their natural habitat is in the wetter part of the tropics. Plants have a great power of adaptation to surroundings, though at the same time there is a limit to their endurance. In soil where it cannot obtain its food and water in sufficient quantity a plant becomes pale and weak. The leaves show an unmistakable yellow tint instead of the rich green, whether light or dark, of the normal plant. It makes but little growth, and is liable to attacks of insects and fungi.

It is, in the first place, of the greatest importance to select a suitable soil. Sandy spots, except in the case of cinnamon, water-logged soils, and soils formed almost exclusively of vegetable debris, or impregnated with salts, should be avoided. It is possible in most of these cases to improve the soils, but the cost may be too great to be worth while. In prospecting for a good site for the estate, the ground should be dug to a depth of at least two feet, in order to form an idea of the subsoil, which is often different from the surface layers.

DISEASES

The diseases from which plants suffer are due to insects or fungi. Bacteria, which play the chief part in diseases of animals, seem seldom to be the cause of disease among plants.

The known diseases of each plant are described in each chapter dealing with the species. The careful watching for disease is one of the most important duties of the planter. No attack, however mild, should be overlooked as unimportant. In an outbreak a disease often begins very slowly, a plant here or there dies, and no notice is taken of this. More are attacked, and usually the disease appears in patches about the estate. Too often it is not until a considerable number of plants are dead or dying that the planter takes any steps to stop it. Sometimes the disease assumes a virulent nature, spreading rapidly from each centre of infection, and before the planter has time to fairly combat it, the estate may be ruined. In any case, when it has once reached the virulent stage the expenses of checking it will be great, while earlier action when the disease first showed itself would have cost but a trivial sum.

A yellowing of the leaves of a plant is usually a sign that it is in an unhealthy state. It may be due to starvation from destruction of a portion of the roots, or to an insufficient food supply, but it is also occasionally due to excessive exposure to heat and sunlight. The destruction or injury to the roots may be due to an underground fungus or to some insect such as the grub of a cockchafer biting through them; again, it may be due to their having reached poor soil, or having exhausted most of the accessible nutriment. The yellowing of the leaves is also noticeable in plants growing in water-logged soil.

When a plant is weak from insufficient food it is much more liable to attacks from insects and fungi, and where a plant has been injured by a pest, it is advisable to manure it, so as to give it a fresh start and enable it to resist the attacks of the pest.

In the case of turmeric and ginger, the yellowing of the leaf is a preliminary stage in the death of the leaf, and is one of the signs that the plant is passing into a resting stage. At this time the plant is ready for digging, and the yellowing is therefore a normal condition.

INSECTICIDES

Many different insecticides have been placed on the market by horticultural firms. In most of them the poisonous part consists of nicotine, or some form of arsenic. Nicotine solutions are prepared by soaking common or waste tobacco in water, enough being used to cover the tobacco. When the solution is of the colour of strong tea it is diluted and sprayed or watered over the plants. Usually, in the East at least, tobacco good enough for this purpose can be obtained cheaply.

Arsenites of copper, Paris green and London purple are often used, but I think it is better to avoid them, as they are apt to burn the foliage, and there is a probable risk of poisoning from them.

Kerosene emulsion is one of the best insecticides. It may be made with condensed or sour milk or with soap, the latter being more generally used.

Kerosene and Condensed Milk

Kerosene	2 gallons.
Milk	3 pints.
Water	6 pints.

Kerosene and Sour Milk

Kerosene	2 gallons.
Sour milk	1 gallon.

When used they should be churned up with a stick or by means of a force-pump, to make the emulsion regular and well mixed, when it can be diluted.

Kerosene and Soap Emulsion.—The best way of making this is with soft soap. One quart of soft soap is dissolved in 2 quarts of boiling water. Remove from the fire and add 1 pint of kerosene and stir briskly. Before using, dilute with an equal quantity of water. This emulsion will keep for a considerable time. Should the soap be too caustic for the foliage, use only half the quantity. Soft soap is not always procurable and hard soap can then be used. The following recipe is recommended by Loder (*Spraying of Plants*).

Dissolve $\frac{1}{4}$ lb. of hard soap in 2 quarts of water, add 1 pint of kerosene oil and pump the mixture back into itself while hot. Dilute with twice its bulk of water before using.

Hard soap	$\frac{1}{2}$ lb.
Kerosene	2 gallons.
Boiling soft water	1 gallon.

Dissolve the soap in the boiling water, then add the kerosene and churn for five or ten minutes. It is essential that the liquids mixed should be as warm as possible. The author himself has been in the habit of heating the mixture after adding the oil, but care has to be taken not to let it catch fire. With experiences of ordinary coolie recklessness, one would not recommend this on an estate worked by coolies.

Tuba root is one of the best insecticides and is the one most regularly used by the Chinese, in the Malay Peninsula, for treating their vegetable and other crops.

The plant known as tuba (*Derris elliptica*) is a woody climber propagated by cuttings. It will grow in any corner of the garden and soon develops into a fairly large mass of stems, lying on the ground. The roots are pounded up in water and the decoction poured or sprayed over the crop, where it will kill all caterpillars, grasshoppers, and other insects. It is perfectly harmless to any plants. The decoction is poisonous to human beings, but only when taken in large quantities, and risk from it in the case of any of our spice plants is infinitesimal.

FUNGICIDES

The best of all these is the preparation known as Bordeaux mixture. This consists of a mixture of copper sulphate and lime in water. The best formula is :—

Copper sulphate (bluestone) . .	4 lb.
Quicklime (in lumps) . . .	4 lb.
Water	50 gallons.

No estate should be unprovided with a bag or two of copper sulphate in case of an outbreak of any kind of fungus. I have arrested many outbreaks of different kinds of fungi on roots, stems, and leaves of plants by the use of this excellent mixture.

It is sometimes complained that under certain circumstances it burns the leaves of young plants. I have never seen this occur.

A very complete account of the making and use of Bordeaux mixture was published by Mr. E. S. Salmon in the *Journal of the Board of Agriculture*, vol. xvi. No. 10. I reprint the following extracts from his article :—

In purchasing copper sulphate, an article of 98 per cent purity should be demanded; substance described as "agricultural bluestone" or "agricultural sulphate of copper" must be avoided, as these are usually adulterated with iron sulphate.

The strength of Bordeaux mixture at present most widely recommended in the United States is $4\frac{3}{4}$ lb. of copper sulphate, $4\frac{3}{4}$ lb. of quicklime, 50 gallons (Imperial) of water. This strength is expressed in America by the formula 4:4:50, since, as Mr. Pickering has lately pointed out, the relative value of the American and Imperial gallon is different, the former weighing 8·345 lb. and the latter 10 lb. As, however, excellent results have followed the use of Bordeaux mixture made of the strength 4:4:50 (Imperial), it would seem advisable, for the present, at any rate, to continue to use this as the "standard" mixture.

Dissolve the 4 lb. of copper sulphate in a wooden tub or bucket—*iron or tin vessels must not be used.* The easiest way to do this is to suspend the material, wrapped in a piece of coarse sacking, in a few gallons of cold water, from a stick placed across the top of a tub, or wooden bucket. If this be done over night, the copper sulphate will be found to be dissolved in the water by the morning. (If hot water be used, the copper sulphate can be placed at the bottom of the tub or bucket, and be dissolved in a few minutes.) Then add the water to make 25 gallons. Now take the 4 lb. of quicklime, and put it in a tin pail. Add a few pints of water till all the lime is slaked, taking care to add only a little water at first; in this way a thick creamy paste is obtained. Add water to make 25 gallons. We have now 25 gallons of copper sulphate solution, and 25 gallons of "milk-of-lime." When the two substances are thus diluted with water, they can be mixed together by pouring one into the other, or a bucketful of each can be poured simultaneously or alternately into a third tub —a wooden bucket being used for the copper sulphate solution. The "milk-of-lime" must be well strained, and it is advisable also to strain the Bordeaux mixture before spraying. In this way we obtain 50 gallons of Bordeaux mixture of the best quality.

Two points are of primary importance in making Bordeaux mixture. The first is that *quicklime,* in lumps, that is to say, as freshly burnt as possible, should be used. Powdered *air-slaked lime,* such as is often found in builders' yards, will not make Bordeaux mixture. The second point to observe is that the two constituents, viz. copper sulphate and lime, are diluted with water as much as possible (consistent with the formula) *before being mixed together.* If concentrated solution of copper sulphate and lime are mixed together, and water then added to make up the 50 gallons, the resulting Bordeaux mixture will be of very inferior quality.

The method of mixing described above is that recommended by all scientific authorities in the United States and in our Colonies. Bordeaux mixture prepared by growers in accordance with these instructions has long proved in these countries to be of the greatest value, under practical conditions in the orchard and plantation, in keeping off fungus pests from cultivated plants. According, however, to the recent important investigations of Mr. S. U. Pickering into the nature of Bordeaux mixture, a slightly superior method of mixing the two constituents is "to take the lime in as weak a condition as possible and, consequently, the copper sulphate in as strong a condition as possible, and to add the copper sulphate to the lime. The 'milk-of-lime,' after being diluted with the bulk of the water and stirred up several times during about half an hour, should be left for the grosser particles to settle before the copper sulphate is added to it, and, after the addition of this, very little more stirring should be done."

Bordeaux mixture is fully efficacious only when freshly made, and will not keep. If more than a day old, it requires to be very thoroughly and constantly stirred while being used, and the use of *only freshly-made* Bordeaux mixture is far more economical in the long run, and is here strongly recommended.

If a considerable quantity of Bordeaux mixture is required for use, the making of *stock solutions* of copper sulphate and lime, which can be kept through the spraying season and used when wanted, saves both time and labour, and is free from all objections. The stock solutions are made as follows: take two 50-gallon barrels. In one dissolve 50 lb. of copper sulphate in exactly 50 gallons of water. In the other slake 50 lb. of lime by the gradual addition of a little water; to the creamy paste thus obtained add water to make exactly 50 gallons of "milk-of-lime." These stock solutions will keep for months. Before the "milk-of-lime" is used, the contents of the barrel must be thoroughly stirred, as the slaked lime will have sunk to the bottom. (Care must be taken to stir the "milk-of-lime" *very thoroughly each time before measuring it out*, so as to get the slaked lime thoroughly in suspension. If this is done there is no difficulty in obtaining the correct quantity of lime per gallon of fluid.) Each gallon which is taken out from the "stock solutions" will be equivalent, respectively, to 1 lb. of copper sulphate or 1 lb. of lime. The required amount of each stock solution is then diluted with water, according to the formula given above, before being mixed together. The "stock" copper sulphate solution must be measured out in a wooden pail.

If it be desired to economise space the "stock solution" of copper sulphate may be kept at the strength of 2 lb. of copper sulphate to each gallon of water, that is to say, 100 lb. of copper sulphate may be dissolved in 50 gallons of water. It is not well, however, to increase the strength of the "stock solution" of lime, since the slaked lime in "milk-of-lime" made at the rate of 2 lb. of quicklime to one gallon of water settles so quickly that it cannot be measured out accurately.

The barrels containing the "stock solutions" must be kept under cover, *i.e.* protected from sun and rain. If stood in a shed, and covered with fairly close-fitting lids made by nailing sacking round the edges of a wooden lid—such "stock solutions" keep perfectly satisfactorily throughout the spraying season. Two 50-gallon barrels hold sufficient for the making of 625 gallons of Bordeaux mixture; while if the "stock solution" of copper sulphate be increased in strength to 100 lb. in 50 gallons of water, and another 50-gallon barrel of "stock solution" of "milk-of-lime" is added, these three barrels will supply enough to make 1250 gallons of Bordeaux mixture. By storing such "stock solutions" made just before the summer spraying season commences, the grower has the means of obtaining in a few minutes at any time a large supply of Bordeaux mixture of the best quality.

The making of Bordeaux mixture on a large scale from "stock solutions" is greatly facilitated if some simple "plant" be erected. The erection consists of two elevated platforms. The higher platform is carried on four 9 ft. 6 in. posts, 5 in. by 4 in., sunk 2 ft. 6 in. in the ground and well rammed. Joists, 5 in. by 4 in., connect the heads of the posts, into which they are halved. An intermediate joist is halved into the middle of two opposite joists. The upper platform is 5 ft. square, and consists of 6 in. by 1 in. boarding in the rough, laid to the edges. The lower platform, which is 6 ft. 6 in. square, is similarly constructed, and is carried on sleepers, 6 ft. long and 10 in. by 5 in., set vertically and sunk 2 ft. 6 in. in the ground and well rammed. The two structures are bolted together at the two back posts, and where the front post of the higher platform touches the joist of the lower platform.

On the higher platform are two 50-gallon "dilution barrels," marked inside at the 50-gallon level, and fitted with taps. If possible, water should be laid on to this higher platform. On the lower platform stands a vat (fitted with a tap) capable of containing 100 gallons. A short length of hose ("canvas hose" is convenient to use) is fitted to the taps of the "dilution barrels" and of the 100-gallon vat. The process of making 100 gallons of Bordeaux mixture is as follows: eight gallons of the "stock solution" of "milk-of-lime," and the same amount of copper sulphate "stock solution" (or four gallons only if this has been made of the strength of 2 lb. of copper sulphate to the gallon of water) are carried up to the upper platform and poured separately into the two "dilution barrels," which are then filled with water up to the 50-gallon mark. The 50 gallons of "milk-of-lime" thus obtained in one of the barrels is stirred vigorously for a couple of minutes. A strainer is now placed over the vat, in such a position as to allow the hose from the taps of the "dilution barrels" to project into it. The taps of the "dilution barrels" are turned on, and—the contents of the barrel containing the lime being stirred continuously—the two 50-gallon barrels empty themselves through the strainer into the vat, filling it with 100 gallons of Bordeaux mixture. The whole process can be easily controlled by one man standing on the higher platform, as with his stirring-pole he can reach the taps and so regulate the flow if necessary, and also stir and clear the strainer should this become clogged. The Bordeaux mixture is immediately ready for use, and can be run off from the tap of the vat into the spraying machine. Thus all the labour and waste of time in handling the mixture are saved; and, given some such "plant" as is shown in the illustration, and "stock solutions," 100 gallons of Bordeaux mixture can be prepared in a few minutes at any time during the spraying season. It is of the greatest importance for a fruit-grower to have the means of obtaining the proper "wash" directly the right period of vegetation and suitable weather conditions arrive,—spraying at the right time is just as important as spraying with the right "wash."

Good straining of Bordeaux mixture is essential for success in spraying, since, as pointed out below, it is absolutely necessary to use a nozzle with a very fine opening. It is best to strain the mixture twice, in the following manner: first, a strainer with meshes of medium fineness should be placed over the vat. Then a second straining must be given as the Bordeaux mixture flows into the spraying machine. Here the best type of strainer is one with copper gauze with very fine meshes—35 to 40 holes to the linear inch. Such a strainer, made with a wooden bottom and sides of copper gauze, is fitted to spraying machines. A simple and very useful type of strainer (suitable for "barrel" spraying machines and for general straining), as recommended by the United States Department of Agriculture, is made as follows: It is in the form of a wooden box about 1 ft. square, the bottom of which is formed of hard wood, with a hole bored through it, into which a piece of gaspipe, $1\frac{1}{2}$ in. or 2 in. in diameter and from 6 in. to 9 in. long, is fitted.

The box is, of course, open at the top. Fitting just inside this box is a second and lighter box, also open at the top, and having an overhanging strip nailed round the top which supports it. The bottom of this inner box should be made so as to slope at an angle of about 30°, and should be made of fine copper gauze. The slanting bottom makes it harder to clog, and the inner box, being removable, can be inverted and washed in a tub of water. Bordeaux mixture, if properly strained, will pass easily through nozzles which throw the finest "misty" spray, while if not properly strained, frequent clogging of the nozzle will result.

If the lime used is freshly burnt (and it must never be forgotten that air-slaked lime is useless for making Bordeaux mixture) and carefully weighed out, there is no need to test the mixture before using it. When using "stock solutions," it is a good plan to apply a test at the first mixing. A rough test consists in immersing a clean iron wire or French nail in the Bordeaux mixture for one minute; if safe to use, the mixture does not affect the nail; while if unsafe, a copper-plated appearance is given to it. A more delicate and quite simple test is as follows: procure from a chemist a 10 per cent solution of ferrocyanide of potassium (which is a poison) and pour a little of this into a white saucer; then drop a few drops of the Bordeaux mixture into the ferrocyanide of potassium. No change of colour occurs if the mixture is safe to use, while a cloudy reddish-brown discoloration (very easy to see) occurs immediately if the mixture is unsafe to use. An unsafe mixture can be made safe by adding more "milk-of-lime" until it passes the test.

In spraying there is no need whatever to add anything to the Bordeaux mixture with the object of making it adhere better; soap is quite unnecessary and should never be used, and treacle is useless. The nature of the precipitate which constitutes Bordeaux mixture causes it, when applied in a "misty" spray (see below), to adhere most intimately to the part sprayed.

The Application of Bordeaux Mixture.—The best type of spraying machine for spraying with Bordeaux mixture depends to a large extent on such circumstances as the height of the trees, and whether they are grown in a plantation or in an orchard. But the chief point that requires to be emphasised is that the nature of the spray is the essential factor for the success in spraying with Bordeaux mixture. The spray *must* be very fine and "misty," or smoke like; a hanging "mist" or "fog" must be produced which drifts over and through the tree and deposits on the surface of the leaves excessively minute drops, which, when dry, give the parts of the tree which have been sprayed the appearance of being almost uniformly covered with a very thin bluish film or dust. Such a deposit of Bordeaux mixture is so intimately attached to the surface of the leaf or fruit that it does not readily wash off.

In order to obtain the right kind of spray, attention must be paid to two points: (1) a special type of nozzle must be used, and (2) sufficient pressure must be obtained at the nozzle. If these two requirements are not fulfilled, the full benefit from spraying with Bordeaux mixture cannot be obtained.

As regards the nozzle, the fact must be emphasised that a special type is required, which may be called the "Bordeaux nozzle." There is at the present time a considerable amount of spraying with Bordeaux mixture being done with unsuitable nozzles. This results not only in a waste of labour and material, but even in actual harm.

It follows that because the spray of Bordeaux mixture must be "misty" and not jet-like, it must be carried close to the part sprayed. In the case of tall trees this necessitates the use of long bamboo "extension rods." The fact that tall trees cannot be sprayed with Bordeaux mixture by means of a jet-like spray sent up from the ground cannot be too strongly insisted upon; to secure a fine "misty" spray which shall drift over and through the tree and deposit itself uniformly over the leaves, a "Bordeaux nozzle" at the end of a rod of sufficient length must be used.

The mixture as used on root fungus of trees may be made stronger and merely poured on the ground. For leaf fungi it must be sprayed in as fine a mist as possible so as to reach both sides of the leaves, for it must not be forgotten that most leaf fungi attack the plant on the underside of the leaf.

There are many spraying machines invented suitable for all sizes of trees or estates. For small lots like nursery beds we often use a simple bamboo squirt made of a joint of bamboo, with the septum at one end perforated, and a stick wrapped at the end in rag for a piston. This, though a very rough apparatus, can be made in a few minutes on the estate and will do for any kind of spraying.

GENERAL HINTS

In selecting seeds of any plant for cultivation, if possible, always take by preference the best stock from well-known, strong and producing trees, even if it costs more than unselected seed. In the tropics the duration of the life of the seed is shorter than in cold climates. Seed kept for any length of time deteriorates, and in germinating often causes disappointment. The seed must be fresh, recently gathered, and kept in a cool, shady spot until sown. Seeds that have been kept too long, especially if hard-coated, such as nutmegs, may be assisted in germinating by soaking in water for a few hours before planting. Warm water is preferred. As a rule, seed does not require to be planted deep in the soil. It should be just covered and no more.

Cuttings should always be made with a sharp knife, so as not to bruise the tissue. It must be remembered that roots and buds can only be emitted at a node or joint, and the cut should be made a little below the node, so as to leave a small portion of the internode to hold the cutting in the ground until the roots are emitted. Cuttings are very liable to the attack of fungi. Should it be found that the cuttings in a nursery bed are constantly or much attacked by any fungi, the bed should be abandoned and the soil thoroughly disinfected with Bordeaux mixture and lime.

In planting the soil should be pressed firmly against the base of the cutting. Rhizome cuttings, such as those of turmeric and ginger, should be sufficiently large. If there is any fungus disease in the bed from which they are taken, it is advisable to soak them for a few hours in a weak solution of copper sulphate to disinfect them.

Nursery beds should be well dug and the sods broken up so as to resemble garden soil. It should be damp, but not water-logged. Small drains should be made to carry off the water in case of heavy rain. The shading should not be too heavy, and should be from 2 to 3 ft. above the soil.

Seeds and plants should not be planted too close together. The actual distance depends on the size of the plant before removing. The greater the size of the young plants, the farther apart they should be planted. Thus nutmegs, which remain longer in the nursery bed than most plants, should be at least a foot apart.

Occasionally, in the case of small seeds as those of capsicum, there is a considerable loss due to the raids of ants, which remove the seed and devour it. Upon finding a seed-bed the ants often transfer the whole nest to the nursery. These can be destroyed with insecticides, or the bed may be flooded for a short time, in order to drive them out.

In planting in lines do not place each plant exactly opposite the one in the next line, but half-way between. This, the quincunx arrangement is now adopted by most planters for all trees.

In holing, make the holes wide enough and deep enough, 2 ft. each way being a good size. Mix and break up the soil and manure well before filling in, allowing a 6-in. mound above the ground level in which to put the plant, so that when the soil sinks, as it will after a few days, the surface will be a little above or on the level of the ground, not below it. Otherwise you will find that the sunken pit in which the plant stands will become a catch hole for the rain, the soil eventually becoming water-logged and foul.

Draining to some extent is necessary on almost every estate. The depth and size of the drains depends on the location and on the amount of water in the soil. Care must be taken to see that the drains are kept open and do not silt up. If possible, they should be made before planting and while the plants are in the nursery.

MANURE

The different kinds of manure to be used are mentioned under the different spices. In the tropics cow-dung, where procurable, is generally considered the best general manure. Stable manure is too hot, and requires rotting for some years before it can be used. The planter, however, often has to depend upon the kind of manure procurable in his locality. In some places poonac and castor cake can be obtained; in others cow-dung, rotten leaves, etc. have to be depended upon. Comparatively little has as yet been done in the tropics with chemical manures.

"Burnt earth" is a most useful manure. The method of making and using it is described under Vanilla. The weeds and dead leaves, sticks, etc., found on the ground should never be entirely removed. It is usual in the case of weeds to dig pits in the ground between the trees and to put them in to rot, covering them with soil and pressing them down. They can also be decayed in piles or open pits and restored to the ground as a mulch. Manure should not be put close to the trunk of the tree, but should be placed at the point to which the farthermost leaves of the tree project, or in the middle line between two rows of trees, and equally distant from each.

In manuring such plants as ginger, the manure added before planting should be well mixed with the soil, and not allowed to remain in lumps scattered through the beds.

Liquid manure should not be applied to plants before four o'clock in the afternoon, or until the hot part of the day is passed, nor should plants be watered during the heat of the day.

THE PRODUCE

The planter should endeavour to turn out his produce in the most perfect condition possible, and no pains should be spared to make it look as well as the best in the market. Inferior qualities should not be mixed with the best. There is often a good sale for inferior and consequently cheaper stuff, but the planter should attempt to make the best finished sample he can, and if he has by accident any that is not up to the standard, let that be separated and sold as second quality. Many spices suffer much from mildew, and it is impossible to dry spices and keep them free from this unless one has a good dry store, in an open dry spot with proper drainage round it to run off rain-water and prevent its accumulation.

Care must be taken to keep the produce free from the attacks of the little godown beetles, which especially attack ginger and nutmegs. These beetles attack all kinds of dried vegetable produce, and may get into the store through infected produce being brought in and overlooked. Grain, coffee, and pulses are not to be stored in the spice godown if possible, as they are very likely to bring these pests. Should these insects appear, the godown should be at once cleared of all its contents, thoroughly brushed out, and completely whitewashed. It may even be necessary to disinfect, especially in corners and such places where the insects can hide, with Jeye's fluid or some other such disinfectant.

PACKING

The directions for packing the produce for market are given in the chapters describing the different spices. All spices must be packed carefully so as to present a good appearance at the sales, in sound gunnies, boxes, or barrels, to avoid injury from water or from insects during the transportation. The spices should be quite dry when packed or they will become mouldy. A small amount of mouldy spice may infect and spoil the whole box or case. Finally, to close these hints, the planter must have his eyes everywhere, letting nothing escape him, and using common sense in his work.

Agriculture, like everything else, has no code of rules, and it is impossible to lay down strict laws for every local condition. A successful planter is one who is always studying and learning, often inventing simple little improvements which save cost and time or increase the value of his product.

ESTIMATES

In a book written for use in all parts of the world it is difficult to give estimates of cost and profit which can be strictly depended upon for all countries. Expenses vary in different places and at different times. It is only possible to give a general idea as to costs subject to local conditions. The cost of land, the expensiveness of labour vary in different places, and either may rise in countries undergoing development. A sample of expenses likely to be incurred, say, in opening up an estate of nutmeg trees, from high forest, is here given, modified from H. C. Belfield's *Handbook of the Federated Malay States.*

Estimates for planting 250 Acres

First Year

Felling and clearing 250 acres at 13 dollars an acre, felling 9 dollars, clearing 4 dollars	$3,250
Lining at 150 trees to the acre at 1·50 per acre	375
Holing and filling 250 acres	750
Planting at 1 dollar an acre	250
Supplying at 50 cents	125
Nurseries	300
Seed	190
Roads and drains at 12 dollars an acre	3,000
Weeding for six months at 1 dollar per acre per month	1,800
Superintendent's salary at 300 dollars a month	3,600
Buildings, Superintendent's house	1,500
,, Conductor's house	250
Coolie lines, say	1,300
Tools	500
Contingencies, medicines, etc.	1,750
Total	$15,945

Second Year

Upkeep $7,500

This upkeep will be continuous annually till the seventh year, but the cost of weeding will be less after three or four years.

To these expenses must be added cost of land, survey fees, etc.

When the crop begins to come in, buildings for stores, drying sheds, etc., will have to be provided.

This rough estimate would do also for cloves, cinnamon, pepper, and plants of that nature, subject to a few alterations due to differences in cultural methods.

The cost of felling and burning naturally varies according to the class of jungle to be cleared, whether it be heavy forest or secondary scrub, or grass and fern, the former being the most expensive.

Nowadays, with a view to avoiding injury from fungi attacking the young trees, it is customary to root out all stumps and roots which are liable to harbour parasitic fungi. This is expensive, but it generally pays in the long run.

Figures for forming estimates for field and garden crops are given under their respective chapters.

The races which supply the coolie labour of the tropics are the Tamils (natives of southern India), Javanese, Chinese, and Negroes; Papuans and Annamites are used in their respective countries. This labour is comparatively cheap; white labour in the hot parts of Australia costing about eight times as much, and it is on the cheapness of black labour that many of these cultivations depend. Much of the work, such as felling and burning, is given out on contract.

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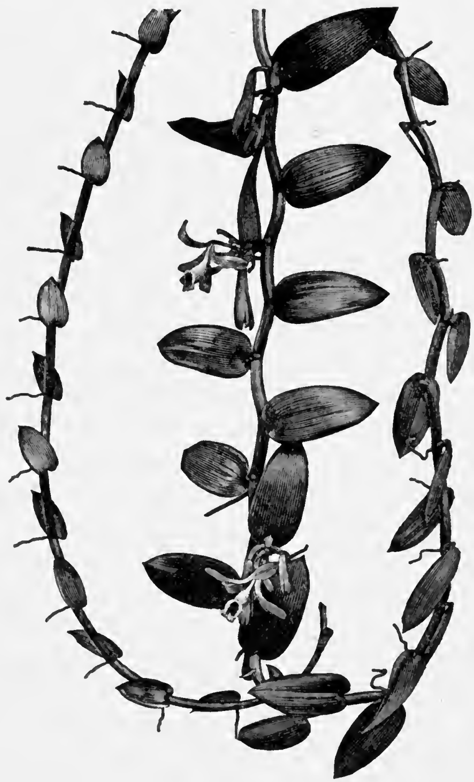
CHAPTER II

VANILLA

Vanilla is the product of a climbing orchid, a native of Central America. There are two species in cultivation or use producing this spice—*Vanilla planifolia*, Andr., the true Mexican vanilla, with long, slender pods, and *V. pompona*, Schiede, West Indian vanilla, with short, thick pods. There are a few other species which have more or less fragrant pods, but none of which ever seem to have been valued as spices.

The most extensively cultivated species is *V. planifolia*, a native of South-eastern Mexico, British Honduras, Guatemala, and Costa Rica. This plant has been introduced into all parts of the tropics, and has been cultivated extensively in the Seychelles, Réunion, Mauritius, Java, Tahiti, the Fiji Islands, and the West Indies.

The plant is a tall climber, with very long, flexuous, succulent green stems, which put out twining white aerial roots opposite the leaves, by which it clings to trees, etc. The leaves are nearly sessile, oblong, acute, succulent, bright green, 4 to 9 in. long, and $1\frac{1}{2}$ to $2\frac{1}{2}$ in. wide. The flower racemes are axillary, 2 or 3 in. long, with numerous oblong, concave bracts. The flowers are about 4 in. across, and borne on pedicels $1\frac{1}{2}$ to 2 in. long. The sepals and petals are linear oblong, 2 in. in length, and pale green. The trumpet-shaped lip is shorter and also pale green, rolled up round the column and united with it, the tip three-lobed, toothed with raised nerves, the front nerves warty and buff-yellow, with a tuft of hairs about the middle of the disk. The column is $1\frac{1}{4}$ in. long. The pod-like fleshy capsule is elongate, linear, obscurely three-angled, 6 to 9 in. long and 6 or 7 lines through.



VANILLA.

Vanilla pompona resembles *V. planifolia*, except that its leaves are larger, 6 to 11 in. long, $1\frac{1}{2}$ to $4\frac{1}{2}$ in. broad; the flowers are larger and more fleshy, the sepals and petals greenish yellow, the lip bright yellow, with the central tuft of imbricating scales rather than hairs, and the pod linear oblong, 6 or 7 in. long, and 1 to $1\frac{1}{4}$ in. thick.

V. pompona is a native of Southern Mexico, Nicaragua, Panama, Surinam, Venezuela, and Trinidad, and has been cultivated in Martinique and Guadeloupe. The pods are thicker and more fleshy than those of *V. planifolia*, and fetch a lower price.

HISTORY OF THE PLANT

Vanilla was used by the Aztecs for flavouring chocolate before the discovery of America, and its use was adopted by the Spaniards. It was, according to Morren, brought to Europe about 1510, and first described by Hernandez in 1651, in the *Rerum Medicarum Novae Hispanae Thesaurus.*

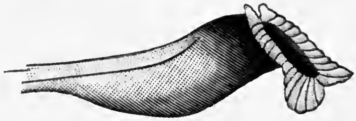
It was introduced into England in the beginning of the nineteenth century, it is said, by the Marquis of Blandford, and flowered and fruited in 1807. In 1812 plants from the gardens of the Right Hon. H. C. Greville were sent to Dr. Sommé, Director of the Botanic Garden of Antwerp, who in 1819 sent two plants to Buitenzorg in Java, where one that had survived the voyage flowered in 1825, but did not fruit. Professor Charles Morren of Liége was the first to produce fruits in quantity, and proved that *Vanilla planifolia* was the true vanilla of commerce. He showed the method of fertilisation by hand, and suggested that vanilla might be readily cultivated in tropical countries.

Vanilla cultivation on a systematic basis was introduced into Java by M. Teysmann, Director of the Botanic Gardens at Buitenzorg, in 1846. In Réunion cultivation commenced between 1850 and 1856, and in 1857, 1917 kilos were exported to France, increasing to 44,000 kilos in 1874, of the value of 4,098,600 francs. From Réunion it was introduced into Mauritius. It was also cultivated in Tahiti, Fiji, Zanzibar, and Java.

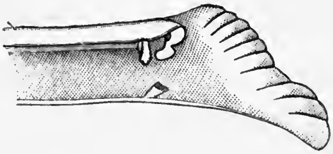
The cultivation of vanilla soon became of great importance. In 1875 the British Consul at Réunion states in his Report (May 1, 1875):—

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 24,854 kilos, and the quantity which will appear

Flower half life size.



Lip.



Lip in section.

VANILLA FLOWER.

in the market towards the month of August next is calculated at about 40,000 kilos. Unless circumstances arise which are at present unforeseen, the colony can produce in two or three years from 50,000 to 60,000 kilos of vanilla. I learn that the cultivation is also extensively carried on in Madagascar and Mauritius, and it is feared by persons interested that by this extended cultivation prices will go down.

CULTIVATION

Climate.—Vanilla requires a tropical climate, hot and moist, with frequent but not excessive rains. It cannot stand dryness nor strong sea-winds, nor does excessive regular moisture suit it.

In the Singapore Botanic Gardens it grows very well and strong, but as its period for ripening the fruits coincides with the wet season, it cannot be cultivated in this region with much success, for if there should be heavy rain-storms during the ripening period, the pods are apt to fall off unripe and are spoilt.

VANILLA FLOWERS.

Both *Vanilla planifolia* and *V. pompona*, however, have produced good pods there. As the flowers are usually produced in June and July, and the fruits ripen about December or January, it is desirable to select a climate for it where the rains are not violent at the end of the year. Curiously, a wild species of vanilla, *V. Griffithii*, common all over the Malay Peninsula, flowers and fruits in almost the same months as the American species, but the heavy rains of December and January do not affect the ripening of its fruit. Unfortunately, this species does not possess the aromatic flavour and perfume of the American plant.

The climates of the Mascarene Islands, the West Indies, and parts of the Polynesian Islands, such as Tahiti and Fiji, are those which suit it best, and it was formerly grown with some success in Ceylon.

It will be noticed that the greatest success has been obtained in insular climates, and possibly proximity to the sea may be an important factor in its successful cultivation.

In the Seychelles Islands, which have been famous for the cultivation of this spice, the temperature varies from 90° to 70° Fahr., rarely going as low as 67°, the commonest temperature being 80°. The rainfall is 100·8 in., evenly distributed throughout the year, but a dry spell is looked for from July to September. The heaviest rains occur in December, but the air is always moist. In the Seychelles it appears that the heavy rains of December do not affect the crops so much as irregular rains in August, for the Curator of the Botanic Station in his Report for 1905, states that the weather was very promising until the end of July, but the rain fell abundantly in August and September, and the vanilla vines put forth new growth instead of flowering, and he therefore predicts a consequent reduction in the crop of pods.

The Colonial Office Report gives the following table of rainfall and temperature for Victoria, in the Seychelles, for five years :—

	Rainfall.	Maximum shade temperature.	Minimum shade temperature.
1901	102·26	F. 88·5	68·4
1902	87·81	88·0	68·0
1903	132·96	88·5	68·0
1904	106·74	87·2	68·2
1905	88·91	88·0	71·0

The average daily maximum was 83·5 and the minimum 78·3. The average rainfall was 100·8, but the value of the rainfall is measured not so much by the inches as by the distribution. Thus in 1904, although the rainfall was above the average, it was coincident with a calamitous drought which extended from the middle of February to the end of October, and caused a great agricultural disturbance. Similarly, in 1905, many parts of the islands were without any substantial rainfall between June and October, and everywhere the crops were damaged by the intense sun-heat and the absence of regular showers. Two droughts in two successive years had the effect of checking the flowering of the coco-nuts and the vanilla. In the latter case the almost entire failure of the flowering season reduced the crop of vanilla in 1906 to one-third of that of a normal year.

These figures give an approximate idea of the requirements of the vanilla as regards climate. As in the case of many other crops, regularity of climate counts for more than the actual humidity and temperature within certain limits.

Soil.—The soil which the plant requires in order to thrive is one rich in humus, light and friable. Stiff clay soils, which dry rapidly, and wet water-logged ground is not at all suited to the growth of the plant. Vanilla is a forest-loving plant, and, like all such plants, requires a rich soil of decaying leaves and partial shade in order to thrive.

Galbraith describes the soil of the Seychelles as follows: "There are three sorts of soil here. (1) Rich vegetable mould, in forest and valley bottoms; for a quick growth this is excellent. (2) Greasy red clay in fair quantity; in this vanilla makes good growth. (3) Coarse quartz sand or gravel; this is best of all, as giving good drainage. In wet years plants are more likely to crop than in other soils."

It must be remembered that in most of the islands of the Seychelles a considerable amount of guano is mixed with the soil, which is therefore rich in lime, nitrogen, and phosphoric acid, so that probably the coarse quartz sand was richer in the salts required by the plant than a similar looking soil would be in other countries.

Selection of a Site.—In Mexico it is usual to select as a suitable place for the cultivation of vanilla a portion of forest, in which a clearing is made, a number of trees being left at a distance of from 15 to 20 ft. apart to act as supports to the vanilla plants.

Delteil suggests a sloping hill-side covered with woods, which, of course, must be suitably thinned out so as to allow of sufficient light during the flowering and fruiting seasons, and such land, if procurable, would undoubtedly be convenient in many ways.

Old orchards which have long been used for the cultivation of vanilla cannot be recommended, as the ground is liable to be infected with the vanilla disease, as will be explained later. In any case, it is preferable to open new ground for a fresh cultivation when possible, whatever the previous crop may have been.

In new cleared ground which is not furnished with trees suitable for the support of the vines, it is necessary either to plant the support trees as soon as possible, in order that they may be ready to carry the vines when they commence to climb, or in default of trees the system of cultivation on trellises must be adopted.

Mr. Macfarlane, in an article in the *Trinidad Bulletin*, vol. xxxii. p. 465, is strongly in favour of selecting as a site a valley with a moderate slope. He claims that the steep little valleys with which the Polynesian Islands abound are the ideal home for the vanilla, and states that in his own plantation in Tahiti, half a mile from the sea and a couple of hundred feet above it, the pods average in length over an inch more than those grown close to the beach or in an undrained soil. Vanilla, he says, revels in moisture, but it wants no stagnant water about its roots.

Heavy dews, more or less moisture constantly descending from the hills above almost obviate the necessity of rain, while the natural drainage keeps the ground always sweet, no matter how heavy or how prolonged the rain is. The vine also delights to send its roots around and among rocks. Indeed, a rocky slope seems as convenient a place for the plant as anywhere, so long as it is not too dry. Macfarlane's advice is to eschew level ground, and select a piece with a *moderate* slope, this being easier to work, for vanilla does not care how steep the slope may be, but the workman does.

Mr. Howard Newport, in the *Queensland Agricultural Journal*, April 1910, p. 184, points out strongly the advantages possessed by the Queensland forest for growing vanilla, and illustrates this by photographs. The trees in this form of forest grow regularly and evenly, and by clearing out any undergrowth and unnecessary trees there remains a series of trees which can be connected with bars or poles on which the vanilla can be grown.

There is enough and not too much shade in this forest, and the soil is rich in humus and the site seems an ideal one, requiring but little labour to make it perfect. In the ordinary tropical forest the trees are of all sizes, and so irregular in growth that it would be very troublesome to clear the undergrowth so that the trees could be connected by trellises or poles in a convenient way. So readily adapted a woodland as the Australian bush appears to be, is rarely found.

Trees for Supports.—Where there are already suitably branched trees on the ground, or trees that by topping and pruning can be utilised, it is best to use these, supplementing them where necessary by posts, trellises, or additional planted trees.

A considerable variety of trees have been recommended as suitable for supports of vanilla, but as what is most suitable in one country may not be adapted for another, the selection must depend to a large extent on local conditions. The ideal tree is a fairly fast grower, which is sufficiently strong to support the weight of the plant without breaking down, and which branches regularly and fairly low down, and does not give too dense or thick a shade, so as to interfere with the growth of the vine. One which grows from large-sized cuttings is preferable to one raised from seed, as it grows faster in the beginning.

Such trees are *Pterocarpus indicus*, and *Lagerstroemia Flos-Reginae* or *floribunda* or *Erythrinas*. Of these a branch 3 or 4 ft. long, and $\frac{1}{2}$ or $\frac{3}{4}$ of an inch through, grows very readily.

Delteil suggests as suitable trees cacao, the Jack tree, mangoes, loquat, *Albizzia Lebbek*, *Bombax malabaricum*, *Ficus elastica*, and *F. indica*, and *Jatropha curcas*, the physic nut. Some of these I would suggest are rather too slow in growth, and others are apt to grow too tall and do not branch sufficiently. The physic nut is recommended by many planters. Its advantages are that it is common, being often used for fences; it can be propagated by cuttings, but also grows rapidly from seed; it does not grow tall and is well branched, and sufficiently strong to carry the vine. In Singapore I find it too slow and not sufficiently tall for the purpose, but in drier climates it appears to grow faster and stronger.

Croton tiglium, the croton-oil plant, is recommended by some, and is said to be the only plant that will carry vanilla through a hurricane. It is not, however, a plant which will grow everywhere, and is not always a fast grower. Macfarlane suggests the shrubby *Bauhinia purpurea* and the arnotto, *Bixa orellana*. The latter, as he justly remarks, gives the deeper shade. Almost any of the erect Bauhinias would do, but *B. variegata* and *B. purpurea* are both strong well-growing plants. The arnotto and the Bauhinias grow fast and easily from seed in good soil, and are able to support the vines in from eighteen months to two years.

In the Singapore Botanic Gardens vanilla has been very successfully grown on the oil-palm, *Elaeis guineensis*, which, from the good light shading its foliage gives and the projecting leaf bases usually full of decayed vegetable matter, forms an ideal support, but unfortunately it is of comparatively slow growth.

Trellis Cultivation.—Instead of using living trees many planters use hardwood posts and bars, the bars resting in notches in the top of the posts. They are put at a height of from 4 to 6 ft. from the ground, and the plants being brought over them and looped up as they grow too long. Wire is sometimes used in place of bars of wood, but though it has the advantage of being cheaper, it has other disadvantages. The vines are apt to break over so thin a support. When the plants thicken into a mass there is no fear of this.

Distancing.—In the earlier days of cultivation in the Seychelles the vines were planted so closely that the workers could hardly pass between them. The yield per acre was enormous, but when the disease got among the vines the destruction was so rapid and complete that this close planting was abandoned and more space left among the vines. About 9 ft. apart is the distance recommended.

Preparation of the Ground.—It is not at all desirable to clear the ground by felling and burning, as is so commonly done in tropical agriculture. The waste of good plant food by burning is very great, and though in the case of many cultivations it is the most inexpensive method of clearing the ground in the way it requires, there is no need for this in the case of vanilla. The ground should be opened up by cutting down all scrub and unnecessary trees; afterwards chopping them to pieces and allowing them to decay *in situ* so as to form food for the vanilla.

In the case of the ground being bare of shade trees and open and exposed to the sun, banana plants, or in Mexico maize, are utilised as shade for the young plant until the trees on which it is intended to let the vanilla climb are sufficiently tall to give the necessary shade.

Delteil recommends the planter also to plant a hedge of red hibiscus round the plantation to protect the plants from the wind, especially when the site selected is on the seashore. Whether this is necessary or not will depend on the position and exposure of the plantation. The important thing to remember is that the vanilla requires partial, but not too heavy shade, especially in its early stages of growth, and freedom from injury by strong breezes.

Weeding.—Macfarlane is strongly opposed to a clean-weeded plantation. He prefers to have his plantation covered with weeds of different sorts. These, he says, act as a mulch for the surface-feeding roots, a very good thing in a dry spell. The deep-rooting varieties of weeds are constantly bringing up nourishment from the deeper layers of the soil, which the roots of the vanilla do not reach. The mulch consisting of decayed leaves and other parts of the weeds is eventually converted into plant food, in the form of humus, the constituents of which can be assimilated by the vanilla.

There is, indeed, a great deal to be said in favour of leaving the ground covered with a carpet of herbaceous weeds, instead of spending time and money in eradicating every blade of grass seen on the estate. All planters admit that weeding forms a large item in the expense of maintaining an estate, and where it is useless and perhaps injurious the principle of clean weeding should be abandoned.

Of course, if there are climbers among the weeds which will strangle the young plants, or strong growing herbs or shrubs which shut out the light from the young plant, or harbour snails or injurious insects, it will be necessary to clear these away, but to spend money in scraping out every tuft of grass or little herbs like *Portulaca* seems unnecessary extravagance.

Vanilla in the wild state does not grow on absolutely bare soil. It is a forest plant growing on land covered with thick scrub or low bushes, and to expose its roots to a blazing sun and to the rush of a tropical rainstorm is not treating it in a natural manner. Exposure of the ground in the tropical rain-forest region, near the equator, has also the objection that the violent rainstorms will wash away from bared ground all the humus and surface soil in a comparatively short time, leaving formerly subterranean roots bare and also taking away their nutriment.

Then when the weather is hot and dry, the ground cracks under the blazing sun, breaking across any young roots which may be in the line of the crack, and the surface soil loses its moisture and the roots beneath, even if not broken, are dried up.

In spite of these obvious objections, there are many planters who insist on having a perfectly bare, dried-up, sun-cracked soil for whatever plant they are cultivating, in fact, what is known as a clean estate. Plants, however, are not accustomed to this condition, and it is quite an unnatural state for any form of tropical cultivation.

Draining.—Whether draining is necessary or not on the estate depends entirely upon the position and lie of the land. Where hill slopes are used there will, of course, be no necessity for any drainage system. In low-lying ground where the soil is at all water-logged, the ground must be drained, but such soil is not good for vanilla, however it is treated, and should be avoided.

Much of the injury caused by the fungus disease in Mauritius was attributed to bad or insufficient drainage.

Manuring.—Where the soil is rich in humus of sufficient depth it is unnecessary to add anything in the way of manure, but the ground should be dug over and broken up before planting. If the soil is poor in humus, leaf-mould or decaying leaves may be spread on the ground, and burnt earth may be liberally used.

As burnt earth is widely used in the tropics for many different crops, and will be mentioned again, I will here describe the method of making it. Low scrub, bushes, boughs of trees and other such vegetation are cut, and partly dried by being left in the sun. A quantity is laid on the ground and covered with soil, adding alternately more branches and more soil, until a good-sized pile is made. This is then ignited and allowed to smoulder for some days or even weeks, until the vegetable matter is charred. After being allowed to cool, it is used for manuring. This burnt earth is very suitable for such plants as vanilla and pepper, which require much potash.

A certain quantity of lime is recommended to be added to the burnt earth and leaf-mould, especially where soils are deficient in this element.

Animal manure, such as cow-dung, is not recommended. Orchids of all kinds seem to dislike any animal manure, and vanilla is no exception. Should farmyard manure be used, it must only be very old and well-rotted stuff, and then but little should be used mixed with the leaf-mould. Some planters have recommended that in cases where the soil is stiff and clayey, and deficient in humus, trenches 3 or 4 ft. long and 1 or 2 ft. deep should be dug and filled with leaf-mould and sand to above the level of the ground (to allow for sinking), and the vanillas should be planted there. Most planters, however, condemn this proceeding, as the holes are liable to become water-logged. Vanilla is a surface feeder, the roots spreading between the humus and subsoil, so that practically the only feeding ground of the plant is the humus layer.

Macfarlane even is inclined to condemn digging or ploughing previous to planting, preferring to leave the humus layer on the top of the soil unmixed with the subsoil. Any rotting vegetable matter, such as the leaves and stumps of bananas, coco-nut leaves, grass, etc., should be thrown on the surface and allowed to decay there.

The amount of manuring required naturally varies with the nature of the subsoil and the depth of the humus. In Tahiti, Bourbon, and Mexico, where the vanilla is cultivated, the soil is volcanic, and consequently richer than the stiff alluvial clays so commonly met with in many tropical regions. In the latter class of soils vegetable manures of the character above mentioned are necessary.

In the Colonial Report of the Seychelles for 1905, Mr. Dupont of the Botanic Gardens there gives an interesting account of some experiments in manuring which are worth quoting. In five beds the plants were grown in ordinary soil, in the others (fifteen) the orchid was planted in fibrous roots of the common fern, *Gleichenia dichotoma*, a fern which to a large extent in most tropical countries takes the place of the bracken. Eighteen months had elapsed since the vanilla cuttings were planted.

They are at present fully grown vines, and those which were planted in ordinary soil have developed much less than those which were grown from the beginning in fern roots. A few of the former possess a yellowish appearance, which is striking even in wet weather. In all the basins in which the vanilla is growing the roots have developed alongside the walls, none having extended as much as one foot from the plants towards the centre of the basins. The cuttings had sprouted in the proportion of 62·5 per cent in fern roots and of 27 per cent in ordinary soil, on the 16th December, or three months after planting. In March 1905 the shoots were 2 ft. long in the basins containing fern roots, and only 6 in. in the others. It was decided at that time to put a small quantity of fern roots on the surface of the basins containing ordinary soil, in order to accelerate the growth of vines growing in them. In August all the vines were well developed, but on examination of the roots it was found that none went deeper than 6 in. in fern roots, and that in ordinary soil they were fewer in number, shorter, and many of them sun-burnt. The aerial roots on reaching the soil were found to make excellent growth and to produce many rootlets. For this reason it seems that much importance should be attached to strengthening and protecting the signs of life in the lower part of the cutting. In an ordinary plantation the vines are in great numbers found dead or sun-burnt at the base, together with all the roots which were produced on that part of the cutting. When this is the case the vines produce aerial roots which replace the subterranean ones, but much of the energy of the plant is lost in this new production of roots, and the flowering delayed.

The action of the sun on the roots is so striking that, in a second series of basins to repeat the experiments which are found successful in the first, I noticed that the growth of the vine is checked when the layer of good loose or fibrous soil is less than 2 in. deep. Under these circumstances it seems advisable to plant vanilla in hollowed ground or trenches 6 in. deep, so as to keep more easily the roots out of reach of the burning sun, or the soil must be porous enough to prevent it being water-logged. This is not done in Seychelles, where vanilla is grown on the surface of the ground and weeds or twigs accumulated in heaps to protect the roots. This kind of protection is insufficient, because as a rule planters protect the roots only once a year, when the time comes for pruning the vines and clipping the props (March to June). I wish to emphasise the sad consequences of this exposure of the roots, because it accounts to some extent for the irregularity of growth and flowering in any one plantation. These physical conditions of growth are of great importance for delicate plants like orchids, and even when the soil is not porous I think that an attempt should be made to plant in trenches filled first with a good layer of broken stones and then with 6 in. at least of fibrous soil. It was thought that improvement in the growth of the vine also could be obtained by manuring them. Up to now the results obtained are very promising, although the manuring was started after the rains in November last, or a few months ago.

After several investigations I came to the conclusion that a careful examination of the roots while the plant was under treatment with manure would establish which kind of manure would be welcomed by the vine and which not. Regarding phosphates I have employed phosphatic guano from Flat Island, which contains 72 per cent of tribasic phosphate and only 0·40 nitrogen (7 kilos per basin). These rocks were broken in small pieces like macadam and placed at mid-distance between two rows of vines placed 4 ft. apart. The coral was used in just the same way (5 kilos per basin). Kainit was also employed in the solid state (1 kilo per basin), but as this salt is hygroscopic, small quantities were arranged in a layer of coco-nut husks placed also at mid-distance between the vines. The kainit would thus dissolve more slowly and be absorbed by the coco-nut husks. After three months it was found to be still incompletely dissolved under these conditions.

Nitrogen is employed in the soluble state as nitrate of soda. The vines are watered once a week with weak solutions of 8 to 16 grams in 100 litres of water (50 litres per basin). As far as these experiments go, it is interesting to record the root development which immediately followed the applications of these measures. As already stated, the roots were, previous to the application, all found within 18 in. of the walls of the basins, but three weeks after the application numerous roots covered with hairs had found their way to the manures where previously no roots were found.

Propagating.—The vanilla plant is always propagated by cuttings. Though it has been raised from seed, in any ordinary case it would not be worth while to attempt to grow it from seed, as it is easy enough to propagate from cuttings.

There is some difference in the length of cuttings used in different places. The Mexicans make cuttings 3 or 4 ft. long or even more. It is more common, however, to make short cuttings of a foot or so in length.

It is claimed that plants grown from long cuttings commence flowering in the first year. The short cuttings certainly take longer, not coming into bearing until about the third or fourth year.

When long cuttings are used, the stem is laid on the ground in a circle up to half its length, or is coiled round its future support. Its tip requires to be protected from the sun, and the plant must be frequently watered. I find also that it is advisable to cover the prostrate stem with a light layer of soil or rotten leaves to save it from injury and hasten its growth.

In planting short cuttings, the base is inserted in the ground for about an inch, and a stick put close to it to start it climbing, or it may be put close to the tree on which it is to climb. At least two joints of the stem must be above the ground. After a week or two the plant puts out a shoot from one of the leaf axils, which soon lengthens, and sending out roots commences to cling to the support. The leaves of the young branch are usually brighter green, smaller and narrower than those of the original cutting. Eventually, however, they attain their full size and deep green colour.

For convenience the cuttings may be started in a nursery and removed to the garden when they have commenced to grow. The nursery beds should be made of good, rich leaf-mould, and shaded. As a rule, at least in the Straits Settlements, the cuttings require watering for the first few days only, but that depends on the climate and season. In dry weather, watering, at least in the evening, will be necessary.

Even if the cuttings are planted, as soon as they are made, in the places the plant is destined to occupy, it is advisable to have a few nursery beds of young plants to use as supplies when necessary. After planting the cuttings require little attention beyond watering. If necessary keep the place clean, and renew the failures from the nursery beds.

It is recommended to allow the weeds to grow round the plants for some little distance to keep the ground cool and moist, and prevent any injury from rain-wash.

The best months for making the cuttings are, according to Delteil, in Réunion, November, December, January, and February, the period of heavy rains and great heat. The most suitable period naturally varies in different areas, according to the date of the commencement of the rainy season. In the Malay Peninsula, where there is seldom a dry period of more than a week or so at a time, almost any time of the year is suitable, as long as there does not happen to be a dry spell at the time.

Should the position of the young plant be too much exposed to the sun, or the soil too dry or not sufficiently rich, the little vine will soon show this by the sickly yellow colour of its stem and leaves, and steps should be taken to remedy this.

In planting the cuttings at the supports, whether tree or trellis, they should be placed in close contact with the support, in such a position that the aerial roots may be emitted against the support, and the cutting should be tied to it.

The leaves and roots of the cutting itself are best removed with a sharp knife, and it is advisable to put some decaying leaves or straw round it to keep the ground damp.

Delteil recommends that the cutting be covered with a layer of leaf-mould and dead leaves and straw, on the top of which are laid flat stones, in order to keep the cutting thoroughly damp, but this is rarely necessary except perhaps in very hot and dry spots, where it might be advisable. Under good conditions the growth of the vanilla is rapid, and from a cutting of three or four joints it will have grown from 10 to 14 ft. long at the end of the second year, and should commence flowering in the third. When the shoots have grown to a sufficient length, they require to be twisted round the branches of the supporting tree, or over the lattice of the trellis, so that it can climb over and hang down. This must be done gently, so as not to tear or bruise the leaves, branches, or roots.

It is on these long hanging branches that the flowers are produced. As long as the vine can climb upwards it will not flower, so that it is not advisable to grow it on too high a support, for not only will it take longer to produce the hanging branches, but there is much more difficulty in getting at the flowers to fertilise them later.

These long branches, when they reach the ground, often take root there and reascend the support. The long shoots turn downwards when the plant has grown to the top of its support, and when grown on low trellises, or posts or bushes, turn down of themselves. On taller trees it is often necessary to turn them down to prevent them from growing out of reach. The vines should be examined every two months or so, and the stems over 10 or 12 ft. long should be turned down over the lower branches. "Do not let the vine hang nearer than a foot from the ground," says Macfarlane, but "pinch off the end when it has reached that length." In turning down it is often found that the plant has clung by its roots to a support and cannot be moved easily without breaking these roots. It is better to cut them through rather than to break them. They are no longer of any use to the plant, and attempts to uncoil them may end in breaking the vine, which is more brittle than the roots.

Raising from Seed.—In 1902, M. Dupont made experiments at the Government Botanic Station of the Seychelles to raise vanilla from seed in the following manner. Fully ripe pods were allowed to blacken, and the seeds when removed were soaked in alcohol for twenty-four hours, and shortly after were thoroughly washed and planted. The seedlings are reported to have grown well.

Though it is probable that growing vanilla from seed as a regular or common thing might be too slow a process for the planter, there is a good deal to be said for this being occasionally done. Plants which like vanilla have been for many generations grown continuously from cuttings, are very apt to deteriorate and become weak and liable to disease. Nature, it is said, abhors perpetual self-fertilisation. And it may be said that nature still more abhors perpetual asexual reproduction. A fresh strain of vanilla in estates would be very desirable. In raising plants from seed it would be advantageous to use pollen from a different plant for fertilising a flower.

Pruning.—The old stems should be cut off after flowering, even if they still carry buds. The plant will replace them with good and strong stems bearing more flowers, and probably better fruit than the old stems would by the next flowering season.

Pruning the young stems has been productive of good results in some cultivations and a failure in others. The opinion of Delteil is, that if a planter wishes to get a rapid return from the vanillery, and does not intend to keep it going for more than two or three years, pruning is suitable. It produces an excessive crop of fruit, but always at the expense of the plant.

In cases where the planter has a number of young plants and wishes to have a succession of good fruiting plants,—one lot ready while the next is coming on,—the system of pruning may pay very well. At the first flowering of the young stems the ends of the branches are cut off. The result of this pruning is that flower spikes appear from all the leaf axils, and at the same time branch-buds appear lower down in great numbers. The most vigorous of these branch-buds is kept and all the others removed. The next year's flowers will be produced from this side shoot.

When the pods are ripe the whole of the branch which carries them is cut off, and only the new shoots of the previous year are kept, so that there is no waste of nutriment on the useless portion. As soon as the flower-buds appear on the second stalk, the tip of that is removed. This treatment is continued as long as the plant produces sufficient pods.

Plants that have been pruned in this manner require a heavy manuring of burnt earth, leaf-mould, rotting leaves, lime and ashes.

To get full success in this way, it is necessary to plant a little at a time, to leave no more stems than are required for the fruit, and to manure the plants not less than twice a year, to give plenty of light and air, and to avoid excess of moisture. Watering the plants, however, is necessary in the dry season.

Vines grown in this manner are usually exposed to the full sun. They have a yellowish tint and are more slender, contrasting strongly with the rich deep green foliage of plants grown in the shade, but they produce a greater amount of fruit, as good in every way as that of the shade-grown plant. Delteil points out that pruning also has the advantage of keeping the plant free and light, thus avoiding the risk of accidents from high winds and hurricanes such as are common in the Mascarene and Polynesian Islands, where vanilla has been so long and extensively cultivated.

DISEASES

The most serious disease to which vanilla is subject appears to be one due to the attacks of a fungus described and figured by Massee in the *Kew Bulletin* (1892), p. 110, as *Calospora Vanillae*, Massee.

This disease seems to have been noticed first in the Seychelles in 1887, when it was found that hundreds of pods were damping off, and it was observed that the finest and plumpest pods went first. They turned black at the end or in the middle, and in the course of a day or two fell off.

The fungus which causes this is a minute species belonging to the group *Peronosporeae*, which attacks the leaves and stem of the plant. It appears as extremely minute, dull red or amber coloured pustules springing in small groups from discoloured patches. These were found on both surfaces of the leaf, but for the most part on the upper side. This form of the fungus is known as the *Hainsea* form. Its mycelium spreading through the leaf destroys the tissue and causes the death of the plant by destroying the organs on which the plant depends for its food and for the regulation of its water supply. In such a case the youngest parts, farthest from the food supply, namely the young fruit and the aerial roots, show the first symptoms of disease, the fruit turning black and falling off, as described.

When the leaf has become yellow and is dying from the attack of the fungus in this stage, a second form of the fungus appears in the form of yellow waxy masses, the *Cytospora* form, eventually presenting a blackened appearance, and finally a third form when the leaf is dead, the *Calospora* form. This form produces spores which enter the stomata of the leaves and develop into the mycelium of the *Hainsea* form.

The *Hainsea* form in the diseased leaves cannot reproduce itself, but from its mycelium, when the leaf is dead, are produced the *Calospora* spores, which can attack healthy leaves and cause the death of the plant. It therefore follows that if all dead and dying leaves of the vanilla are rigorously destroyed by burning, the disease may be checked or exterminated. The continuance of the disease depends entirely on the diseased dead leaves lying on the ground.

In the Seychelles it was observed by the first reporter of the disease that it was confined to a certain area of flat, damp land, insufficiently drained, and during his experiments Mr. Massee found that the presence of an excess of moisture in the leaf favoured the development of the fungus. Macfarlane, too, in describing a very similar disease, observed that it was worst in rainy weather and in dense shade.

Thus overcrowding and excessive dampness in the estate are things to be avoided.

This disease has been seen in Mauritius, the Seychelles, Réunion, Antigua, New Granada, and apparently the same fungus in Tahiti, where also a fungus known as *Colletotrichum Vanillae* has been met with attacking the foliage. *Calospora Vanillae* has also been seen attacking other orchids, viz. Oncidiums and Dendrobiums at Kew.

INSECT PESTS

These are comparatively few. The most destructive one recorded is a bug, *Trioza Litseae* (*Hemiptera, Psyllidae*) recorded from Réunion. It seems first to have attacked an introduced tree, *Litsea laurifolia*, and later attacked the vanilla. It attacked the buds and flowers of the plants, puncturing them and producing spots of decay. When it attacked the column no fruit was produced.

Another bug (*Heteroptera*), known as the emerald bug, *Nezara smaragdula*, a small grass-green insect occurring all over the world, lays its eggs on the leaves and stalks of the vanilla, and the insects when hatched suck the sap of the stalks and flower-buds. It is not as destructive as the previous insect.

A moth caterpillar, *Conchylia vanillana*, attacks the rudiment of the young fruit after fertilisation, and if it does not cause the fruit to dry up, it produces irregular marks on the pod which spoil this, or lower the value of the product.

The caterpillar is black with ash-grey spots, and hardly 7 to 8 millimetres long. It runs with remarkable rapidity. If the eggs are laid on the flower just after fertilisation has been effected, the pest can be destroyed. Another moth caterpillar, *Plusia aurifera*, common in Réunion, Madagascar, Africa, Saint Helena, Teneriffe, and even southern Europe, is troublesome in eating the buds of the plant. The caterpillar is pale green, about 3 centimetres long, with few hairs. The moth is reddish brown, with a broad band of gold across the upper wings; the lower wings are grey, the head and collar red, thorax and body grey.

The caterpillar of *Simplica inarcualis* is also reported as occasionally attacking vanilla.

A small lamellicorn beetle, *Hoplia retusa*, and an ashy-grey weevil, *Cratopus punctum*, bite holes in the flowers and often destroy the column. But the most destructive is a weevil (*Curculionidae*), *Perissoderes ruficollis*, which inhabits Madagascar. The grub burrows up the stems of the vine, completely destroying it, and all the parts attacked turn black and die. The grub pupates in its burrow in a cocoon of dried fibres of the stem. The branches affected should be at once cut off and destroyed.[1]

Large and small snails (*Achatina* and *Helix*) and a slug in Tahiti attack all parts of the plant, and a green dove in Tahiti eats the flower-buds. These, however, do not appear to be very destructive, and are easily dealt with.

FERTILISATION

In its native country of Mexico the flowers of the vanilla are naturally fertilised by small bees of the genus *Melipona*, and also by humming-birds. But, although there are plenty of bees in other parts of the world where the vanilla is cultivated, for some

[1] E. Bordage, *Revue des cultures coloniales* (1901), July, p. 50.

reason they do not visit the flowers, or if they do so, fail to fertilise them, and there seems to be scarcely a case recorded of natural fertilisation of the plant under cultivation. It is, therefore, necessary to fertilise the flowers of the plant by hand in order to procure fruit. This, though a matter of some delicacy and skill, is by no means a difficult operation, and can be easily carried out by natives with a little training.

HAND FERTILISATION

Vanilla planifolia flowers but once a year, usually from September to November, but often beginning as early as June and July. Occasionally it flowers in March, but this appears to be generally considered as an indication of an unhealthy state of the vine.

V. pompona, according to Macfarlane, gives in Tahiti two crops of flowers, with occasionally a few flowers at other seasons. The main season begins about the middle of July, and lasts till September. The second usually begins early in the year, in January, running through February into March. He suggests that both kinds of vanilla should be cultivated on the estate, as they flower at different times, and so the estate can be kept working most of the year with one or the other kind.

V. pompona is not as strong a grower as *V. planifolia*. Indeed, in the Singapore Botanic Gardens, where the two plants were grown on one tree, *planifolia* after a few years smothered the *pompona* and killed it out. Neither are the pods of *pompona* very highly valued, so that in most places it dropped out of cultivation. Still for the reason given above it might be successfully grown, and add to the profits of the estate.

A good strong vanilla plant in full vigour should produce as many as 200 bunches or racemes of flowers at a time. Each raceme carries from 15 to 20 flowers, or even more. Mr. Hart of Trinidad gives as many as 30 to 40 flowers to a raceme. Thus under good conditions a plant can give 4000 flowers.

In no case, however, should all or nearly all of the flowers be fertilised; opinions vary as to how many should be fertilised on each raceme, but it is generally agreed that some of the terminal flowers should be removed.

In some cases ten fruits may be allowed to ripen on each raceme; in the case of weaker plants two or three are quite enough. Macfarlane, in dealing with *Vanilla pompona*, would fertilise from 8 to 15 flowers on each raceme, and later removing the shorter beans, would reduce the number from 6 to 12, fertilising one-fifth more flowers than he intended to keep.

Vanilla planifolia should have fewer developing fruits kept than *V. pompona.*

If the price is highest for the longest fruits, as indeed it usually is, it is recommended to reduce the number of flowers to be fertilised to fewer, and so get a smaller number of large first-class fruits in preference to a larger number of smaller ones.

In order to prevent the plants from being soon worn out by over-production, Delteil recommends that the plantation should be divided into four equal portions, and that only one of these should be fertilised each year. Thus at the end of four years from the time that the plants commence to flower the whole vanillery will have undergone fertilisation once only and, thanks to this prudent method, the plants which have had a rest of three years between each crop will last a very long time and will not be worn out in a few years. Thus the planter, though he gets a smaller return at first, will be certain of seeing his crops constant for many years without the necessity of replanting.

The flowers remain open for one day only, so that if there is a heavy bloom on the plants extra labour will be required during the flowering season. Women and children are generally employed for the work of fertilising the flowers, as they are quicker and more skilful with their fingers than men.

The flowers open one by one on the raceme each day, but occasionally two or three are open at once in the same raceme. The best time for fertilisation is from eight o'clock in the morning till one or two o'clock in the afternoon. The flowers take badly when the fertilisation is done during rain or in a prolonged drought, but when there has been rain on the previous day fertilisation succeeds very well.

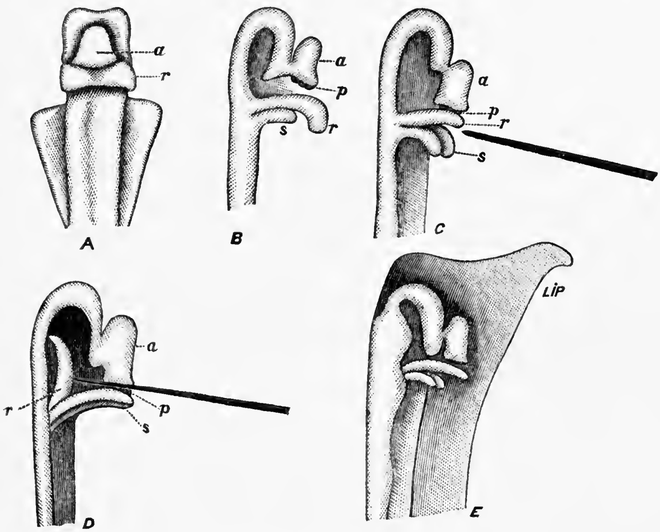
The number of flowers which can be properly fertilised by one individual in a day's work has been variously stated. Macfarlane says that a quick worker with the vines close together and full of bloom can fertilise 3000 a day, and from 1500 to 2000 is a good average number. Some writers say that 6000 can be done by a man in the day, but this seems absolutely impossible. The day's work commences at 7 A.M. and ends at 3 P.M., when the flowers begin to close, and are no longer fit for fertilising.

METHOD OF FERTILISING

The only instrument required for this operation is a small pointed stick of any kind of wood, or a splinter of bamboo, the size and shape of a toothpick, but by preference sharpened at both ends so as to save time in use, as it does not then matter which end is employed. A good number are made and carried in the brim of the hat, or in the coat, so that if one is dropped no time need be wasted in looking for it. With this instrument the operator must transfer the pollen masses to the stigma of the flower. The flower is held in the left hand and the lip pressed down so as to expose the column, which is held between the finger and thumb. The anther cap and the rostellum which covers the stigma are lifted or pushed up with the stick, the upper part of the column being so held that by the pressure of the thumb and finger the anther cup rises, exposing the pollen covered by it. Now the pollen-masses are removed by the point of the stick, to which they will adhere, and placed in the stigma below the rostellum (see page 50).

The stigma, being very sticky, retains the pollen and withdraws it from the stick; the rostellum then released flies back to its original position and helps to press the pollen into the stigma.

Another method sometimes used is to employ a thin flat stick and to press the rostellum upwards beneath the anther cup, pressing this with the thumb so as



VANILLA FERTILISATION.

A. Column from in front.
B. Side view.
C. Side view showing position of fertilising stick.
D. Rostellum pushed up and pollen touching stigma.
E. Side view of column showing attachment to lip.
a. Anther.
p. Pollen.
r. Rostellum.
s. Stigma.

to slide it over the rostellum, and force the pollen into the stigma. This method, however, is not so satisfactory as the first one. It is rougher and perhaps easier to effect, but there is a certain amount of uncertainty as to whether the pollen has quite reached the stigma and is well inside.

By both these methods the pollen of a flower is used to fertilise its own stigma. It is probable that better results would be obtained by transferring the pollen of one flower to the stigma of another. This is the natural method of fertilisation, but it takes a little longer time, and there is certainly a risk of dropping the pollen or having it accidentally brushed off during the transfer, but it would probably produce larger and finer fruits.

The operation is by no means so difficult as from the above account it might appear to be. With a very little practice it is easily and satisfactorily performed, and I have found no difficulty in teaching natives to perform it successfully.

The planter should, however, examine the flowers while the workmen are operating so as to make sure that the pollen is being properly put into the stigma. After successful fertilisation the flower quickly commences to wither, and soon the petals and sepals fall off, but the column remains attached to the top of the ovary, which is below the petals, and so remains till the fruit is nearly ripe. If the operation has failed and the flower is not fertilised, the column falls off with the petals. Macfarlane says that though flowers fertilised after three o'clock (that is to say, when they have begun to wither) will take, the column is apt to fall off earlier than it should, and if so the fruit will be shorter and consequently of less value. In heavy rain the pollen masses become soft, and though the fruits may develop they are not so large or fine, and the column soon drops off.

This is quite intelligible, for when the pollen enters the stigma it puts out the pollen tubes, which, following down the centre of the column, enter the ovules in the ovary, and it is not till this has happened that the fruit is fertilised, so that if the flower has begun to fade or much of the pollen is spoilt by the rain, only a few of the ovules may be fertilised, and this imperfect fertilisation would undoubtedly produce imperfectly developed fruits. The ideal fertilisation would be the natural one of fertilising one flower by another, as is always done in nature, and the injury caused by imperfect fertilisation, as above described, certainly suggests that cross-fertilisation would give a higher standard of fruit.

The period during which fertilisation can be carried on and the number of flowers which can be fertilised during the period are shown by the returns of the number of flowers fertilised in a vanillery at Mayotte, in 1895.

From June 1 to 20 . . .	5·280
„ June 21 to July 20 . . .	8·820
„ July 21 to Aug. 20 . . .	233·150
„ Aug. 21 to Sept. 20 . . .	1·209·640
„ Sept. 21 to Oct. 20 . . .	524·340
Total . .	1·981·230

Thus in this region August to September gives the highest return of flowering (Wildeman).

The importance of the suitability of the weather during the flowering and fruiting season is shown by the returns given by Dr. Galbraith from a plantation in the Seychelles.

1893.	(Flowering season in 1892, a long dry spell) .	1800 lb.
1894.	(Continuous rains)	120 „
1895.	(Result of previous year's rain) . . .	40 „
1896.	(Early rains after fine weather) . . .	500 „
1897.	(Early rains after fine weather) . . .	600 „

FRUITING

After fertilisation the ovary commences to grow and in about a month has attained nearly the size of a ripe fruit. It takes, however, about four months to become fully ripe. Macfarlane gives nine as the period required for ripening. Delteil says six to seven in Bourbon, or in Cochin-China three to four. In the Straits Settlements I find it takes about four. Delteil considers this quicker ripening unsatisfactory, the fruits being smaller and less powerfully scented. Probably much depends on the weather at the time. I found in Singapore that heavy storms of rain seriously affected the ripening of the fruit, often causing them to fall unripe, and the ripening season, January and February, is unfortunately usually the wettest time of the year in this region.

The fruit is at first dark green and smooth, but when it is ripe it becomes yellowish. In *Vanilla pompona*, which is not liable to split, the pod is left until it becomes quite distinctly yellow, or even until the lower end becomes brownish.

The pods of *Vanilla planifolia* have a tendency to split in ripening, which, should it occur, reduces their value as a commercial product. The pod cannot for this reason be left to hang long on the plant, and is gathered when it begins to turn yellow in the lower part, or even when the line along the side becomes yellow. Care must be taken, however, not to cut them too soon.

During the ripening attention must be paid to the position of the pods, to see that they hang straight down and are not curved or bent. As the flowers appear one by one on the raceme, the fruits will also ripen one by one, so that those at the upper end of the hanging bunch will be ripe long before those at the lower end are ripe.

A fully ripe pod of *V. planifolia* is a cylindric, fleshy capsule about 5 or 6 in. long and $\frac{1}{4}$ in. thick. That of *V. pompona* is shorter and thicker.

It is quite scentless, not developing its pleasant scent till the fermentation produced in curing takes place. During this process it passes from a yellow colour to a dark chocolate brown tint, and as it dries has a tendency to split more or less completely into two valves, one of which is larger than the other, and is grooved down the centre.

The seeds are very numerous, minute, and black. They are surrounded by a dark-coloured oil known as balsam of vanilla. Those of the cultivated plants (which it will be remembered are self-fertilised) are usually sterile.

Formerly many attempts were made to raise the plant from seed in Bourbon and elsewhere, but without success. Orchids are usually troublesome to raise from seed, but probably the self-fertilisation of the flowers in the cultivated plants was the cause of the failure.

As stated above, however, M. Dupont in 1902 was successful in raising plants from seed.

CURING

The drying and curing of the pods after gathering is the most important part of the work of the planter, and requires the greatest attention and care, for the value of the product depends more on this process than on any other part of the cultivation.

It must be remembered that at first, when the pod is ripe, it has not the characteristic odour of vanilla, which is developed during a process of fermentation which takes place while the fruit is drying.

The pod, while green, consists of an acid pulp containing raphides and crystals of oxalate of lime; and there is also a citron-coloured oil surrounding the minute seeds. This oil possesses an odour somewhat resembling that produced by the fully-ripened pod. If left on the plant, the pod begins to turn yellow at the lower end and gives off an odour of bitter almonds. The pod begins to split into two unequal valves, and a small quantity of a dark balsamic oil, of a brown or red colour, is produced. Gradually the pod darkens in colour from brown to black. The epidermis softens and the real vanilla odour develops. The oil, which is called "Balsam of vanilla," then increases in quantity. This balsam is carefully collected by the planters in Peru and other parts of South America, but not sent to Europe. The pods, ripening slowly upwards from the tip, take about a month to fully ripen. Eventually, if left, the pods become dry and black and brittle, and are then scentless.

The artificial methods in use for curing the vanilla, by the aid of hot water, or sun heat, or stove heat, are intended to hasten the maturity, to produce a uniform ripening of the pod throughout its entire length all at once, and to prevent splitting of the pod and consequently loss of the perfume.

There are a number of methods in use for artificially curing vanilla, adapted for various climates and conditions of weather prevailing at the time of ripening. The best known of these are given in detail.

1. *The Guiana Process.*—The pods are put in ashes and left there till they begin to shrivel. They are then taken out and wiped, rubbed over with olive oil, and the lower end tied to prevent them from splitting, after which they are left to dry in the open air.

2. *The Peruvian Process.*—The pods are dipped in boiling water, tied at the end and hung in the open air. After drying for twenty days they are lightly smeared with castor oil, and a few days after are tied in bundles.

3. *The Mexican Process.*—As soon as the pods are gathered they are piled into heaps in a shed to protect them from sun and rain, and in a few days, when they begin to shrivel, are submitted to the sweating process.

This is carried out in two different ways, according to the weather at the time. If it is warm and fine, the pods are spread out in the early morning on a woollen blanket, and exposed to the rays of the sun. About mid-day, or one o'clock in the afternoon, the blanket is folded over the pods, and the bundle left in the sun for the remainder of the day. In the evening all the vanilla is enclosed in air-tight boxes, so that it may sweat the whole night. The next day they are again exposed to the direct action of the sun. They then become dark coffee-coloured, the shade being deeper according to the success of the sweating operation.

If the weather is cloudy the vanilla is made into bundles, and a number of these are packed together in a small bale, which is first wrapped in a woollen cloth, then in a coating of banana leaves, and finally the whole is enclosed in a thick matting and sprinkled with water. The bales containing the largest beans are now placed in an oven heated to 140° Fahr. When the temperature has fallen to 113° Fahr. the smaller beans are introduced, and the oven closed tightly. Twenty-four hours afterwards the smaller beans are taken out, and twelve hours later the larger ones. During this process the vanilla has sweated and acquired a fine chestnut colour. Now they have to be dried.

The pods are spread on matting and exposed every day to the sun for nearly two months. When the drying is nearly complete, sun heat is no longer required, and the pods are spread out in a dry place till they are sufficiently dry. They are then tied in bundles for market.

This process has been employed successfully at Réunion for some years, says Delteil. It requires some judgment and skill in the baking process, as vanilla from dry places should have a higher temperature in the oven than those from wet localities. The time that the pods must be left in the oven also depends on the number of bundles and the size of the pods.

4. *The Boiling Water Process.*—This has given good results in Réunion. Large iron cauldrons full of water are put on the fire, and as soon as the water is nearly boiling, at about 194° Fahr., the pods are lowered into it in cylindrical baskets of rattan. Sometimes they are dipped only once for fifteen to twenty seconds, at other times they are dipped and taken out again two or three times, remaining three or four seconds in the hot water each time. After this the baskets are emptied on tables covered with black cloth, or on mats to drain. When all the pods have been scalded they are piled together, covered up and put in an oven for a quarter of an hour. They are then spread on tables covered with blankets, and exposed to the sun until two or three o'clock, and afterwards rolled up in the blankets and transferred to a shut-up room, where they will keep warm till the next day, or they can be put in cases lined with wool, where they can retain their heat longer. This is continued for four, six, or eight days, according to the weather. During the process the pods are examined from time to time, and those that have reached the stage at which further heat would hurt them are taken out.

This stage is recognised by the pod becoming flexible and the skin of a uniform deep chocolate brown, and marked with longitudinal furrows.

Over-exposure to the sun makes them dry, of a reddish colour, and less aromatic.

They are now removed to a drying-house, usually roofed with zinc, with windows opened during the middle of the day. Here they are arranged on tables, preferably of rattan or perforated, so that a free current of air may circulate round them. The pods remain for about a month or a little more, during which time they require to be frequently turned, so that they dry evenly. Those that are sufficiently dry are removed for packing. They should be black and sufficiently supple to be twisted easily round the finger without cracking. Before sorting, however, the pods are smoothed by passing through the fingers repeatedly, for the pods exude an oil during fermentation, which gives them their suppleness and lustre.

5. *Potier's Process*, invented by J. Potier.—The pods are plunged in rum for twenty to thirty days, then exposed to the air for thirty-six to forty-eight hours without completely drying. Then they are replaced in the rum, and so shipped. The inventor claims that the process is simple, and that the rum can be used as a flavouring agent as well as the pods. This process is not recommended; for one thing, it is too expensive.

DRYING BY CALCIUM CHLORIDE

This method was described in a Report of the British Consul in Réunion in 1897, and the description was republished in the *Kew Bulletin* for 1898, p. 43. The process of drying is as follows: the pods are put in tin cases (old petroleum oil tins were used), which are fitted with lids closing on the outside of the case and lined with wool. The pods are placed on end, close enough to secure pressure without damage by rubbing. A horizontal layer was put over this, the woollen cover folded over all, and the lid put on. The boxes are put into halves of wine-barrels, which are filled with water up to the lids of the boxes, care being taken that no water gets into the boxes. The barrel is then covered with a piece of sacking and left for the night. Next morning the pods are taken out and exposed to the air to dry, and then for two or three days kept under woollen coverings in full sunlight.

Now the pods are ready for the drying process, which is effected by the use of closed boxes of galvanised iron containing chloride of calcium. The boxes are 1 metre square, with a hinged door, closing on an india-rubber edging to ensure air-tightness. Each box has eleven trays. In the sixth tray and on the bottom of the box are placed 18 kilos of calcium chloride. The rest of the trays contain 45 kilos of vanilla. The trays should not be made of resinous or strong-smelling wood, as vanilla absorbs and retains odours it meets with. The bottom of the tray is made of split rattan in the form of a hurdle. Several layers of vanilla are placed in each tray. The calcium chloride is put in double-bottomed vessels, the inner one perforated to allow the escape of the liquid calcium chloride. Whenever the boxes are opened the chloride is examined and replaced or added to, as may be required. The doors are hermetically closed.

The vanilla is examined every two or three days, and damp pods removed and put aside to be sunned. In twenty-five or thirty days the pods will be sufficiently dry.

After being taken out of the box the vanilla is put on frames in a covered, well ventilated place for several days, and then transferred to tin boxes, each containing 15 to 20 kilos. There it remains for several weeks, being examined every few days, and any pods showing mildew are carefully wiped.

When it is thought that it has reached perfection and the perfume is well developed, it undergoes a treatment to remove any dust and spores of mildew upon it.

Into a perfectly clean receptacle is put 25 to 30 litres of water at about 140° Fahr., and 15 to 20 kilos of vanilla are thrown in and vigorously stirred up by hand. The pods are then taken out, lightly wiped, and put to dry in the shade.

It is claimed for this process that it saves much of the perfume lost in the open air or stove treatment, and saves a good deal of hand labour.

Macfarlane's Process. — Macfarlane adopts a different process for *Vanilla pompona* from that used for the pods of *V. planifolia*, for the process used for the first named cannot be applied to the latter without the loss by splitting of many of the pods.

Vanilla Pompona.—The pods when gathered are taken to the house and spread out where the sun cannot strike them, 6 or 8 in. deep, upon shelves or on the floor until they turn brown. This takes from one to three weeks, according to the ripeness of the pods when picked. Pods gathered too soon sometimes lie for six weeks before turning brown. Thoroughly ripe pods begin to turn brown at the tip, the immature ones at the stem end or in the middle. When they are of a uniform deep red brown colour they can be exposed to the sun.

For this purpose wooden trays are used 3 ft. by 6 ft., and 2 in. deep. The pods are spread on the trays about $1\frac{1}{2}$ in. deep.

For the first two or three days it is immaterial whether the pods are covered with blankets or not. They must be turned over two or three times a day, so that all are equally exposed to the sun. This is of the utmost importance throughout the whole process of curing, for if neglected some of the pods are sure to be burnt red by the sun.

About 3 P.M., or whenever rain threatens, while the pods are still hot, the trays are removed to the house, stacked one upon another, and covered with blankets, so as to keep warm through the night.

After the third or fourth day the pods are removed from the trays and packed while hot into tins, old 40-lb. biscuit-tins being used. They remain in the tins for two days, and are then spread out in the trays again, but after the first sweating in the tins, must always be covered with blankets when exposed to the sun heat. During the sweating in the tins the pods exude much water.

From this time onwards the processes are alternated, one day in the sun, one or two in the tins, till they are nearly dry. When they have begun to shrivel and become soft and pliant they can be left for a couple of weeks at a time in the tins, so long as they are air-tight or nearly so.

The best pods take the longest time to dry, and the dry ones must be taken out each day before the exposure to the sun. When they are nearly dry they should never be exposed more than half a day at a time, and should be turned over at least twice, to prevent their being sun-burnt. They must never be spread singly in the trays, or the stalk end will burn.

Another plan is to remove the pods when they have lost about half their weight, and are distinctly wrinkled, to frames covered with wire-cloth or thin sacking. These frames are put in a well-ventilated drying-house, and the pods are dried there. This plan is safer, but requires more house room.

COST AND PROFIT

Mr. Howard Newport, in the *Queensland Agricultural Journal* (May 1910), p. 239, gives an estimate for opening up a 5-acre plantation of vanilla in Queensland. He says it should not cost more than £200, made up as follows :—

Land at £4 per acre	£20	0	0
Fencing, 30 chains at 6s. a chain	9	0	0
Brushing (*i.e.* clearing away scrub), 12s. an acre	3	0	0
Carry forward	£32	0	0

Brought forward . .	£32 0 0
Plants, say	20 0 0
Planting at 20s. an acre	5 0 0
Tending till bearing for two years, including supports, etc.	108 0 0
Drying-house trays, sundries . . .	35 0 0
Total . .	£200 0 0

This, however, he points out does not necessarily represent the capital necessary, especially in a case of a settler opening up a vanilla plantation as an auxiliary crop on his already running farm. In this case, allowing that he himself tended the plants till bearing, the outlay would be confined to brushing the scrub, cost of plants, and planting.

The estimate is high on account of the higher cost of white labour than black, and on account of the high price of vanilla plants in Queensland at the time. If there were a demand among planters for stock, a Government Botanic Gardens should be able to supply them at two or three pence a piece. In another part of the tropics, where labour is much cheaper, the cost could be very materially reduced.

He gives the profit as follows: "Scrub brushed so as to leave 250 trees to the acre, and two vines to each tree, and producing on an average twenty-five to thirty pods per vine, which in turn on curing, average, say, 125 to the lb., would give a return of 100 to 125 lb. of marketable vanilla to the acre, which at an average of 10s. a lb. represents £50 to £60 an acre. These figures, shown to be readily attainable by the experimental plot at Kamerunga, might possibly be exceeded by devoting more detailed attention to the plantation."

The profit per acre is given in the Seychelles at £250, and in Tahiti at £120 or so.

Of course, where support-trees have to be planted or trellises made and kept up, these expenses would have to be reckoned, and there are the costs of preparing, packing, and shipping to be added; still with all these there remains a very substantial profit even under white labour in Australia, and still more under native labour.

MOULDINESS IN VANILLA PODS

The vanilla pods are much subject to injury from attacks of mildew, which has the effect of reducing their value, for they take on an odour of mouldiness which is nearly impossible to eradicate. The importers of vanilla remove the mildew by rubbing the pods gently with the cloth, and prevent to a certain extent the reappearance of the mildew with formaldehyde, but nothing can get rid of the mouldy odour of the pods.

In the matter of mouldiness the pods vary, and in the *Journal d'agriculture tropicale* (August 1905), p. 227, M. Henry Lecomte gives an account of observations and experiments which he has made on this subject. Taking a fruit of Mexican vanilla with the patch of mould on it near the stalk, he found, after keeping it in a glass tube for three months, the patch of mildew hardly increased in size, and by putting a number of partly mouldy fruits of Seychelles vanilla together in a tube he found that the mouldy portions did not infect the healthy parts of the pods, though they were in actual contact. Hence he argues that the only vanillas attacked by mildew are those which have some defect in the preparation, and that under ordinary conditions vanilla appears to resist mouldiness. The mouldiness constantly develops at the base of the capsule near the stalk, which is the part which contains the least vanillin. He suggests that too early a cessation of the drying process may predispose the vanilla to mouldiness. The last phase of preparation, the desiccation of the fruits on platforms, has no fixed period, depending as it does on climatic conditions. There is nothing to show the preparer when they are dry enough, or when they require further drying. This being so, one would expect the commercial vanillas to show great variations in dryness: M. Lecomte obtained, therefore, seventeen samples of commercial vanillas and tested them to find the proportion of water in them. This varied from 32 per cent in a Mexican sample to 49·5 per cent in a Seychelles sample (which was mouldy).

The table he gives shows that if the vanillas containing a large percentage of water are not always mouldy, due perhaps to their freedom from infection (*i.e.* the absence of mildew on the drying stages), those that were found to be mouldy were among the wettest fruits.

The proportion of water in a fruit is excessive when it contains over 35 or 36 per cent of moisture, by weight. The proportions of water in the mouldy fruits were as follows:—

Seychelles—49·5, 36·6, 36·4, 47·6.
Comoro—39·0, 39·3.

The importers of vanilla have noticed that the vanillas of Mexico are less liable to mildew than those from the Mascarene Islands. In the latter region, instead of exposing the fresh pods to the full sun first, the planters plunge them at once into hot water at 80° to 85° C., or some expose them to steam for a considerable time. This destroys the waxy coat of the fruits more or less, according to the length of time they are exposed to the water and also to the temperature of the water. The vanillas of the Mascarene Islands are therefore not as bright in appearance as those of Mexico. The absence or rarity of crystallisation (*givre*) in the Mexican vanilla is probably due to this, for in the Mascarene Islands vanilla crystallises readily, and it seems certain that the waxy coat of the fruit prevents the exudation and consequent crystallisation of the vanillin.

M. Lecomte put the dried vanillas in a stove with wet air and found that there was a considerable difference in the amount of water taken up by the different kinds. The Tahiti vanillas took up 49·9 per cent of water; Javanese 10·1 per cent; the Mascarene Islands 5·2 to 5·6 per cent. The excess of water taken up by the first two he attributes to the almost complete absence of the waxy coat. If the deductions of M. Lecomte are correct, it is clear that it is advisable to dry the vanillas, partly, at least, in the sun before submitting them to the action of steam or boiling water, and in any case to be careful to keep the platforms on which the vanillas are put out to dry clean of mildew or of anything which may encourage the growth of mildew.

SORTING AND PACKING

It is recommended to keep the vanilla for a month at least before packing it for export, to make sure of its being sufficiently dry.

The pods are first sorted into classes for packing. In Mexico five classes of vanilla are known. The best is *primera*, the pods of which are 24 cm. long and proportionally thick; the second are called *chica prima*, the pods being shorter and two counting as one; the third is *sacate*; the fourth, *vesacate*, are still smaller, and are gathered before they are ripe; the fifth quality is *basura*, with small, spotted, and much broken pods. Usually, however, the pods are first sorted into qualities and then according to length. The first-class pods are oily, strongly perfumed, black, and without defects. The second class contains the over-dried pods, reddish in colour, with a rough outside. In the third class are put those that have split. The pods of *Vanilla pompona*, known as vanillons, would of course not be mixed with the other kind, but kept and packed separately. There is only one class for these.

When the pods have been sorted out into the classes above-mentioned, they must be measured and sorted according to length.

For this a measuring board or table is used. A most convenient form consists of a piece $\frac{1}{4}$ or $\frac{1}{2}$ in. broad, 3 in. wide and 14 in. long. A strip of wood is nailed at one end, and a scale of $\frac{1}{4}$ in. interval from 4 to 11 in. is marked from the strip of wood, as even when cut with the chisel the marks are soon obliterated by the oil of the vanilla. Macfarlane recommends making a scale on a piece of paper pasted on a 2-in. strip of glass, so that the scale can be seen through the glass, and embedding it in putty in a hollow of the board, so that the surface of the glass may be level with the surface of the board. Placing the end with the strip of wood next him, the operator takes the pods, and putting the flower end next to the strip reads the length of the pod, and thus sorts them by their length into piles, or into compartments of a box.

When sorted into lengths, the pods are made up into bundles, and the following method is the one most commonly used.

Each packet contains fifty pods. First, sixteen of the finest are put aside for the outside of the packet. Then eight of the straightest are taken to form the centre, the others ranged around these so as to fit nicely together, and the sixteen finest put one by one outside. They are tied up with a band of raphia-bast, which goes twice round the bundle, a little below the centre of the packet. The ends of the pods are pushed in so that all are level and the bundle can stand on its end, and a band of bast is tied round each end.

Where bast is not easily obtainable, ordinary cotton twine can be used for tying.

The bundles are then packed into tin boxes containing 85 lb. of vanilla each.

Delteil says that no packing of paper or any other material should be used to wrap the bundles. Macfarlane, however, recommends the use of paraffin paper, each bundle being wrapped separately.

The advantage of this is that in case there is a bad bean or two in a bundle that goes mouldy, this mould will not spread to the other packets.

The tins are now soldered up and put in wooden cases holding three boxes apiece, and are ready for shipment.

WEIGHT OF PODS

A fair crop of vanilla should weigh out at about 100 cured pods to the pound. Galbraith gives the weights as follows :—

9-in. pods	66 to the pound	7-in. pods	110 to the pound
8-in. pods	80 ,, ,,	6-in. pods	160 ,, ,,

VANILLISM

This is the name given to an ailment caused to persons employed in handling vanilla. It takes the form of headache, gastric trouble, and urtication, or a kind of rash. The latter is perhaps caused by the crystals of oxalate of lime, which are so abundant all through the plant. The juice of the leaves and stalks of some species at least is very irritating to the skin, and the leaf of the cultivated vanilla is used as a blistering agent in Réunion. That of the wild species of the Malay Peninsula, which produces a considerable amount of irritation on the softer part of the skin, is used by the Malays as a stimulant to the growth of the hair.

DISTRIBUTION OF CULTIVATION

In America.—Mexico, the original home of the plant, still produces a large quantity of the spice, both from wild and from cultivated plants. The headquarters of the cultivation is in the state of Vera Cruz. The greater part of the produce is sent to the United States.

The amount exported for the years from 1883 to 1893 are given as follows :—

1883–1884	53,532 kilos	1888–1889	73,144 kilos
1884–1885	52,165 ,,	1889–1890	72,099 ,,
1885–1886	43,878 ,,	1890–1891	49,982 ,,
1886–1887	43,575 ,,	1891–1892	98,440 ,,
1887–1888	28,064 ,,	1892–1893	92,577 ,,

French Guiana.—Vanilla is hardly cultivated here, but there is a good deal of wild vanilla, and in 1898 1500 kilos of pods were exported.

Dutch Guiana.—The cultivation has not been very successful, though *Vanilla planifolia* occurs wild.

West Indies—Trinidad.—It has been experimented with satisfactorily, pods grown in the Botanic Gardens being valued at 10s. to 11s. a pound in 1896.

Martinique. — Vanilla was cultivated as early as 1839. However, it has never been grown on an extensive scale, and the cultivation appears to have been dying out. In 1899, 973 kilos were exported; in 1900, 273 only.

Guadeloupe.—In this island a good deal of cultivation has been carried on both of *Vanilla planifolia* and *V. pompona.*

The exports for some years are recorded as follows :—

1879 . . .	3566 kilos.	1882 . . .	6166 kilos.
1880 . . .	5102 „	1883 . . .	5506 „
1881 . . .	9846 „		

In 1892 the export had immensely increased, 22,733 kilos being obtained; in 1889 it fell to 5935, and rose again in 1900 to 24,276 kilos, valued at 216,910 francs.

This was distributed between France, the French colonies, and the United States.

In 1901, 2591 kilos, valued at 43,676 francs, were exported.

Jamaica.—Vanilla is grown to a small extent by a few small farmers. The plant is said to grow naturally in a western part of the island, climbing over rocks and trees.

Africa — Mascarene Islands, Mauritius. — The extensive cultivation in this island has been already described. It is mainly in the hands of small cultivators. It is estimated that there are 3000 vanilla planters in the island.

The following are the records of export :—

1865 . .	2,285 kilos.	1894 . .	4000 kilos.
1874 . .	6,107 „	1895 . .	3000 „
1888–1889 .	24,876 „	1896 . .	6000 „
1892 . .	7,000 „	1899 . .	3700 „
1893 . .	3,500 „	1904–1905 .	2000 „

The yearly production varies between 3000 and 4000 kilos, of which nearly all goes to London.

Réunion.—The history of the introduction into this island has been previously mentioned. It was first brought in 1793, and again introduced on two later occasions. Its cultivation began to increase largely in 1874, especially in the northern part of the island, which seemed to give the best results.

At present there are 4000 hectares under cultivation. The product takes the highest price in value of any in the world except that of Mexico, and with care might perhaps equal or eclipse that.

The exportations are given as follows :—

1879–1880 . .	44,689 kilos	1888–1889 . .	52,217 kilos
1880–1881 . .	23,031 „	1889–1890 . .	48,049 „
1881–1882 . .	27,764 „	1890–1891 . .	85,847 „
1882–1883 . .	21,095 „	1891–1892 . .	90,722 „
1883–1884 . .	28,049 „	1892–1893 . .	94,282 „
1884–1885 . .	48,648 „	1893–1894 . .	82,943 „
1885–1886 . .	57,073 „	1894–1895 . .	82,000 „
1886–1887 . .	18,549 „	1895–1896 . .	60,000 „
1887–1888 . .	89,067 „	1896–1897 . .	65,000 „

In 1904–1905, 75,000 kilos were exported. As will be seen, this ranks only second to Mexico in bulk of export.

Madagascar.—An account of the cultivation of vanilla at Nossibé, in Madagascar, is given by M. Paul des Grottes in the *Journal d'agriculture tropicale*, which contains many suggestive notes and ideas. The vanilla of Nossibé was, he says, considered by M. Simon, the great vanilla merchant in Paris, to be in the near future of the same rank as that of Bourbon, which is considered the best next to that of Mexico, the finest in the world. The Nossibé cultivations were made under the shade of woods, the shade tree used being *Albizzia lebbek.* The support, *Jatropha curcas*, is a comparatively small tree, but of fairly rapid growth, and occurs in most parts of the tropics. But some planters having remarked that the pods produced at the edge of the woods on vines fully exposed to the sun, were longer and more aromatically scented than those from the shady spots, and having remarked also that the *Albizzia* and the *Jatropha* shed all their leaves in the dry season, that is to say, just at the time when the vine most required shade, conceived the idea of planting in full sun. M. des Grottes saw a plantation of this type at Androdoat, where there was a fine vanillery in full sun, and affirms that the result was most successful; the vines were full of strength though yellow from the sun's action, which is quite natural. But this single experience cannot be taken as a proof that the system can always be used with success. No absolute rules can be laid down in the cultivation of vanilla. All depends on the actual situation, and methods vary from one country to another and even on different estates.

The cultivation of vanilla in full sun is subject to certain essential conditions. In the first place, the soil must be perfectly suited for this method of cultivation, and then the cuttings selected by the planter must not be taken from vines growing in too dark shade, which would expose them to a certain check, and thirdly, the mulching of the ground with straw must be perfect. It is essential that the straw or grass used for shading the soil must be completely dry. M. Mersaime urges the attention to several little points of importance in this method of cultivation. He advises that the cuttings should not be planted at the foot of the supports, but at a distance of 30 to 40 cm., and should be led up to the support after the manner of a hammock; again, he warns against twisting the vines round the supports so that the backs of the leaves are exposed to the sun. Vanilla does not naturally expose the backs of its leaves to the sunlight, and if in twisting the climber round its supports the backs of the leaves are exposed to the sun, they gradually twist themselves round so as to regain their correct position.

In regard to the question as to what shade trees are best for vanilla, M. Mersaime condemns the banana for several reasons. In the first place, he says, it is insecurely attached to the ground, and is uprooted by the least puff of wind and in falling will crush the vines. In Bourbon as well as the Antilles, people talk of a banana-wind (*coup de vent banane*), a wind strong enough to upset the bananas, but not strong enough to uproot ordinary trees. The violence of wind and its action in different parts of the world is extremely variable, but the author has seldom, if ever, seen banana plants uprooted by wind in the Malay region, even where big trees have been blown down.

A second objection raised is that thieves who are tempted by the bananas cut down the stems of the plants to get the fruits, thus crushing the vines; and thirdly, that the banana exhausts the soil of important elements of nutrition, such as potassium and lime, to the injury of the vanilla.

I doubt if, provided the planter restores to the soil the remains of the leaves and dead stems of the bananas, this loss of plant food will affect the vanilla to any extent. Bananas are often used as shade for other plants, and do not seem to injure the ground at all, but on the contrary rather improve it by breaking up the soil, and at the same time the planter has the benefit of the fruit. However, M. des Grottes observes that bananas can be used as temporary shade until the other shade trees are grown up, and admits having seen very fine vines grown under the shade of bananas.

Some recommend the *Moringa pterygosperma* (often known as the horse-radish tree) on account of its rapid growth from seed or cuttings, and its light, open, lattice-like foliage. This would be satisfactory in a country where the natives are not so fond of the foliage and bark as vegetables as they are all over the East, where the tree is very quickly despoiled. Papaya, again, suggested by some of the Nossibé planters, is objected to on the ground that it grows so luxuriantly in and about old walls and house rubbish, which suggests that it would deprive the soil too extensively of its lime.

A greater objection, to my mind, is its poverty of shade.

Most of the Nossibé planters voted in favour of *Albizzia lebbek* as a shade for vanilla. Its advantage over the rain tree, *Inga saman*, so much used formerly as a shade for coffee, seems to be that it is smaller and more easily cut out, if this is for any reason necessary. I should, however, class it as a slower grower, and it has a much smaller spread of foliage.

The use of the mango tree as a shade is condemned by the Nossibé planters, being injurious to the vanilla, as the shade is too thick and dense. Its slow growth, further, is against its use.

The cultivation of the vanilla in Madagascar is carried on under somewhat different circumstances to those in many other parts of the world, in that there is a long period of drought, so that even the *Jatropha curcas* sheds its leaves. M. Touchais ("Culture de la vanille à Mayotte," *Journal d'agriculture tropicale*, 1902, p. 38) objects to this plant as a shade tree on these grounds. He points out that the cultivation of vanilla on living supports is open to the objection that during the droughts the moisture of the soil is used up by the supports, to the detriment of the vanillas. If, however, shade trees are used, and the vines grown on trellises, the irrigation, manure, dew, and drops of fine rain are utilised by the vines, and they do not have to share these with the supports. There is a good deal to be said for this point of view. It should be pointed out that the system of cultivation adopted by the planter must be adapted to the climate and meteorological conditions in vanilla culture as in everything else. A system that works well in one country will perhaps be unsuitable in another, and here the planter will require powers of observation and careful thought. In the rain forest region of the tropics excessive humidity must be guarded against; in the regions of periodic droughts insufficient humidity is the point that should be looked at. Trees that shed their leaves in the dry season will expose the vanilla to the heat and droughts at their worst, and in this case an evergreen is what is required as a shade tree. In the equatorial districts of the rain forest region all the trees are evergreens, or if they do shed their leaves are bare only for a day or two. The choice of suitable shade trees is therefore much larger. Leguminous trees, such as *Inga saman*, possess one great advantage in that they close their leaves in the evening and in dull, wet weather, thereby allowing the plants beneath them to get the full value of dew and rain, while during the hotter part of the day the leaves are expanded and shade the plants so as to prevent excessive loss of water by transpiration and actual burning by the sun rays. At the same time the shade they give is not too dense.

Africa, Mainland.—The cultivation has been experimental, and though in many places it has been proved that the plant can be grown and can be depended upon to produce well, the culture has not been taken up or spread to any extent.

Zanzibar. — The plant was introduced comparatively few years ago, but seems to do well, and there is every probability of its proving successful if taken up. In 1901 there were 3000 vines in cultivation. In a recent Annual Report of the Director of Agriculture of Zanzibar, Mr. Lyne records that vines of four years of age gave 12·13 flowers to a plant, those of one year old ·13 flowers. He fertilised 14,826 flowers and obtained 13·571 lb. of pods, which when dry sold at from 6s. to 12s. a pound.

French Congo.—The plant was introduced by Audry Lecomte in 1852, but his plants all died. It was reintroduced by Father Klaine in 1873. He brought a single plant from Paris to Libreville and from it established a small plantation. In 1904, 47 kilos of pods valued at 27 francs the kilo were exported, and in 1906 this was increased to 263 kilos. There is, however, only the one plantation, the natives not having as yet taken up the cultivation.

Congo Independent State.—Vanilla has been in cultivation ever since 1894, in a few places. No returns of export have been recorded.

The plant has also been introduced into the Cameroons, San Thomé, Sierra Leone, Lagos, and German East Africa. In Bagamoyo, in the last mentioned district, it was exported by the missionaries, who grew it with some success, and its cultivation seemed very promising, but the plantations have not increased, and in the other localities it is also stationary.

Seychelles.—In this group of islands vanilla was for many years the main production, but lately the cultivation has fallen off very considerably. The cause of this has been attributed to a severe drought in 1904, which destroyed half of the vines and injured the vitality of the rest. The low price, due to a certain extent to the artificial vanilla, contributed to the diminution of the cultivation.

The chief islands in which it was produced are Mahé, Praslin, La Digue, and St. Anne.

The exports for the past years have been recorded as follows:—

1891 . . .	40,929	kilos valued at	3,73,190	rupees
1892 . . .	28,177	,,	3,94,478	,,
1893 . . .	28,689	,,	3,46,426	,,
1894 . . .	24,444	,,	2,93,328	,,
1895 . . .	4,553	,,	60,344	,,
1896 . . .	31,229	,,	9,36,000	,,
1897 . . .	30,691	,,	9,20,730	,,
1898 . . .	25,177	,,	7,48,810	,,
1899 . . .	41,835	,,	13,38,720	,,
1900 . . .	17,569	,,	5,80,877	,,
1901 . . .	71,899	,,	11,08,792	,,
1902 . . .	59,816	,,	6,41,610	,,
1903 . . .	59,744	,,	5,03,592	,,
1904 . . .	38,772	,,	2,79,040	,,
1905 . . .	40,265	,,	2,41,590	,,
1906 . . .	30,000	,,		

It will be noticed that the export of this spice varies very much in quantity, as also in price, which is doubtless due to the variations in climate in the Seychelles, and the occasional occurrence of serious droughts.

The greater part of the crop is exported to France, but a considerable proportion goes to England.

The Colonial Office Report for 1905 gives the following table of exports to different countries, in values:—

	1904.	1905.
Great Britain . .	1,30,593 rupees	1,37,185 rupees
France . . .	1,48,466 „	1,36,462 „
Mauritius . . .	3,987 „	64 „
Switzerland . .	8,400 „	8,400 „
Germany . . .	...	764 „
	1902.	**1903.**
Great Britain . .	3,56,616 rupees	3,22,656 rupees
France . . .	3,84,994 „	1,80,936 „

Comoro Islands.—The cultivation started in 1893, and by 1903 there were more than 70,000 vines in cultivation, giving a yield of 90,000 lb. of pods. The vine here grows up to an altitude of 2500 ft. In Great Comoro 45,000 vines gave, in 1901, 1060 kilos of pods.

In Moheli 700,000 vines gave, in 1901, 3000 kilos of vanilla, which is described as being of a specially fine flavour, and of unusual size.

Anjouan Island possesses 1,200,000 vanilla plants, which gave, in 1901, 16, and in 1902, 18 tons of pods.

Mayotte possessed, in 1901, 500,000 vines, giving 13,000 kilos of pods, valued at 40,000 francs.

Asia.—The cultivation of vanilla has never been large anywhere in Asia, although the plant has been long introduced to most of the gardens and botanic stations of the continent and islands. I can find no records of any attempt to grow it commercially in India, Siam, Cochin-China, or China.

In Ceylon, Mr. W. H. Wright seems to have been the first to cultivate it with some amount of success, and later a good deal was grown in European plantations, notably near Dumbara, where a native gardener, from a small vanillery, obtained pods to the value of £100 to £150 per year. The plant was introduced about 1853, or probably earlier, and both Dr. Thwaites and Dr. Trimen strongly urged its cultivation. Samples to the amount of 64 lb. were sent home in 1866 from the Peradeniya Gardens. In 1884, eight packages, valued at 1245 rupees, were sent to England and Australia.

In 1885 . . .	284 lb.	valued at	3370 rupees
1886 . . .	333	,,	1715 ,,
1887 . . .	130½	,,	310 ,,
1888 . . .	1300	,,	4710 ,,

The cultivation, however, has never been very extensive.

Malay Peninsula.—Both *Vanilla planifolia* and *V. pompona* have been cultivated at the Botanic Gardens in Singapore, and good pods produced. The region, however, seems to be too wet for successful plantations. *V. planifolia* produces its fruit during the wettest part of the year, and when heavy rain-storms occur during the ripening period most of the pods fall. There have been no successful commercial plantations in Malaya.

India.—Comparatively little seems ever to have been done in the cultivation of vanilla in India. Mr. A. J. B. Gisseleire, Superintendent of the Agri-Horticultural Society's Gardens in Calcutta, in a paper quoted in *Planting Opinion* (June 16, 1900, p. 419), said that the cultivation of vanilla had been taken in hand more than once, but had never had a thorough trial. The experiment was not continued long enough, although it was shown that this plant grows and fruits in Bengal without any difficulty. "The experiments in the Alipore Gardens have not been carried out on such an elaborate scale as was attempted in several places in Bengal some years ago; in fact, the plants were growing almost in a wild state in a mango grove, and such as they were, they served all the more to show what little trouble there is attached to their cultivation." In the gardens the vanilla was planted at the base of the trees in good leaf-mould, mixed with plenty of brick refuse as a drainage for the young plants. Once put down, they grew at their own sweet will, and soon attained vigorous growth. The plants showed their flower buds in March, and by the 10th of April were fertilised. The pods attained their full size in the beginning of November, and by December the nose of the pod turns yellow first, then brown. This is the time to gather the pods. The pods being few in number in this experiment were sun dried, wrapped in a woollen cloth, and developed a fine aroma, and soon assumed the dark chocolate colour which is recognised as very good.

In the same Journal (p. 193) is quoted an Assam planter's article published in *Capital.* The author says, "where the vanilla plant will thrive well and set its pods there can be little doubt that it would pay, and pay handsomely, but it has always to be borne in mind that though the plant may grow and set its pods in many of our tea and coffee districts, it will not thrive in all such districts. It flourishes in a great many districts during the monsoon, where, if not killed outright in the cold season, it is so weakened by the effects of the damp, foggy weather which obtains in many of our Assam tea districts that it takes all its time to recover itself during the following rains. It appears to thrive very well in South Sylhet, and flowers abundantly year after year in that district without showing any bad effects from the cold weather, but it ought to be pointed out that South Sylhet enjoys a much higher temperature during the cold season than the majority of the Upper Assam districts. The low temperature is not so antagonistic to this plant if not accompanied by a damp atmosphere. When the latter condition obtains the leaves get covered all over with black spots, the plant ultimately dying outright or to within a foot or so of the surface."

The writer recommends *Albizzia moluccana* as a support, as its top is not too dense and allows of a broken light and sunshine to penetrate to the plants. It is advised to plant the albizzias 12 ft. apart, and they will be large enough in one year to allow a vanilla to be planted at each tree. The branches of the albizzia should be cut off to about 6 or 7 ft. They should be weighted to induce them to grow out horizontally, until they meet with the branches of the neighbouring trees.

This seems rather a good idea. *Albizzia moluccana* is a rapid grower, but normally makes a tall, smooth stem running up to 60 or 80 ft. without branches, and is in this way unsuited for vanilla, which would not be able to grip the bark sufficiently firmly, and if it did would soon climb out of reach. As to mangoes, recommended by M. Gisseleire, they are usually considered too dense a shade for vanilla, but were perhaps the best trees available in Bengal. There can be no doubt that vanilla would do well in many parts of India, and might readily be grown as an adjunct to other crops on the estate.

Java.—The cultivation has been successful, and a considerable quantity was at one time exported, but later the lower prices seem to have caused a large falling-off. The pods, which still appear from time to time in European markets, are said to have a peculiar aroma, like those of the Mexican vanillas, but the produce is of a poor colour and often second rate. The greater part goes to America.

1874 . .	2435 kilos	1882 . .	1,344 kilos
1875 . .	14 ,,	1883 . .	373 ,,
1876 . .	2297 ,,	1884 . .	974 ,,
1878 . .	443·5 ,,	1885 . .	219 ,,
1879 . .	373·5 ,,	1886 . .	83 ,,
1880 . .	234·5 ,,	1887 . .	133·5 ,,
1881 . .	139 ,,	1888 . .	129 ,,

Polynesia.—Tahiti ranks as one of the great producing centres of this spice. The plant was introduced from Manila in 1848, and in 1850 the cultivation began to extend largely, until it attained a very considerable development. Of late years, however, Tahiti vanilla seems to have deteriorated, and its price in 1904 fell very low.

There have been many and various suggestions as to the cause of this deterioration. It is suggested by M. Busse that the plant cultivated in Tahiti is a local variety altered by climatic influences from the original form. Others suggest that the methods of preparation are not suitable, and that the habit of the Chinese of buying up green pods and roughly preparing them, and then fraudulently mixing them with good pods, is the cause of the fall in price; and again, it is pointed out that it is not yet certain that the Tahiti plant is the same as the true Mexican *V. planifolia*.

Whatever be the cause, the result is said to be that the pods are poor in vanillin and have too strong a scent of heliotrope, or piperonal. For this reason the Tahiti vanilla can hardly be used at all as a condiment, and can only be used in perfumery. The fall in price is shown by the following table:—

	s. d.		s. d.
In 1897–1899	9 5½	to	5 2 per lb.
1900	3 11½ per lb.		
1901	4 4 ,,		
1902	2 11 ,,		
1904	1 0¾ ,,		

The export is still, however, very considerable. The following is the record of export for some years:—

1885	4,919 kilos	1891	24,585 kilos
1886	8,408 ,,	1892	28,560 ,,
1887	7,610 ,,	1901	92,398 ,,
1888	12,569 ,,	1902	134½ tons
1889	8,789 ,,	1904	134,405 kilos
1890	15,882 ,,	1905	122,083 ,,

Of this the United States took 92 tons, France 35½ tons. The rest went to New Zealand and England.

Fiji Islands.—A few attempts have been made to produce an extensive culture of the plant here, but there is as yet but little exported.

Honolulu.—The Agricultural Station Report of Hawaii for 1903 gives some account of attempts to introduce and develop the industry here. In 1902 two plants produced 300 pods, and in 1903, 150, about a quarter being of good size and quality. The writer says that plants over-cropped soon die, the roots and stalk rot, or the whole vine becomes yellowish, the leaves soft and white, the tendrils (aerial roots) dry and the plant dies. He estimates the following returns from an acre in Honolulu :—

Each plant produces 10 pods ; there are two plants to a support, and 680 supports to an acre ; this gives 13,600 pods. 1000 fresh pods weigh 45 lb., 13,000 pods give 58 lb., which when cured weigh 120 lb. ; one-half of this should be of good superior quality, valued at 6 to 9 American dollars a pound, the balance valued at 1·25 to 4 dollars a pound, giving a return of 435 dollars, *i.e.* £87 per acre.

Australia.—Nothing seems as yet to have been done in the cultivation of vanilla in Australia. Mr. Howard Newport, however, in an article on vanilla culture in Queensland (*Queensland Agricultural Journal*, April 1910, p. 184), urges the cultivation to the attention of the planter. He shows the suitability of the forest, soil, and climate, a temperature between 70° and 90° Fahr. and a rainfall from 50 to 60 up to 200, well distributed, with August to October (the flowering season of the vanilla) fairly dry months. His photographs show that he at least has cultivated some successfully, and there really does not seem to be any reason why Australia should not grow its own vanilla.

Summary.—It will be noticed from this distribution of the cultivation area that it practically extends from lat. 20 N. to lat. 20 S., but that of this area a considerable portion is more or less unsuitable ; part doubtless on account of its long dry periods, such as on the mainland of India, and part on the equator on account of its excessive humidity; and further, that all the most extensive cultivations are on islands, with the exception of the original home of the plant in Mexico.

TRADE AND WORLD SUPPLY

Professor Dunstan (*Bulletin Imperial Institute*, 1904, 30) points out that it is difficult to obtain reliable statistics of the production of vanilla, since the cultivation of this product is so widely distributed in tropical countries, and the imports of it into the principal consuming countries are comparatively of so little value that they are rarely separately given.

Imports into the United Kingdom:[1]—

Year.	Quantity.	Value.
1867	8,178 lb.	£2864
1868	6,846 ,,	2164
1869	4,805 ,,	3748
1870	10,785 ,,	9706

The United States Trade Returns for 1902 give a table of imports into that country, from 1894 to 1902, and their valuation.

Year.	Weight.	Value.	Average value per lb.
		$	$
1894	171,556 lb.	727,853	4·2
1896	335,763 ,,	1,013,608	4·2
1899	272,174 ,,	1,235,412	4·5
1900	255,966 ,,	1,209,334	4·7
1901	248,988 ,,	875,229	3·5
1902	361,739 ,,	859,399	2·3

The following figures are taken from an article by M. Henri Vermond in *La Dépêche coloniale illustrée*,

[1] Simmonds, *Tropical Agriculturist.*

and show the rise and fall in amount exported from the different countries for the past few years.

Crops in	1899-1900.	1900-1901.	1901-1902.	1902-1903.	1903-1904.
La Réunion	96,000	62,000	110,000	100,000	90,000
Seychelles	42,000	18,000	72,000	52,000	65,000
Comores	12,000	28,000	40,000	70,000	55,000
Madagascar	...	...	...	...	...
Mauritius	4,000	3,000	2,500	2,000	2,000
Antilles	8,000	2,500	5,000	10,000	6,000
Java and Ceylon	15,000	15,000	1,500	4,000	3,000
Fiji	1,000	1,000	2,000	1,500	2,000
Mexico	50,000	30,000	30,000	38,000	35,000
Tahiti	45,000	89,000	145,000	131,000	135,000
Total kilos	273,000	248,500	408,000	408,500	393,000
Crops in	**1904-1905.**	**1905-1906.**	**1906-1907.**	**1907-1908.**	**1908-1909.**
La Réunion	55,000	72,000	30,000	54,000	68,000
Seychelles	50,000	45,000	20,000	52,000	22,000
Comores	95,000	125,000	105,000	85,000	68,000
Madagascar	20,000	30,000	40,000	50,000	55,000
Mauritius	2,000	2,000	3,000	2,000	2,000
Antilles	3,000	2,000	2,000	10,000	6,000
Java and Ceylon	3,000	2,000	3,000	6,000	6,000
Fiji	1,500	1,000	1,000	5,000	5,000
Mexico	130,000	75,000	120,000	100,000	100,000
Tahiti	122,000	135,000	141,000	173,000	200,000
Total kilos	481,500	489,000	465,000	537,000	532,000

France was for some years the largest importer of vanilla, importing in 1899, 113,000 kilos, of which 37,000 kilos were consumed in that country and the rest exported to other parts of Europe and America. The consumption increased to 60,043 kilos in 1904.

Germany imported 50,000 kilos only in 1899, but its importation increased from 78,900 kilos in 1904 to 118,900 kilos in 1906.

America imports considerable quantities in a less regular increase, from 171,556 lb. in 1894 to 361,739 in 1902.

"London," says Mr. W. E. Davidson, Governor of the

Seychelles in 1906, "is looked upon as the better market when the prices are good, but Paris sales are steadier when demand is dull; that conclusion is based on the fact that there are regular monthly sales in London, where parcels are sometimes put up for forced sales, whereas in Paris there is no open market, but the principal buyers having standing contracts with the wholesale consumers are ready to buy at a figure which is not subject to market fluctuations. As the price ruled uniformly low during 1905, the proportion sent to London was only 46 per cent of the total; in prosperous years the proportion sent to London has been as high as two-thirds." (Colonial Report, Seychelles, 1905.)

THE PROSPECTS OF VANILLA GROWING

Inquiries have recently been received by the Imperial Department of Agriculture as to the prospects of vanilla growing in the West Indies, and the advisability of the extension of its cultivation. An increased demand has arisen in some of the markets; by some, the reason for this is stated to be the recent passing of a Pure Food Law in the United States. The chief competitor with vanilla is vanillin, which is artificially produced from eugenol, a constituent of oil of cloves. The Pure Food Law, to which reference has just been made, makes it imperative, in relation to vanilla, that all packages containing artificial vanillin shall have a declaration to that effect on the wrapper or label, and it is explained in some quarters that this has decreased the sale of this product in favour of that of vanilla. The Department has obtained definite opinions in regard to the prospects in the vanilla markets of London and New York; before giving these, it will be convenient to review the general position.

The following were the prices of vanilla on the London market (Messrs. Dalton and Young) in July, September, and November 1909, as given in the *Journal d'agriculture tropicale*:—

SEYCHELLES

Description.	July.	September.	November.
Fine (long)	12s. to 15s.	...	...
Fair	10s. 6d.	10s. to 11s.	...
Fair to good	8s. to 11s.	9s. 6d. to 12s.	11s. to 15s.
Red and split	7s. to 8s.	...	10s. 6d. to 11s. 6d.

MAURITIUS

Description.	July.	September.	November.
Good	12s. to 15s.	...	...
Fair (long)	10s. to 10s. 6d.	...	...
Ordinary (long)	8s. 3d. to 9s.	...	...
Fair to good	9s. to 11s. 6d.	...	...
Ordinary (short)	7s. 6d. to 8s. 9d.	...	...
Fair (short)	8s. 6d. to 9s.	...	...

The remarks in connection with the above were as follows :—

July 1909.—"Demand good" (*Journal d'agriculture tropicale,* No. 97).

September.—"Only 108 boxes were offered. There has, however, been a large demand for the article, and the prices realised are higher by 6d. to 2s. per lb. than those of last month" (*Journal d'agriculture tropicale,* No. 99).

November.—"There was an extremely poor supply, amounting to 138 boxes. The demand was good, and the whole lot was sold at 1s. 6d. to 2s. 6d. above the ordinary prices" (*Journal d'agriculture tropicale,* No. 101).

An interesting article, entitled "La Vanille des colonies françaises et la vanilline chimique," appears in *L'Agriculture pratique des pays chauds* for October 1909. In this it is pointed out that, next to Mexico, the French colonies have become the most important exporters of vanilla. The production of this substance is, however, becoming a matter of greater difficulty year by year, owing to the lowering of the prices that has been brought about by the competition of the artificial product vanillin.

The following table, showing the quantity of vanilla exported from the French colonies, as well as from other parts of the world, in 1901, 1904, and 1908, is taken from the article mentioned :—

Source.	1901.	1904.	1908.
	Kilos.	Kilos.	Kilos.
Tahiti	92,398	134,405	173,411
Madagascar . . .	7,019	9,289	57,285
Martinique . . .	226	317	1,806
Mayotte and its dependencies	1,364	76,094	69,867
Guadeloupe . . .	2,591	8,657	30,954
Mexico (July to June) . .	25,588	98,334	108,071
Seychelles	71,899	41,072	24,776

The re-exports from France to various countries are also given; from this information the following is abstracted :—

Exported to	1901.	1904.	1908.
	Kilos.	Kilos.	Kilos.
England . .		69,783 [1]	37,971
United States .	113,015	249,793	259,620
Germany . .	40,200	71,900	90,300 [2]
Italy . .	4,500	7,200	78,961
Austria-Hungary	10,700	16,800	24,200
Belgium . .	4,110	6,893	7,436

Taken altogether, the figures show that the general production and consumption of vanilla are decidedly increasing.

Toward the end of the article the following statement is made :—

Up to the present, the large quantities of vanilla produced in the different countries—quantities which have varied between 500 and 600 tons per annum—have always found buyers. Over-production, in the true sense of the word, has thus not taken place, since there are not at present large stocks in hand. But it may be stated definitely, that there is, on one hand, a too abundant production of vanilla, and, on the other hand, this is concurring with a large manufacture of vanillin. This forms an explanation of the low prices that have just been under consideration.

[1] In 1905. [2] In 1907.

Reference is made to the American Pure Food Law, which compels the makers of commodities for consumption to indicate, in a plain manner, whether their products are perfumed with vanilla or vanillin.

It is interesting to note, in passing, that the following measures are proposed for the purpose of putting prices in the French vanilla market on the most satisfactory basis:—

1. A tax of 416 francs per kilogram (about (£7 : 10s. per lb.) on vanillin.
2. Application of the adulteration laws to vanillin.
3. Reduction of the areas cultivated in vanilla in the different countries where it is produced.

The last recommendation is of special interest, in view of any proposal to extend the production of vanilla in the West Indies.

Evidence as to the increased production of vanilla is also given in the *Diplomatic and Consular Reports*, No. 4243, Annual Series, *Report for the Year 1908 on the Trade of Réunion.* Here it is stated that the quantities produced in recent years were as follows:—

Year.	Kilos.
1906–1907	35,588
1907–1908	48,865
1908–1909	70,000

It is further stated that, of the last crop, 44 tons was exported up to February 26, 1909, when prices varied between 6s. 4d. and 9s. per lb. for first quality, and 3s. 2d. and 4s. 9d. for inferior quality. The final opinion given is: " there has been a great over-production of vanilla during the last five or six years, and prices are likely to go still lower as new plantations come into bearing.

The Semi-Annual Report of Schimmel and Co., dated October 1909, contains the following:—

The French Government has received a memorial, containing 2500 signatures, from vanilla planters in the French colonies, urging the imposition of a sufficient excise duty upon vanillin to enable the vanilla producers, who describe themselves as struggling for their existence, to compete successfully with the artificial scent. As a result of this step, it is intended to ask the French Parliament to sanction an increase in the import duty on vanillin to 15 francs per kilo (5s. 5d. per lb.), in addition to an excise duty of 60 francs per kilo (£1:1:8 per lb.). Six colonial Deputies, chiefly from Réunion, are agitating with great zeal for the adoption of the proposal, and it will be a matter of great interest to watch whether it will be carried into law, or whether the French industries which consume vanillin will successfully oppose a scheme under which, in future, they would be deprived of the advantage of being able to employ the most important odoriferous substance.

The Report of Messrs. John Hadden and Co., Salisbury Square, E.C., for September 1909 (given in the *Agricultural Bulletin* of the Straits and Federated Malay States), mentions that the offerings of vanilla met a good demand; fine black sold particularly well, and even foxy red and split had improved in value.

A general consideration of the above figures and facts would appear to show that the only immediate danger of over-production of vanilla exists in the French colonies; this is probably because nearly all the vanilla produced by them is marketed in France. The demand in the other markets seems to be fair to good.

As was stated above, inquiries were made in London and New York by the Department, with a view to ascertaining the positions in those markets. In replying to the first, Mr. J. R. Jackson, F.L.S., sends a copy of a letter received by him from a Mincing Lane expert, to whom he applied for information, which runs as follows :—

The quantities of vanillas now offered on the London market are considerably less than was the case some years ago, and there is a good demand, at increasing values, for all that can be brought forward, so that I am inclined to think that considerably increased supplies would find a ready market at full rates. Of course the quality should approach that of the Bourbon (Réunion) or Seychelles varieties, and not be of the coarser type, such as Tahitis. If your friends could supply the right grades of vanillas, I have no doubt that they would meet a ready sale, and at remunerative prices, and we might again see London the chief market for vanillas. In spite of the ever increasing demand for the synthetic vanillin crystals, the beans still hold their own.

The inquiry in New York was made from Messrs. Gillespie Bros. and Co. Part of the letter of reply from this firm stands as follows:—

We have interviewed the principal broker in vanillas, and also one of the largest users. Neither of them is inclined to attribute the present high price of vanillas entirely to the Pure Food Act, but rather to short crops and an increasing demand. The Pure Food Law has probably had some effect, but articles such as vanillin, which is a synthetic vanilla, is being used in as large quantities as ever, and its sale is not prohibited so long as the packages are clearly marked vanillin.

The broker advises us that there is always a ready sale for vanilla of good quality, but was unwilling to name any price as being obtainable for an article or quality with which he was not entirely familiar. He laid great stress upon the fact that the value of vanillas depended almost entirely upon the curing and the packing, but, on the whole, was inclined to encourage planters to go in for the cultivation.

The consumer, on the other hand, is not in favour of attempting to grow vanillas on a large scale in the West Indies. He says that he has himself several times tried to work up the trade in two or three of the islands, and that his experience is that there is not sufficient labour, or cheap enough labour, to enable the article to compete with the products of other countries. He admits that, on present prices, the vanilla could be grown with good profit in the West Indies, as prices are two or three times as high as were obtainable three years ago, but in his opinion there will be a large crop next year, and price will adjust themselves. He points out that it takes three years before the vines will bear, and that as the present high prices have now been in force for two or three years, the older planters in the other islands, who planted immediately, have now got large new plantations just about to commence bearing, and it is for this reason that he expects a decline in the market.

This particular buyer obtains practically all of his supplies from France, and tells us that, whereas in former days he used to be able to buy in London to good advantage, the fact that the Bourbon (Réunion) Island vanilla has to go to France, has resulted in making the French market more important than the London market, and that the Seychelles vanilla is now going there in consequence. In that market he is now paying from 36 to 40 francs per lb. for vanillas which, three years ago, he bought for 12 to 15 francs per lb. We mention these high figures to show you the impossibility of giving you any actual idea of probable prices, for we have seen vanillas here which are not quoted at more than \$2.50 per lb. They are, of course, not Bourbon or Mexican vanillas, and are not well dried or well packed.

These considerations serve to show the conditions in the different markets, and must be taken into account before, in any particular instance, the matter is discussed in relation to the agricultural aspect. They should be helpful in giving some idea of the purely commercial tenor of the subject (*Agricultural News*, vol. ix. p. 53).

CONSTITUENTS OF THE PODS

The amount of vanillin in the pods varies in proportion in different gatherings and even in different years. The following analysis shows the proportions under different circumstances :—

	Vanillin per cent.
1. Mexican first quality collected in 1873	1·69
" " 1874	1·86
medium	1·32
2. Bourbon first quality collected in 1874	1·91-2·90
" " 1875	1·97-2·43
medium	1·19
inferior quality collected in 1874	1·55
" " 1875	·75
3. Java first quality collected in 1873	2·75
medium collected in 1874	1·56
4. Brazilian Vanillas	
Goyaz	1·25
Santa Catherina	1·34
Para	·95
Rio de Janeiro	1·50-1·68
5. German East Africa, collected in 1894	2·16
Ceylon	1·48
Tahiti	1·65-2·02

(Analyses 1-3 by Tiemann and Haarmann, 4 by T. and G. Peikoly, 5 by Dr. Busse.)

WORLD'S VANILLA CROPS

"Mr. Hermann Mayer, senior, sends us the following statistics of the 1909-1910 vanilla productions:—

	Tons.
Seychelles	10
Bourbon	35
Mexican	70
Comores, Mayotte, etc.	40
Madagascar and Nossi Bé	25
Mauritius	2
Ceylon, Java, Fiji, Zanzibar, etc.	10
Guadeloupe and Martinique	15
Tahiti	180
Total (say about)	390

"This quantity falls 110 tons short of the 1908-1909 crop, and, as Tahiti shows an increase of 40 tons, the actual deficiency in the finer qualities totals 150 tons, or 40 per cent on the previous year's yield, which was of full average extent. Prices during the past twelvemonth have moved in accord with the statistical position, showing an improvement of 30 to 40 per cent for all varieties except Tahiti; these have profited by the shortage of all other sorts and maintained their value, notwithstanding the larger returns. Only unimportant balances remain in the colonies, and, as new crops are unlikely to be landed in quantity before November next, statistically the position appears exceptionally sound" (*The Chemist and Druggist*, April 30, 1910).

USES

Vanilla is chiefly used as a flavouring for chocolate, confectionery, and liqueurs, and formerly to a certain extent in medicine, as an aromatic stimulant with a tendency towards the nervous system, and it was formerly used in cases of hysteria and low fevers, and also as a flavouring for medicines. It has long had a reputation as an aphrodisiac.

Practically its use in medicine has been now abandoned.

Piesse gives the following account of the preparation and use in flavouring, and also in perfumery, for which it is much used.

In order to obtain the perfume or essence ½ lb. of vanilla pods are cut up small, and put into 1 gallon of pure alcohol of a strength known as 60 over-proof, giving the whole a shake-up daily. The ingredients must remain together for four weeks, at which time all that is worth extracting will be found in the spirits, which may then be strained off quite clear and bright.

It is then suitable as a flavouring agent, or, when blended with other scents, makes delicious perfumery. These sold under the names of Clematis, Heliotrope, Wallflower, etc. mostly contain half in bulk of vanilla extract (*Kew Bulletin*, 1888, p. 80).

Vanillin is considered better than ordinary extract of vanilla pods for manufacturing purposes, being soluble in concentrated and diluted alcohol, water, especially hot water, ether, glycerine, and petroleum jelly.

In confectionery and chocolate factories, pure crystallised vanillin is best used in the form of a 2½ per cent vanilla sugar which, weight for weight, is equal in aroma to the best vanilla. Vanilla sugar is made by taking 6 drachms 13 grams of vanillin crystals, dissolving them in 4 fluid oz. of pure, odourless, absolute alcohol. This is poured on 2 lb. 2 oz. of the finest sugar and mixed so as to be thoroughly distributed through it. The alcohol is evaporated in a warm place, and the sugar when dry is pounded in an earthenware mortar and sifted.

Vanilla sugar thus made is ready for use in confectionery, etc., and will keep without losing its aroma for an indefinite time.

Vanillin crystals should be stored in well-stoppered bottles, as by the exposure to a damp atmosphere it is converted into vanillic acid, which is scentless.

The aromatic resinous substances in the pods preserve the vanillin from changing to vanillic acid to a large extent, but it is always advisable to keep the pods in well-stoppered glass jars.[1]

[1] Sawer's *Odorographia*.

A maceration process for extracting the vanillin is suggested by M. Dupont. A number of vases containing vanilla pods are arranged as in a battery, and alcohol at 80 to 85 per cent is poured into a vase and allowed to remain there a week, after which it is transferred to another vase with fresh vanilla. This is carried on until all the vases have received the solution as many times as there are vases, and the extract should then contain all the vanillin in the pods.[1]

Another method suggested is the following, taken from the *Indische Mercuur*, and originally published in the *Spice-Mill.*[2] The process has been patented by an American, and is effected by a cylindric boiler with special openings and steam jacketed, into which a mixture of 40 per cent alcohol and 60 per cent water is put with the pods, and the heat gradually raised to about, but not above, 110° Fahr. The essence obtained is said to be strong and good even if inferior pods are used. No further details are given, but the principle of using a gentle heat to extract the vanillin seems to be an excellent one, and would probably be a more speedy method of making the extract than the cold method without any injury to the flavour.

For confectionery only the best vanilla can be used. The vanilla of Tahiti resembles that of *Vanilla pompona*, "vanillons," in having a flavour of heliotrope or piperonal, which makes it unsuitable for high-class confectionery, and it is therefore used chiefly for perfumery.

ARTIFICIAL VANILLIN

Vanillin from the pods of the vanilla was first investigated by Gobley in 1858, and Tiemann and Haarmann in 1874 to 1876, in the course of further investigations, discovered that it could be formed artificially from coniferin, a glucoside occurring in the

[1] *Jamaica Bulletin, Colonial Office Report*, 1905.
[2] *Journal d'agriculture tropicale*, 1910, 31.

sapwood of certain pine trees. Since then a number of processes for the manufacture of artificial vanillin on a commercial scale have been devised. In 1891 De Laire commenced to work a process for forming it from eugenol, the substance to which oil of cloves owes its characteristic odour. This process was carried on from 1891 to 1896 without producing any material change in the price of natural vanilla, but in 1897 a period of competition set in between various continental firms, which resulted in the fall on the price of vanilla from £9 per lb. in 1890 to £1 : 1s. per lb. in 1903.

The vanillin being made from eugenol, the price of it depended on that of oil of cloves, from which the eugenol was obtained. But in 1891 a patent was taken out for making vanillin electrolytically from sugar.

Vanilla, however, kept its price up to from 17s. to 19s. 6d. per lb. till November 1904, in spite of the fact that an equivalent amount of artificial vanillin could be purchased for a thirtieth part of the cost of the natural product. This was perhaps due partly to the conservatism of the consumers of vanilla, and partly due to an idea that there were other aromatic substances in the pods which were not in the artificial substance.[1]

The French vanilla-growers have formed a "Ligue à la défense de la vanille," and have attempted to obtain the passing of legislation to compel users of artificial vanillin to mark it on their products, and to tax the import of it into France.

Although artificial vanilla is so much cheaper and can be put on the market at so much lower a figure, the cultivation of the real thing is by no means one of the past. Good vanilla is in request, and will probably always remain so, and though the large profits formerly made in this cultivation will probably not be obtained again, still it is well worthy of attention by the tropical planter, and if carefully managed should bring a good substantial profit.

[1] *Bulletin of the Imperial Institute*, 1904.

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CHAPTER III

NUTMEGS AND MACE

These spices are the produce of the East Asian nutmeg tree, *Myristica moschata*, Linn., belonging to the order *Myristicaceae.* This order contains the single genus *Myristica*, of which upwards of 100 species are known, scattered all over the tropics, but in greatest abundance in the Malayan region. Although so large a number of wild nutmegs are known, only one species contains enough of the aromatic principle *Myristicin* to be of any value for cultivation. There are, however, a few others which are slightly aromatic, and occasionally collected by natives and exported to Europe, more as adulterants of the true nutmeg or its extracts, than for separate use. The larger number of species known possess no aroma and are quite valueless. A certain number, however, produce an essential oil from the crushed seed which is valued for soap-making and other purposes.

DESCRIPTION OF THE PLANT

The nutmeg plant is a somewhat bushy tree, about 30 or 40 ft. in height, though as grown in the Malay Peninsula it is usually much smaller. The bark is of a rather dark-grey colour. The branches are spreading, and, as a rule, are produced nearly to the base of the trunk. The leaves are alternate lanceolate and acuminate, with a rather long point and narrowed towards the base, to the short leaf-stalk. They are about

4 in. long and $2\frac{1}{4}$ in. wide, coriaceous and shining, moderately dark-green above, paler beneath, quite glabrous, as is the whole plant. In bad soil or when insufficiently manured they have a more or less yellow

NUTMEG TREE.

colour, and in shady places are of a deep green. The trees are usually unisexual, bearing male flowers or female flowers only, but it is not uncommon to find a tree with flowers of both sexes upon it. It has long been known that a male tree after some years, usually about six, frequently commences to produce female flowers, and eventually becomes wholly female.

The male trees usually appear to have more erect branches and smaller leaves than the females, but I am by no means sure that this is always the case. They are often conspicuously less leafy and shabbier looking on native plantations, but this is attributed to the natives not wasting manure on male trees. The flowers are produced on small cymes from the branches, each cyme a little above a leaf. They have a short, woody stalk about $\frac{1}{2}$ in. long, and several branches, each bearing a number of flowers. The flowers hang down on short green pedicels, and are bell-shaped, with three short triangular lobes, all light yellow and aromatic flavoured. They are more globose and smaller than the female flowers. The walls of the perianth are rather thick, and there is usually some honey inside at the bottom.

The androecium, or mass of stamens in the centre, consists of a white cylinder terminated by a cone of about twelve narrow linear anthers closely joined together, and reaching to the mouth of the tube of the perianth.

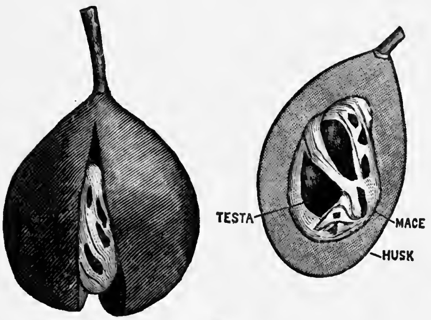
The female flowers are borne in similar positions to the males, but they are either solitary on simple curved pedicels, or there are three together, but seldom more. They are rather larger than the males and more oval in outline, dilated at the base and narrowed at the tip below the three spreading lobes, rather more fleshy than the males, light yellow and shining, $\frac{1}{4}$ in. long. Inside the tube, in place of the staminal column is the ovary, a green conic body ending in a pair of erect, parallel, triangular white stigmas, which nearly fill up the mouth of the tube. Like the males they contain a quantity of nectar at the base of the tube, and are fleshy and aromatic to the taste, having the same flavour as the nutmeg. I have occasionally met with fasciated flowers, two being joined together by their sides.

The fruit when ripe is one of the most beautiful in nature. It is a pendulous, fleshy drupe rather variable in form, those of some trees being globular, while other trees have oval or pear-shaped fruits. They are smooth and of a pale orange-yellow colour, with a groove running down one side. They are somewhat variable in size, large ones being about 2½ in. in length.

NUTMEG FLOWERS.

When quite ripe, the fleshy husk opens by splitting from the top, along the groove, into two halves, nearly to the base. The husk or *pericarp* is of a somewhat firm texture and ½ in. thick, rather acid in taste, with an aromatic flavour of nutmeg. Within the husk is the seed, the nutmeg of commerce, enclosed in a deep brown shining seedcoat, the *testa*, and over this lies a splendid crimson network, the mace, which is an *arillus* or outgrowth from the base of the seed.

The mace is attached to the seed only at the base, but closely enwraps it to the top. It is rather leathery in texture, and cut into narrow flaps of irregular form. The testa of the seed is deep brown, polished, and marked with shallow grooves corresponding to the flaps of the mace, which overlie it. In the shell a good nutmeg should measure about 1 in. long. The shell is woody and brittle, and encloses the seed, the nutmeg of trade, which is oval but rather variable in shape, a little under 1 in. long.



NUTMEG.

It is hard and woody in texture, and marked inside with brown on a greyish ground, strongly aromatic and oily.

When fresh the nutmeg nearly fills up its shell, but as it dries it shrinks somewhat, and when shaken rattles in the testa. Seed used for sowing should not be dry enough to rattle, while for trade purposes it is essential for it to rattle in the testa when shaken.

DISTRIBUTION OF THE PLANT

The nutmeg is a native of the eastern islands of the Moluccas, known as the Spice Islands from the presence of this plant and the clove tree, and is stated by Blume to be wild in Ceram and the southern and eastern islands of this part of the Malay Archipelago. It is also indigenous to Banda, an island which has long been famous for its nutmegs, Amboyna, Gilolo, and Western New Guinea.

NAMES OF THE PLANT AND ITS PRODUCTS

The nutmeg is known in France as Noix Muscade; in Germany as Muskatnuss. In Malay, Pala; Bali, Pa. In Tamil, Jadicai; Hindu, Jaephal; Sanskrit, Jatiphala; Persian, Jouzbewa; Arabic, Jouzalteib.

Mace is Macis in French, Muskatblüte in German, Bunga Pala (flowers of nutmeg) in Malay.

HISTORY

Nutmeg and mace do not appear to have been known to the Greeks and Romans, though von Martius (*Flora Braziliensis*, fasc. 11, 12, 133) maintains that it was alluded to in the *Comedies* of Plautus. The words macer, macar, or machir found in the works of Dioscorides, Galen, and Pliny evidently do not refer to mace, but to the bark of a tree, probably *Ailantus malabaricus* of Malabar. These spices, however, were imported from the East Indies by the Arabian traders in early days, and Aetius, resident at the court of Constantinople about A.D. 540, mentions *Nuces Indicae* among other aromatics, such as cloves, costus, and spikenard, as an ingredient of the *Suffumigium moschatum.*

Masudi, who visited India in A.D. 916-920, pointed out that the nutmeg, like cloves and sandal-wood, was obtained from the eastern islands of the Malay Archipelago, and about the thirteenth century the Arabian writer Kaswini identified the Moluccas as the source of the nutmeg.

The first record of nutmegs in Europe is in a poem written about 1195 by Petrus D'Ebulo, describing how at the entry of the Emperor Henry VI. into Rome, before his coronation, the streets were fumigated with nutmegs and other aromatics. By the end of the twelfth century the spices were both well known in Europe, but very costly, for it is recorded that about 1284, 1 lb. of mace cost 4s. 7d. the value then of three sheep, or half as much as a cow.

Mace seems at this time to have been much more in request than nutmegs, which are hardly mentioned in these early days in Europe.

The Portuguese located the home of the plant in Banda in 1512, and held the trade in these spices until they were driven out by the Dutch, who held the monopoly for many years. They endeavoured to limit the trees to Banda and Amboyna, destroying all the trees in the other islands, but it is said that the fruit pigeons more or less frustrated their efforts by swallowing the seeds and transporting them to other islands in the neighbourhood.

The accumulations of nutmegs and mace in Holland were so large that it is said that the crops of sixteen years were in their warehouses, and in 1760 an immense quantity of nutmegs and cloves were burnt at Amsterdam to keep the prices up.

Prices were very high till much later, for we read of the import price of mace in London in 1806 being 85s. to 90s. per lb., with an import duty of 7s. 1d. per lb. added.

But now Sir Stamford Raffles had begun to foster the cultivation of the spices in Bencoolen, in Sumatra, and in Penang, and to break down the monopoly of the Dutch. In Bencoolen he records in 1820 that he had 100,000 trees, of which one-fourth were in bearing, but on the abandonment of that settlement by the British, all cultivation disappeared and cultivation centred in Penang.

IN PENANG

The history of the cultivation of the nutmeg in Penang dates almost from the first colonisation of the island by the British. The founding of the settlement by Captain Light took place in 1786. At that time the Dutch had the monopoly of nutmegs and cloves, and it was hoped that it might be possible to break this monopoly down by the introduction of these spices into English colonies. The Honourable East India Company therefore deputed Christopher Smith in 1796 to go to the Moluccas to collect spice plants to introduce into Penang and elsewhere in the countries under their control, and in 1798 there were 600 nutmegs and some clove trees in the Penang plantations. In 1800, 5000 nutmeg plants and 15,000 cloves arrived, and in the following years more, until by 1802 Smith had sent 71,266 nutmeg and 55,265 clove plants to Penang. Of these a few were sent to Kew, Calcutta, and Madras, the others were planted in the East India Company's spice gardens in Penang, or distributed to planters in various parts of the island.

Owing to the shyness of cultivators and their carelessness in handling the plants, and the ignorance as to methods of cultivation, a large proportion of these died, and by 1802 only about one-third of the number were living. By 1805 the spice gardens contained 5100 nutmegs, 1625 clove trees, and 1050 seedlings, and the gardens were sold for 9656 dollars.

The first nutmeg fruited in 1802, according to Hunter, in his account of Penang.

The abandonment of these spice gardens by the Government was due, it would appear, to the disappointment in the results of the introduction, and the distrust of the reports of the botanical superintendent. This want of perseverance was certainly much to be regretted. In 1810 there were 13,000 nutmeg trees on the island, but only a few hundreds in bearing. The ignorance of methods of cultivation and the subsequent slow progress produced such apathy that the cultivation showed signs of a speedy extinction.

In these early days of colonisation, and for many years after, the importance of a properly equipped botanic garden with a staff of experienced men under Government control, to experiment and assist the planter in cultivating a crop which is slow in returns, and which requires a considerable amount of study, was not understood.

All pioneer work was left to the planter, who had not only to conduct the necessary experiments, but to make his profits at the same time. Fortunately there was one man, David Brown, who persevered in the cultivation of spices, and after his death his son George continued the work with such spirit and judgment that, after thirty years of trial, the cultivation was established on a sound and profitable basis.

In 1818 the productive nutmeg trees on the island were estimated at 6900, and in 1836 Captain James Low writes that there were upwards of thirty spice plantations in Penang and Province Wellesley. The biggest of these contained 20,000 trees, and the whole of the estates comprised some 80,000 trees, of which more than half were fully developed and fruiting. The gross annual produce was estimated at 130,000 lb. weight.

The Court of Directors in 1803 desired that every encouragement should be given to the Penang spice planters, as Dr. Roxburgh had in the previous year expressed his opinion that this was "the most eligible spot of all the East India Company's possession for spice cultivation." The Penang planters meanwhile complained of the duties imposed on their produce, and also desired that the Dutch merchants of Batavia should be prevented from taking advantage of the difference in the taxation of British grown nutmegs and foreign spices, by shipping their produce to Singapore and Malacca, and thence to England and Bengal, to save the extra duty of a shilling a pound imposed on foreign spice.

Even at this early period the superiority of the Penang nutmegs and mace over those of the Dutch islands (then chiefly Amboyna) was observed by the London dealers, a reputation which Penang and Province Wellesley maintain to this day.

From 1836 onwards the cultivation increased steadily till 1866, when the trees were badly diseased and the industry suffered severely.

After the founding of Singapore in 1819, Raffles commenced the introduction of spice plants, and nutmegs and cloves were extensively planted, but the disease of 1866 practically exterminated the cultivation on the island, and it was never renewed to any large extent. Indeed, Singapore seems less well suited for the nutmeg than Penang. In Penang, however, the cultivation revived, and is still a very important one, though the plantations have passed from European hands to those of Chinese and Malays.

In the Dutch Islands the cultivation still continues, and there is a considerable export thence.

The plant has been exported to all other tropical countries but, except in the West Indies, has hardly entered the stage of important cultivation. In Zanzibar, Mr. Lyne informs me it grows on selected soils, but is not extensively cultivated though it bears freely.

It might be grown with success in most of the tropical islands, for it seems to require sea-air, but the price of nutmegs and mace, though still remunerative, is not at present sufficiently high to induce the ordinary planter to take it up extensively.

SOIL AND ALTITUDE

Soils.—The soils in which nutmegs have been cultivated with success are remarkably varied.

The Spice Islands of the Banda group, long famous for their nutmegs, are volcanic islands. Dr. Oxley describes them thus :—

> Neira is little else than volcanic ashes mixed with quantities of pumice-stone, which, broken into minute portions, form in many places a sort of brownish gravel on the surface. The colour of the soil is nearly black. It is a sandy, friable loam, enriched by the constant falling of a very dense foliage with a large proportion of vegetable matter. The soil of Great Banda is, generally speaking, of a brown colour, and has more tenacity than that of Neira. There is no granite rock to be found on either of the islands, and but very little iron-stone. The hills are composed of basalt, conglomerate, trachyte, and obsidian.

In great contrast to this is the soil of Penang and

Province Wellesley in the Malay Peninsula, whence are derived the finest nutmegs in the world. Here the trees grow on the steep exposed slopes of granite hills, the soil of which is the yellow loamy clay so characteristic of what are known as the laterite formations of the Malay Peninsula. The more friable the clay the better the plants seem to thrive. Dr. Oxley affirms that the deeper the tinge of iron in the soil the better it is for the full development of the tree. Bare clay slopes or sandy soils do not suit the plant at all. The rain-wash in such places, especially if it is impossible to grow shade trees to check this, is most injurious.

The slopes of the Penang and Province Wellesley hills are rocky, with projecting boulders and masses of granite, and among these the trees do well.

In Malacca, at Pringitt, there was formerly for many years an excellent little plantation which throve well and yielded good crops on a hard ferruginous gravel, or pebbles of clay iron-stone (laterite).

In Bencoolen, Sumatra, Lumsdaine says that the soil of the plantation was generally of a red colour, with stony fragments or pebbles scattered through it; the surface of the forest lands being of a chocolate colour.

In Trinidad, virgin forest with rich soil is preferred, but the soil need not necessarily be very rich, for the plant throve well in red-brick soil, the poorest in the district (Hart, *Trinidad Bulletin*).

Alluvial flats are recommended by Lumsdaine, but in most cases these are too low-lying and wet. Wet or flooded ground is fatal to nutmegs, as is also excessively dry ground.

Altitude.—The limits of successful cultivation in the West Indies are from sea-level to 1000 ft. elevation. In the Straits Settlements it is seldom grown as low as sea-level, but is generally cultivated on hills from about 200 ft. to 2000 ft. above the sea.

On the hill known as Bukit Mertajam, in Province Wellesley, where every suitable spot is covered with nutmeg and clove plantations, the limit is reached at under 1000 ft., above which the tree will not grow.

The highest point of Great Banda is 1500 ft.

CLIMATE

It is commonly said that nutmegs must be able to smell the sea, and cloves must see it, and it is certain that if proximity to the sea is not altogether essential for the success of the cultivation, there have been very few, if any, really successful plantations of nutmegs at any distance from the sea. It will be noticed that all the great cultivations of this plant have been on islands, viz. the Moluccas, Penang, Grenada, and Trinidad, while attempts to cultivate the plant far inland never seem to have been attended with much success.

With regard to *temperature*, Dr. Oxley gives the temperature of Banda as ranging from 76° to 86° Fahr. in the south-east monsoon, and from 80° to 92° in the north-west monsoon. In the Straits Settlements the temperature is rather less regular, ranging from 64° to 93°, with an average of 79° for Penang, and 81° for Province Wellesley.

The temperature of Trinidad is given as from 75° to 90°.

Rainfall.—The rainfall of Banda is described as similar to that of the Straits Settlements, that is to say, from about 87 to 142 in. per year. This rain is constant, and there is no dry period. Occasionally, in the Straits Settlements, a month or even two may occur with very little or no rain, but this is not a constant occurrence, and usually there is a little rain every day, with heavier storms at the break of the monsoon.

In Penang there is distinctly more of a trace of a dry season than there is in Singapore, and farther north in the Lankawi Islands, within sight of Penang, it is still more marked. A little drying of the air in the months of June and July does not seem to hurt the tree, even if grown with full exposure, as in Penang and Province Wellesley, and I can certainly testify that the temperature of the nutmeg hills in the hotter parts of the hot days in Penang is extremely high. At the same time it must be noticed that on the nights following these extremely hot days there is a very heavy fall of dew, which compensates largely for the loss of water which the plant must undergo in the hot weather. The temperature in the shade during these times is 84°. Then again, even during the hotter months, rain-storms are not infrequent, so that there is never a continuous dry spell of some three or four months, as occurs farther north. In estimating a rainfall as suitable to any form of cultivation, it is not sufficient to take the actual number of inches which fall in the year. Climates may have a full rainfall for the tropical rain forest region, but they may be quite unsuited for a plant of that region, because the rain falls excessively heavy at one time and does not fall at all at another; the result being that the climate is too wet at one time and too dry at another, and either the wet or dry spell may kill the plant.

In 1895, Mr. Hart published a circular showing the influence of the rainfall on the fruiting of the plant in Trinidad, from observations taken for five years on the trees in the botanic gardens there.

	Monthly average of nuts per annum.	Rainfall.
1890 . . .	262	82·90
1891 . . .	181	53·74
1892 . . .	257	91·14
1893 . . .	335	92·49
1894 . . .	234	52·21

This seems to show that the diminution of the rainfall is accompanied by a falling off in the crop, the biggest crop being obtained when the rainfall was highest (over 90 in.), the lowest when it was under 60 in.

He further says that the rainfall should be not less than 65 in. in the year, but that 80 to 90 in. are better for this cultivation. Certainly 65 in. is low for the nutmeg, and perhaps the best climate for it would be from 90 to 100 in. in the year, well spread over the different months, with no absolutely dry spells of more than four or five days, and no continuous heavy rains, without sun, for a fortnight. In the Straits Settlements during the wet months from December to February, it is not uncommon to have a day's rainfall of from 4 to 6 or even 8 in., but this is not continued. After a few days of heavy rain, with perhaps one excessive fall of 6 or 8 in., the rain ceases for a time, and the sun soon dries up the excessive moisture.

It is during these wet spells that the parasitic fungi are most active, and the continuous dampness of the air is very apt to lead to an outbreak of some fungus disease. This is, I believe, often the reason why, though the rainfall may be in inches the same in two regions, a plant which succeeds well in one fails in the other.

CULTIVATION

The Seed.—In selecting seed for growing care should be taken to choose large and well formed seed. Those that are of irregular shape, or of a pale colour, should be rejected, as should also the seed that rattles in the shell, as these are too dry.

The native theories as to the possibility of determining the sex of the tree from any given seed are mentioned below. They can hardly be said to be reliable.

The seed, like most oily ones, does not keep long in good condition for planting, so that it should be planted within twenty-four hours of gathering, if possible.

If it is necessary to send seeds to a distance, they should be packed in small tins in slightly damped powdered charcoal, or fine powdered soil.

Nurseries.—The seeds should be planted in beds of good soil, well dug over and manured. Care must be taken to give them sufficient drainage. They should be placed from 12 to 18 in. apart in rows, and at a depth of about $2\frac{1}{2}$ in.

The beds should be shaded with the leaf-roofing known as *ataps* in the Malay region. These are made of plaited or folded palm or pandanus leaves, and should be sufficiently loose in texture to let through a certain amount of light. The roofing is supported on sticks about 3 ft. tall. If the place is very exposed, it may be advisable to shade the sides also of the nursery beds.

The beds should be watered every other day or oftener, according to the temperature of the air and dryness of the soil. It should not be allowed to get too dry, nor should it be over-saturated.

The seeds germinate in a month or six weeks, sometimes later. They sprout very freely if they are sound seed, and under ordinary circumstances at least 95 per cent can be raised.

During their growth, which is rather slow at first, all that is necessary is to keep the bed watered, and to remove the weeds which spring up in the beds. It is a good plan to lighten the shading of the nurseries as the plants grow, so as to accustom them gradually to full light, and to allow a good current of air to pass through the foliage of the seedlings.

The young plants remain in the nurseries till they are about 6 in. tall, or even taller, that is to say, about six months, after which they are planted out in the estate in the positions they are intended permanently to occupy.

It is advisable to have the nurseries in close proximity to the plantation, to save trouble and expense in transporting the seedlings.

Hart, in the *Trinidad Bulletin*, recommends that the seeds should be planted in old brandy cases, about 500 or 600 in a dozen cases. When they are 6 or more inches tall, he would transfer them to bamboo pots, to grow for another six months before transplanting.

Some planters prefer planting the seeds in bamboo pots and allowing them to germinate and grow there till they are big enough to plant out. The advantage of bamboo pots lies in the facility with which the young plants can be transported to any part of the estate with a minimum of risk. I never think, however, that plants grow as well in bamboo pots as they do in a nursery bed. Conical baskets of split rattan are better for this kind of work.

Sowing seed at stake is occasionally practised, but is hardly to be recommended. If it is found more convenient to do so, two seeds should be put in each hole, and after germination the weaker plant should be removed.

Sexes of the Plant.—The nutmeg tree is normally monoecious, that is to say, is either male, bearing only male flowers, or female, bearing only female ones, and it is stated by some that the males never become females, nor the females males. It is, however, often stated that male trees have been known to produce at first a few, and later all female flowers in from two to six years.

There are, however, also trees which produce both kinds of flowers at the same time, and these are known, according to Rumphius, as Boy-trees (Pala boi) in Amboyna. The origin of this name is unknown.

Dr. Oxley seems to have considered that these hermaphrodite trees are inferior, as they have a tendency to produce double nuts, and the nuts themselves are inferior in quality and quantity.

Janse, in the *Annals of the Buitenzorg Gardens*, 1904, in treating of double and triple nuts, says that the hermaphrodite trees bear more or fewer nuts each year, that a large percentage of these have double or triple nuts, and that such nuts are not produced at all by female trees. Dr. Oxley states that the female flowers of weakly trees (by which he seems to mean hermaphrodite trees) are entirely yellow instead of being of a greenish colour at the base, and are imperfectly urceolate, approaching in form more nearly to the staminiferous flowers of the male trees.

I cannot say that I have noticed this, nor do I find that the female flowers are tinged with green at the base, but are usually entirely yellow coloured.

Dr. Oxley recommends the destruction of the hermaphrodite trees, as giving an inferior product, and this, I think, is advisable.

The male trees are usually exterminated by the native planter as soon as they have developed enough to show their flowers, and so become distinguishable. The tree takes about seven years to grow before the sex is discoverable by the flowers, and a planter may have the mortification to discover, after long years of patient cultivation, that too many of his plants are males. All kinds of ideas have therefore sprung up as to the possibility of distinguishing the future sex of the plant by the form of the seed or seedling. The Malays affirm that the male seeds are rounder in the back, and those that will become females are flatter. The Chinese say that seed with rounded backs produce female, and those with a ridge on the back male trees.

Prestoe, who studied the plant in Trinidad, said that he could tell the sexes by the foliage, even in the seedlings. The male has leaves broader towards the point than in the middle, with a much longer point, with the veins much more roundly curved in towards the tip than in the female, which has more perfectly elliptical leaves with straighter nerves. I find in Singapore something similar, but, as the leaves vary very much on the same tree, and, as Prestoe remarks, one may find elliptical leaves on the male tree and obovate leaves on the female trees, it is not very easy to distinguish the sexes by the leaves with absolute certainty. Planters of experience may, however, distinguish them more or less accurately by eye.

The adult flowering, or at least well-grown, male may be distinguished by its more straight branches and narrower or smaller leaves, but even that is not certain. In the Malacca plantations this was rather well marked, and male trees could be distinguished at some distance, but I found here the difference in general appearance was accentuated by the male trees not being manured, the Chinese thinking it was not worth while to manure them. But in trees in the Singapore Gardens, where both sexes were treated similarly, this drawn-up appearance was still conspicuous in most of the males. In Trinidad, according to Prestoe, males occur more frequently than females by from 10 to 15 per cent. In most cases where I have had the opportunity to observe in the Straits Settlements, I find the males in a considerable minority.

In the plantation one male to from eight to ten female trees is sufficient for adequate fertilisation.

The plants being unisexual, and it not being, so far as one can see, possible for the female flower to be fertilised by the aid of the wind, as happens in grasses and such plants, are no doubt fertilised by insects, but I have only seen a small flat beetle, and occasionally some small bees, visiting the flowers; indeed, it is rare to find any insect at the flowers. Nevertheless, female trees widely distant from any males seem to produce ripe fruit, often in abundance, a thing which occurs also in many of the wild species of nutmeg and other unisexual trees.

Planting.—The young nutmeg trees are planted at a distance of 26 to 30 ft. apart, either in lines or in the quincunx arrangement. In rocky or broken ground it is frequently impossible to plant them with the regularity of line which the planter loves, but so long as they are not too close to each other this is immaterial. The holes for planting should be about 4 ft. wide and 3 ft. deep at least. Dr. Oxley recommends that they should be not less than 6 ft. across and 4 ft. deep. The depth and diameter of the hole depends on the richness or poverty of the soil. The poorer the soil the larger the hole. The hole is filled up with a mixture of leaf-mould, burnt earth, and old cow-dung, if procurable, well mixed together. Care must be taken not only to fill the hole, but to raise the mound above it for at least 1 ft., to allow for sinking and settling of the loose earth.

The commonest mistake in planting is to fill the hole in which a tree is to be planted with its new soil only to the level of the ground, or even lower. The result of this is that rain-water collects in the sunken ground and fills the bottom of the hole, causing death of the roots from water-logging. The little plant is now planted in the centre of the hole, and the soil firmly pressed down round it. Care is to be taken to see that the tap-root is straight. Plants that have been too long in pots or bamboo tubes are apt to have the tap-root bent, or in the act of planting it may be somewhat bent. A tree with a bent tap-root may grow for many years, but eventually remains stunted and is a complete failure. I have seen estates of coffee in which the tap-root of almost every bush was badly bent. The plants after a few years were worthless, and the mistake could never be remedied. In planting any tree it is a good plan while pressing down the soil on both sides with the feet to firmly but gently give the little plant a pull upwards. This will straighten the root if it has been accidentally bent in planting.

It is worth while to take some trouble in planting neatly and properly, for, as a tree is planted, so will it grow, and a mistake made in planting may never again be remediable.

In hot places the little plants require a certain amount of shading till they have settled in the ground, and commence to push out their roots. This is commonly done in the Straits Settlements by sticking fronds of the bracken ferns, *Gleichenia* or *Pteris*, into the ground so as to make a light shade over the plants. If these are not available small roofings of portions of palm leaves, or boughs of other trees may be used. Dr. Oxley recommends the use of what are known as *ataps*, a roofing of pandanus leaves bent over a stick and fastened with slips of rattan. This, however, would be too dark under ordinary circumstances. The object of the shade is to keep off the direct sun rays in the hot and dry time of the day, and very heavy rain, but at the same time to allow the plant sufficient light, and the advantages of light rain, and dew. The shade can be removed in ten days or a fortnight at latest, or before this if the plant has pushed up its shoots, so as to touch the covering.

The time for planting should be by preference the beginning of the rainy season in countries where the seasons are distinct. Planting in the dry season is not giving the plant a fair chance, and can only be successful by a regular system of watering every evening.

Watering is sometimes necessary for the young plants for the first few days after transplanting, but seldom unless the weather proves very dry.

In planting under shade, unless the weather is exceptionally hot, and by chance the plants are too much exposed, additional shading is of course not required, nor indeed is watering. But the planter, visiting the seedlings on the second or third day, will be able to judge by their appearance as to whether additional shade or water is required.

Shading.—The nutmeg trees in Banda are cultivated in alleys beneath big canary-nut trees (*Canarium edule*), but the trees in the Penang and Province Wellesley plantations, and in fact all over the Malay Peninsula, were grown quite in the open, without any shading at all. Indeed, on the steep slopes of the Penang hills, it would be difficult to shade them in any way. The hills here are terraced, and the terraces supported with granite boulders, and there is little room for shading.

It is to this want of shade that Wallace and others, who have seen the Banda trees, attribute the collapse of the industry in Singapore, and to a large extent in Penang, in 1860. This, I do not think was directly the cause, which is explained under the account of pests, but I think it is clear that trees do grow better for shading, to a certain extent. The nutmeg is not a tree of open country, but a jungle tree, and it is certainly unnatural for it to grow in bare ground with no shade. The heat on the Penang and Province Wellesley hills on hot days is excessive, and this must certainly injure the roots, the ground being kept scrupulously clean of weeds, and so receiving the full and continuous heat of the sun. In the Singapore Botanic Gardens a number of trees were grown in open ground. The soil (except just round the trees, where it was kept clear for convenience in manuring) was covered with grass. No shading was used, but two or three trees were close to taller trees of the kind known as Tembusu (*Fagraea fragrans*). These two or three trees, shaded from the afternoon sun partly or altogether, are much larger, more bushy, and produce much more fruit. The leaves are of a richer green, and the whole plant much more healthy in appearance. In several old gardens in Singapore were formerly some old trees which seemed to have remained over as relics of the long abandoned cultivation here. These had been neglected in many cases, and were shaded by old fruit trees. They were of large size, with fine and abundant dark-green foliage, but I observed that most of them produced very little fruit. Probably in these cases the shading was too dense, and the plants too much crowded by the other trees. I am strongly inclined to think that, in most places at least, a good light shade would be very beneficial to the growth of the nutmeg.

In Trinidad the well-known rain-tree (*Pithecolobium saman*) is used for shading, and is, I think, as good a shade tree as could be found. It grows readily from seed, and is a fast grower. It is not too dense, allowing a good quantity of light to pass through its foliage. During rain and at night it closes its leaves so as to let rain and dew fall on the plants beneath it. The saga (*Adenanthera pavonina*) is another tree that might be used. It is a fast grower from seed, but spreads less than the rain-tree, and sheds all its leaves during the dry season, which might expose the nutmegs to the full heat at the hottest period. The rapid-growing *Albizzia moluccana* is often used as a shade tree for coffee and other plants. It gives a light lattice-like shade, but is objected to on account of the great size it attains in a short time, and the brittleness of its branches, which are apt to fall and damage the plants beneath. The canary-nut, which is the main plant used in Banda, is of rather slow growth. *Erythrina lithosperma*, and other species, might be used in suitable spots, but they are not usually very long lived, and appear to be very attractive to lightning stroke. It has been suggested that planting nutmegs along tracks cut through the forest would be found satisfactory, and would be well worth trying. This plan has proved very successful with gutta-percha trees, which grow much more easily in partial shade than in the open; but this plan is open to the objection that the trees and fruit would suffer much from the depredation of deer, pigs, monkeys, squirrels, and other animals which would be difficult to keep in check if the forest was extensive.

Lumsdaine deprecates the use of shade trees altogether for nutmegs on the ground that they would exclude sun-rays and dew, and would rob the soil of its fertility. If the shade trees were too close and dense they might, of course, shade out the nutmegs, but this is easily obviated by lopping the excessive branches, and so letting light in. It is very improbable that they would interfere with the growth of the trees by destroying the fertility of the soil. It is certain that this is not the case in the Banda plantations. If necessary, the shade trees could be so arranged as only to cut off the hot rays of the sun during the middle of the day and the afternoon, and allow the nutmegs to have the full benefit of the morning sun.

Besides preventing the injury to the trees by the excessive heat, the shade trees would aid in breaking up the soil, in forming humus, and in preventing injury by high wind, to which nutmegs are very liable. In Penang, where no shade trees are used, the Chinese often find it necessary to erect screens to keep the wind from injuring the plants.

Weeding.—In the Straits Settlements and Ceylon, it is considered by the planters of the utmost importance to weed the ground completely free of all herbaceous and other plants, and this is one of the heaviest expenses in cultivation. It may be doubted whether this method of cultivation can pay at all, and whether, on the other hand, it is not extremely injurious to the plants. In Banda no such weeding is done.

Here is Dr. Oxley's description of a nutmeg estate in Banda:—

> There being no obstruction, as I have already observed, from underwood, and the lowest branches of the nutmeg trees being far above the level of vision, you can walk about with perfect freedom and see distinctly for a considerable distance, according to the undulating nature of the ground. Under your feet is a carpet formed of short grass, mosses, ferns, or soft lycopodiums.

Photographs in Warburg's *Muskatnuss* show exactly the same thing. The ground is covered with cool, soft undergrowth, grass and ferns, and resembles an English wood in summer. What a contrast is this to the hot, dry, exposed soils of the Penang and Province Wellesley hills. Personally, I have little doubt that the habit of scraping every scrap of herbaceous plants from beneath the trees in an estate of any tropical tree goes far to account for many failures of crops. No trees grow thus in nature, and he would be considered insane who removed all the turf from his apple orchard, and left the bare exposed soil. But absurd as this would be in Europe, it is still worse in the tropics. The denudation of the soil by the violent tropical showers, washing off all the humus, and soaking out all the soluble food salts of the soil, followed by a blaze of heat which cracks the ground for some depth, tearing through all the small roots in the line of the cracks, and which dries up the water in and round the roots, cannot but be very injurious to any plant.

The nutmeg roots grow very high, and quite near the surface, at least in the Malay Peninsula. Portions of the roots may even be seen projecting from the ground, and these are sometimes exposed to a temperature of 110°, and even higher. This cannot be beneficial to the growth of the plant.

It is, however, advisable in any case to keep the ground clear of weeds around the young plants, and to see that climbers do not strangle them, and that they get sufficient light. Hart recommends weeding up to the twentieth year, and after that considers it unnecessary. A good deal has been written, of late, as to the effects of the poisons excreted by grass roots (the root-toxins) on other plants grown in the same soil. A good deal more research is wanted in this direction, but even if the root-toxins did delay the growth or injure the tree to some extent, the injury caused by rain-wash and denudation of the soil, and exposure of the young roots to the excessive heat of the sun, cannot be ignored, and the question resolves itself into the choice of two evils.

If clean weeding is practised the weeds should not be removed from the ground, as that entails a loss of potash, sodium, and nitrogen, which will have to be replaced in the form of manure. They should be rotted down in a pit, with dead leaves, sticks, etc., and re-applied to the tree as a mulch, or they may be burnt and the ash utilised.

Manuring.—In 1860, when the great collapse of the nutmeg plantations occurred in the Straits Settlements, the cause of the disease was attributed by Mr. José d'Almeida, in Collingwood's article, to over-manuring. The trees were said to have been unnaturally forced by digging trenches too closely around the spongioles (*i.e.* the young root-ends), and by too rich and long continued manuring, by which heavy crops had been obtained, but which at last exhausted the trees. To a certain extent this was corroborated by the fact that in Penang, where the planters were rich and could afford much manure, the destruction when the disease came was more complete than in the plantations of the poorer owners in Malacca.

This, however, had probably little to do with the destruction, though it is true that the use of too strong manures, especially those that give off ammonia in considerable quantities, quickly must and certainly do exercise a bad influence on any plant.

In the rich volcanic soils of Banda and the other islands of the Moluccas, manuring is not necessary and does not seem to be used. But in the poor clay soils of the Malay Peninsula it is different. The nutmeg is rather a greedy feeder, and requires manuring in the sterile soil of Penang and Province Wellesley, and in other similar places.

Dr. Oxley recommends a system of trenching round the trees which apparently was in vogue in the early days of nutmeg cultivation in the Malay Peninsula. Trenches 2 ft. deep were dug round each young tree, and filled with a mixture of cow-dung, cut grass, and earth. This was repeated on two later occasions, the second trench being dug just outside the first, and the third outside that, so that each circular trench was a wider circle than the previous one, and the third of each tree met with the outer trench of the next tree. This plan cannot be recommended. It is expensive, and while the tree is developing it is impossible to avoid cutting through many of the roots. It is therefore injurious to the tree. There is no need to dig the manure into the ground. If laid on the top of the soil, especially if a little earth is thrown over it, it will act quite as well on the roots as if put in direct apposition, and there is no risk of injuring the roots. Cow-dung, if procurable, is about as good a manure as is possible to use, but it should not be used fresh. It should be kept till it is well rotted before use. Oxley points out that the use of fresh cow-dung, in the trenches above described, caused the rootlets to turn black and die. In Malacca a cart-load of cow-dung is thrown at the foot of each tree once a year, and a little soil spread over it.

Stable manure is always considered too "hot" for use in the Straits Settlements for any plant until it has been thoroughly rotted down. Oxley used some tons of guano on his trees, and found it unsatisfactory. He considered it the least beneficial substance that could be given to trees. It caused the trees to assume a deeper tint of foliage and at first to throw out young shoots, but there seemed to come a very unpleasant reaction afterwards, and he was inclined to think that the quality of the produce deteriorated. Some of the Chinese in Province Wellesley used the urine from the coolie lines, and others the night-soil. It is said, however, that if these manures are once used on a tree it is necessary always to use it, or the tree fails.

It is probable that the evil effects of these manures are due to their too rapid decomposition in a hot tropical climate, and the production of excess of ammonia caused by this decomposition. Guano was quite a new manure in Dr. Oxley's time, and he probably used it in excess. If used in smaller quantities, and where possible allowed to rot till a portion of the ammonia has been dissipated, very different results might have been obtained. The Chinese in the Malay Peninsula keep their pigs in sties with a floor of planking above a large cemented tank, into which fall all the excrements of the animals. This pig-manure is highly approved of by the planters for nutmegs. They also use prawn-dust. This consists of the shells and waste bits of prawns used in making the well-known Malay condiment "Blachan." Fish refuse, either used in a liquid form or solid, is considered very valuable, and blood and oilcake imported from Java are also considered by the Malays as very suitable manures. Dr. Oxley got excellent results from the carcasses of animals buried near the trees, and I have seen poor nutmeg trees develop into good fruiting trees very shortly after a dead pariah dog or two were buried at their roots.

In some parts of the peninsula planters used bat guano from the limestone caves, which is found there in immense quantities, and consists of bat-dung mixed with lime in the form of a powdery dust. It was imported in junks from the Lankawi Islands north of

Penang, and was rather expensive, costing 3 dollars for 100 little baskets.

These animal manures are not used in great quantity. Prawn-dust, which costs from 1 dollar and 80 cents a pikul (133 lb.), is dug into the ground once a year at a point just outside the spread of the branches, each tree receiving 10 or 12 lb. a year. It would be better, perhaps, either to put the manure on the ground and let it rot in, as the Malacca planters do with cow-dung, or to prick over the ground and after throwing in the manure, to cover it up with soil. The nutmeg roots high and produces such a network of roots round the tree that it would be impossible to dig in manure without injuring them.

Mulching with cut grass and dead leaves is useful, and is used by the Chinese, who spread cut lalang-grass (*Imperata cylindrica*) at the foot of the trees and between them. It has the advantage of keeping down weeds, keeping the ground cool, and supplying as it decays a certain amount of food for the plant. I observed too, that in Province Wellesley the trees so treated were less attacked by the nutmeg beetles. The Chinese also use grass dug into trenches round the young plants, as described by Dr. Oxley. This, however, should be avoided, unless done when the plants are quite young and the trenches made at some distance away, so that the roots cannot be interfered with. In the early days of the plantation the weeds can be utilised in this way, being dug into the trenches running between the rows of young plants.

Pruning is really seldom necessary, but if the trees take to throwing up vertical shoots among the spreading branches, these should be removed as early as possible. As the tree bleeds rather freely on being cut it is recommended, when removing large branches, to seal the wounds with a mixture of two parts of pounded lime and one of tar, applied warm. All dead branches and twigs and all parasitic plants, such as the *Loranthi* or mistletoes, should be removed as soon as seen. It is to be remembered that in cutting off these parasites the branch on which one is growing should be cut off *below* the point of attachment of the parasite, as it thrusts its roots downwards in the branch, and merely breaking off the branches of the Loranthus is not sufficient to kill it. Nutmegs are less liable to the invasion of epiphytic plants, such as mosses and lichens, than cloves, but when these appear it is advisable to pull them off.

Grafting.—Grafting to improve the production of the fruits and to make certain of having many female trees has often been suggested and tried by planters for many years. It does not, however, seem to have ever repaid the planter for his expense and trouble in the operation.

Dr. Oxley describes how he grafted several plants by approach, and writing three years later says, that though the plants are looking well and growing, they have thrown out their branches in a straggling, irregular manner, having no leaders, and consequently they cannot develop their branches in the regular verticils necessary for the perfect formation of the tree. Without these the trees must ever be small and stunted, and consequently incapable of producing any large quantity of fruit. Hart, who also tried grafting in order to produce a larger supply of female trees by grafting branches of female trees on male ones, found it a long and expensive business, and states that though grafted plants fruit earlier they do not last as long. He says that while seedling nutmegs cost 6 cents in Trinidad, owing to the expense and labour entailed grafted plants cannot be sold under a dollar.

Much the same statements are made by others who have tried grafting, that is to say, they find it is not worth the cost.

In Grenada, in order to obviate the difficulty of having too many males and too few females, it is advised to grow the trees until the fifth year, when the sex can be determined, and then to remove the unnecessary males. As a rule, however, the greater proportion of trees prove females, and there is no need for troubling about the comparatively few males.

The Chinese in Penang and Province Wellesley cut down every pure male tree as soon as it is possible to distinguish the sex, so that the few bisexual trees they possess have to supply all the pollen for the females. In Malacca they leave the males, unless there are too many in the plantation, when they cut them out, and in any case do not waste any manure on them. Besides manuring, occasional pruning and destroying parasites and insect pests, and such weeding as is absolutely necessary, there is little for the planter to do till the trees begin to fruit, which is usually about the sixth year.

GROWTH OF THE TREE

The trees in Banda grown in rich soil and under shade attain a much greater height than those of the Straits Settlements grown in full sun and in poor soil. In Banda 50 or 60 ft. in height is not an uncommon size, and Dr. Oxley states that he saw some which he thought could not be less than 70 ft. tall. They commence to fruit generally in the eighth or ninth year, and are not considered in their prime until they are about twenty-five years old. They are said to bear well up to sixty years, and even longer. The male tree is said to be shorter lived than the female.

In Penang, on the other hand, the trees are much shorter, usually about 20 to 25 ft. tall, bushy and compact. Old trees grown in shade have often a wide spread, but they do not attain any great height.

They commence to fruit between the fifth and sixth years, occasionally earlier, but many (and this is preferred) only commence to fruit in the eighth or ninth year. They are at their best in fifteen years, and fruit well for ten or twenty years more. Thus the whole life history is shorter in the Straits Settlements than in the Moluccas. This is presumably due to the somewhat unnatural method in which the cultivation is carried on in the

Malay Peninsula. Not infrequently a planter will announce with jubilation that his trees have commenced to fruit in the third or fourth year, but this is not a matter for congratulation, as trees which commence to fruit so early are short-lived, and soon crop themselves out. It is much better when they delay fruiting till the ninth year.

The fruits ripen in about six months from the flower. When they split and show the seed covered with its brilliant red mace, they are ripe. The fruit is sometimes allowed to fall, and is then picked up, the collector going round the plantation every day and collecting the seed and mace in baskets. But it is more usually gathered by hand, which is preferable. For this a hooked stick is used to pull the fruits off where the tree is low, as it is in the Straits Settlements. In Banda, where the trees are lofty, the gatherer uses a long rod with two deflexed prongs, below which is a small bamboo basket. When the nutmeg is grasped between the prongs and falls off it is caught in the basket, and so does not become bruised by falling to the ground, which injures the mace. Modifications of this rod and basket are used for all kinds of fruits easily injured by bruising all over the Eastern islands.

The number of nuts a collector can gather in a day varies according to the height and propinquity of the trees and the amount of crop, but Warburg says a good worker can collect in the full season 1000 to 1500 nuts in a day. In Singapore one man can collect from 100 trees in a day. In Menado each worker can pluck 40 to 50 trees, and in Banda often 2 or 3 trees will keep a man employed all day.

The smaller size of the Malay Peninsula trees is a distinct advantage to the gatherer.

YIELD OF THE TREES

The actual return in amount of nutmegs given by each tree varies considerably. Some trees are very heavy croppers, while others are much less productive. This depends chiefly on the soil and the method of cultivation, amount of shading, distance between the trees, amount and quality of manuring. Dr. Oxley, writing of the cultivation in Penang and Singapore, says: "The best trees do not show flower before the ninth year, and one such tree is worth a score of others. This will be evident when it is stated that I have seen several trees which yield more than 10,000 nuts in a year, whereas I believe there is not a plantation in Singapore that averages 1000 from every tree."

Nicholls mentions trees as giving 20,000 nuts a year. Warburg states that in Banda trees seldom give as much as 3000, Simmonds gives from 1000 to 5000, and a tree in Jamaica is said to have given 4000.

Good trees should average from 1500 to 2000 nuts a year.

In the matter of weight, each tree should give 10 lb. of nutmegs to 1 lb. of mace. Some trees give much more than this. Hopkins, quoted by Crawford, gives 10 to 14 lb., Olivier 12 to 15 lb., Hogendorp 15 to 20 lb., and De Sturler mentions a tree as giving 30 to 40 lb. of nuts and 9 to 12 lb. of mace.

In Ceylon, Mr. Dewar says that in his experience about 750 lb. weight of nutmegs, including the shells, and 120 lb. of mace may be obtained from an acre of trees in full bearing. In Grenada, where nutmeg cultivation has been very successful, a tree has given as much as £30 worth of nutmegs in the year.

In studying these figures it must be remembered that the nutmegs vary much in size, large ones being much more highly valued than small ones, weight for weight, and that some trees may give a comparatively small number of large nutmegs and be more valuable than others which give a larger number of small ones.

CROPPING

The tree fruits more or less all the year round, but as a rule in most places the heaviest crop is obtained in

May and June, and again in August and September. In the Straits Settlements the July and August crop is the heaviest, though fruit can be obtained all the year. This coincides with the season for the cropping of fruit trees. Crawford says that three crops are recognised in the East Indies, one at the end of July and in August, which gives the best nuts; the second in November, the heaviest cropping time; and another at the end of March. Lumsdaine says that the great harvest in Sumatra is obtained in the period from September to December, and a smaller one from April to June.

The fruiting seasons in Trinidad are shown in a table published by Mr. Hart in 1895. He gives a daily average of fruit from trees in the Botanic Gardens for five years, thus :—

January	65·8	July	405·4
February	111·2	August	405·8
March	224·6	September	304·2
April	374·2	October	210·6
May	402·2	November	65·8
June	442·0	December	55·6

The steady rise from February to June and falling off from July and August to December is well marked. This is quite distinct from the East Indian two-cropping periods, and is probably due to climatic differences.

Lumsdaine states that the trees yield most abundantly every second year. This is usually the case in fruit trees all over the East. A heavy crop one year is followed by a short crop the next, and *vice versa*.

PESTS

Phloeosomus cribratus, Blandford.—The most injurious insect to the nutmeg tree that I have seen is a very small Scolytid beetle belonging to this species which I found in abundance destroying the trees in Penang and Province Wellesley. There seemed to be two species attacking the trees. The first one is a short cylindrical beetle, only $\frac{1}{8}$ in. in length, of a dark-brown colour, almost black. It is very convex above and has a small, bent-down head, sunk in the throat and ornamented with a brush of yellow hairs. The antennae are clubbed, the tip of the club being whitish. The elytra is strongly ribbed, with a row of raised dots between each rib. The other beetle is rather larger. It deposits its eggs beneath the bark of the tree, either at the base of the trunk below the ground or in the branches. The very small white grub attacks the cambium layer between the bark and the wood. When it attacks the branches it burrows at the base of the twigs, cutting away the cambium where the twigs join the main branch. In this case the twigs die speedily, and the leaves do not fall, but dry on the twig, and boughs may be seen with all the lower twigs dead and bearing dry leaves while the upper twigs are still alive. After burrowing round the base of the twig the grub often bores into the centre of the woody part.

The beetle remains for some time, even weeks, in the boughs and will, unless destroyed, attack other parts of the tree.

The subterranean portion of the trunk is next attacked, and sometimes even before the boughs show any signs of the presence of the beetle.

Usually the injury to the base of the tree is overlooked till the disease has reached above-ground, when it is almost too late to save the tree. Hence it is commonly said that the tree dies in ten days after it is attacked.

In Collingwood's description of the destruction of the trees in Penang and Singapore in 1860, which was, I have little doubt, caused by this pest, it is said that a tree would be attacked in the night, and in the morning the topmost branches would be withered. In reality, doubtless the tree had been attacked weeks before, perhaps months, but the injury was not noticed till the tree was at the point of death.

As the beetles work away from the parts of the tree they have killed into still living parts, many other wood-eating beetles attack the dead portions and hasten the decay of the trees.

I observed that for some reason the beetles only attacked the tree on the side facing the greatest amount of light. As in Penang and Province Wellesley the trees are usually planted on terraced hill slopes, and no shade trees are used, the attack usually takes place on the side of the tree farthest from the hill slope, so that dying trees could be seen to have the bark destroyed in a line on this face, and all the boughs on that side dead.

The beetles probably breed very fast, as thousands were to be seen in a single tree.

That this insect was responsible for the catastrophe of 1860, when the cultivation of the nutmeg in Singapore was quite destroyed and that of Penang largely diminished, I think there can be little doubt, from Collingwood's description. He writes as follows :—

> In the night a tree would be attacked and the morning light would show its topmost branches withered; the leaves fell off; the disease slowly spread downward, *chiefly at one side of the tree* (the lower portion often for a long time green and bushy); the tree became one unsightly mass of bare and whitened twigs. No situation was exempt from its ravages, hills and valleys alike suffered, nor could any principle be traced in its promiscuous attacks. Upon a close examination of diseased parts it is found that the *formative layer inside the bark dries up and turns black*, the leaves then wither and fall off, and soon *the bark is found to be full of small perforations*, but no insect of any kind has ever been discovered in connection with the change, nor has any fungus been charged with the destruction.

I have italicised the passages which seem most strongly to point to the disease and destruction being caused by the Scolytid.

The death of the tree from the top downwards is very characteristic of destruction caused by deficiency in nutrition due to injury to the roots, or what is equivalent, the ringing or partial ringing of the tree at the base. This is confirmed by the blackening of the cambium layer, which, cut off from the roots by the beetles having destroyed the subterranean portion, soon dies. The small perforations in the bark (where the adult beetles had escaped) should have shown the planters that small beetles of the Scolytid group were at work in the tree, and the only question then was, were the beetles destroying the living tree or only attacking dead portions. This point is settled by finding the beetles in the still-living bark, and especially in the twigs of the living branches.

There was, unfortunately, no entomologist in the colony at that time, or the cause of the plague would soon have been detected and steps taken to remedy it. As it was, to quote Collingwood again :—

> The planters abandoned the plantations in disgust in many cases where there were still healthy trees, and the land reverted to Government. In other cases, where expensive bungalows had been built upon the estate, they were sold for a small proportion of the sums expended in building them, since they were, as a rule, too far from town to command any competition, and ceased to be conveniently situated. Many planters, both English and Chinese, whose whole estates were invested in nutmeg plantations, were thus reduced to ruin and absolutely penniless, and distress and disappointment everywhere prevailed.

Many of the trees which were abandoned, and round which a thick jungle undergrowth had sprung up, recovered, which Collingwood attributed to their being no longer manured, for it seems that at the time an idea arose in the minds of the planters that the disease was caused by over-manuring the plants, and they even went so far as to condemn any manuring of the plants at all as fatal to the tree. But this recovery was what might have been expected. The beetles apparently dislike shade, as may be seen from the fact that they were found in the sunniest side of the trees in greatest abundance, and furthermore, the isolation of the remaining trees by secondary scrub prevented the beetles from finding their way from one tree to another. There are still in old gardens in Singapore a few of the old nutmeg trees which seem to be the relics of the plantations of

1860, recovered from the attacks of the pest by being abandoned in a mixture of bushes and trees which have sprung up since.

Remedy.—It must be remembered that certainly at the present day, and apparently, too, in the early days of the nutmeg plantations in Penang and Province Wellesley, the nutmeg trees are grown in open, well-weeded soil with no shade, and extremely hot, so that the trees themselves are less strong, and the beetles have everything in their favour, warmth and light, and every facility for flying from tree to tree. Shading, as is the custom in Banda and elsewhere, is therefore desirable.

The Chinese cultivators in Penang, I observed, did not cut off and burn the dead or dying branches of the affected trees, as good cultivators would do, but left them on the ground in piles, or even used them to bank up the earth round the stems of other trees, thus absolutely bringing the pest into close proximity with young and healthy trees. As I found the beetle living 6 in. below the ground, burying the boughs as the Chinese do does not kill it, and it can easily dig its way out. The irregular way in which trees in a nutmeg plantation are attacked is very remarkable. I have seen three trees standing side by side on a terrace destroyed utterly, while all around them were trees in the finest condition, with no signs of beetles even in the branches. But the dead trees were standing on a very exposed slope well above the tops of those on the lower terraces, so that beetles flying, as beetles so often do, in a straight line across the valley would strike these trees first. Here again shade trees would be of value in checking an incursion of pests of this nature.

As is almost invariably the case in attacks of this kind, the disease commences with the destruction of a few branches, and the planters take no notice of this. The beetles increase in numbers, a few trees die, still no notice is taken. Then almost suddenly the disease becomes virulent, every tree is attacked and quickly dies, and the planter in despair abandons the plantation, leaving the dying trees to infect the other plantations.

It is imperative, therefore, to prevent the beetles from increasing in such numbers that it becomes impossible to check them, and this can be done by destroying by burning all sticks that can furnish them with a breeding-ground.

It is more difficult to prevent them from attacking the underground part of the stem. I observed, however, that the better class of cultivators were in the habit of covering the ground beneath the tree with cut grass, the common grass known in Malay regions as lalang (*Imperata cylindrica*) being the grass used, and that trees so treated suffered less from the beetles. This mulching also serves to protect the high-lying roots from the excessive sun-heat, and also supplies a certain amount of nutriment.

If a tree, however, has got badly attacked, and it may be considered worth while to try and save it, all affected bark should be cut off and burnt, and tar or lime-wash liberally applied. The underground part of the stem, which is often difficult to get at on account of the close network of roots, could be treated by picking over the soil and loosening it, and pouring over a strong solution of some insecticide, and mulching with cut grass or dead leaves.

The Mango-Borer.—The caterpillar of a fairly large moth, which is commonly found in the Malay Peninsula boring in the branches of the mango tree, occasionally attacks the nutmeg when there are mango trees in the immediate neighbourhood. Probably this only appears when there are not sufficient mango trees for the moth to lay its eggs on, and may be classed as an accidental attack.

Aphis or greenfly occurs occasionally on sickly or weak trees.

A small *pychid moth caterpillar*, which makes a kind of case for itself out of bits of leaf, I have met with browsing on the stigmas of the female flowers.

This, of course, would prevent fertilisation, but it seems to be an infrequent occurrence.

A leaf mining caterpillar has been met with both by myself and Dr. Oxley, who says that these insects rapidly spread and cause great havoc.

Batocera Hector, Dej.—A large, brown longicorn beetle, not uncommon all over the Malay region, is accused by Dr. Koningsberger of attacking the nutmeg in Java. Its larva burrows beneath the bark and into the wood. It attacks a number of trees, such as *Albizzia moluccana* and *Erythrinas.* The larva is about 4 in. long and rather flat. The perfect insect is 3 in. long, with long antennae and a thorn on each side of the thorax.

Lachnosterna sp.—A small brown chafer of the group of Lamellicorns, less than 1 in. long, of a deep chocolate-brown colour, quite smooth except the under parts, which are covered with a soft down, and its legs, which are hairy. The grub is a white larva with a brown head, about 1 in. long and of the usual form of the lamellicorn larvae. This chafer attacks the roots of many plants, the larva burrowing among them and eating them. It has been found attacking nutmegs in Penang.

Astychus chrysochloris, Wied.—A green weevil, about $\frac{1}{2}$ in. long, covered with golden scales, which are easily rubbed off, has given some trouble in various parts of the Malay Peninsula by devouring the leaves of all manner of trees, including nutmegs. Mr. Wray has described it in *Perak Museum Notes*, vol. ii. 1, 1897.

The egg is laid in the ground, and the grub, which apparently feeds on decaying vegetable matter till it grows to a length of $\frac{3}{4}$ in., forms a chamber in the earth and pupates there, about 2 in. below the surface of the ground. It hatches out at night, and commences to devour the leaves of any tree it comes across. It lives for three months, eating voraciously the whole time, and does not leave a tree till it has eaten every leaf. It breeds a month after hatching, and lays its eggs one month later. It does not fly readily, but can be shaken off the tree or destroyed by hand picking.

Spangle-scale *Lecamium expansum*, Freem., var. *metallicum*.—This is a rounded, oval, flat scale-insect, $\frac{1}{4}$ in. across, of a pale green colour at first, with a fine ridge across the back and four tubes, two on either side. It is very firmly attached to the leaf on the upper side, so that it is difficult to detach it without breaking it. Beneath, when adult, are to be seen the larvae, very small red or black fleshy insects. It is met with on the leaves of the nutmeg, usually on the upper surface. I have found it in Singapore and Malacca, and usually on weakly trees. These scale-insects suck the juice of the leaf with their beaks, and are sometimes very injurious. This one is, however, not very common, and the Chinese planters who knew it said it was not injurious. It eventually becomes silvery in colour and prettily reticulated, hence its English name.

A white *Coccus* is not rare on weakly trees, but appears usually to do but little harm. If numerous, the leaves should be washed with a solution of soft-soap and tobacco-water, or phenyl mixed with water, and sprayed with syringe.

Where these blights are seen it may be assumed that the plant is weak and requires manuring.

Formica smaragdina.—This common red ant, known as the keringga in the Malay Peninsula, makes its nest by drawing together the leaves of a tree and attaching them with silk. It is troublesome not only on account of its bite, but also because it spoils the leaves by sewing them together, thus causing them to die. They are almost a certain sign that there is blight on the tree, as they live largely on the sugary excretion of the *coccidae*, and frequently bring the pests to the tree from elsewhere as a food supply, and thus are injurious. They also, however, kill caterpillars and other noxious insects, and are in this way useful. They are easily evicted by destroying the nests with a blow of a stick, or killed by any ordinary insecticide.

Termites.—Dr. Oxley mentions white ants or termites as being troublesome to the nutmeg trees in the Straits Settlements in 1848, but says they only attack weak plants. "It is only upon the first symptoms of decay that they commence their depredations." "Every planter must lay his account to losing occasional trees by them, but he who has his ground clearest and most free of old roots and stumps of trees will lose fewest."

I cannot say I have ever seen nutmeg trees really attacked by any kind of termites. At present in the East Indies there is only one species out of a very large number which attacks living trees, and that is *Termes gestroi*, the well-known species which does occasional damage on rubber estates. This species might certainly attack nutmeg trees, if it happened to be in the ground near the trees. I gather from the description that Dr. Oxley does not refer to this insect, but rather to one of the common dead-wood eating species. These frequently may be seen attacking the outer bark, coating it with mud and nibbling the dry bark layers off, and occasionally tunnelling up the centre of any small trees. The occurrence of such an accident is a clear and certain sign that the plant is dying from some other cause, and the termites are merely devouring already dead portions. It is, indeed, usually in very bad soil that this attack of termites is seen, and it may be taken as evidence that the ground is unsuited for cultivation.

Dr. Oxley recommends the use of pig's dung in solution for driving them off; any putrefying animal matter will have this effect, and night-soil or urine will soon cause them to go away.

Parasitic Plants.—The mistletoe, *Loranthus*, is sometimes very troublesome to the planter. The seeds are brought by birds which pass them on the boughs, where they germinate and push their roots into the host-plant. If neglected the whole bough on which the parasite is growing dies and falls off, and eventually the whole tree may be killed.

It is of no use to merely pull off the branches of the mistletoe, as it will continue to grow again. The bough on which it is must be cut off below the parasite. The planter should regularly look over the trees to see if there is any mistletoe, so that it may be cut off while young.

The presence of any quantity of this parasite implies great neglect of the plantation on the part of the manager. I have, however, seen valuable nutmeg trees owned by natives and Eurasians almost destroyed by this pest, and in some cases, where the trees were near the seashore, they had even been attacked by the climbing parasite *Cassytha*, which attacks seashore shrubs and had climbed upon the nutmeg trees. It is a leafless, yellow, cord-like plant, with white flowers.

Hypocrella scutata.—On the leaves of sickly trees it is not uncommon to find some round bun-shaped bodies of a light orange colour, $\frac{1}{4}$ in. across and about $\frac{1}{8}$ in. thick. These are, I believe, the fruiting state of an ascomycete fungus, *Hypocrella scutata.* Under a lens they are seen to be elevated in the middle, and covered with sticky brown projections. These are the mouths of the asci, from which the spores are ejected. These bun-shaped fungi are easily detached and there is no sign of any injury to the leaf beneath them, except a small yellow spot in the centre where the chlorophyll is destroyed. On the rest of the leaf, however, is a quantity of a black mycelium of *Hypocrella.* To the naked eye it has the appearance of a little soot rubbed on the leaf.

The fruit and mycelium seem to be always on the upper side of the leaf, and do not inflict any apparently serious injury. *Hypocrella* is said to be saprophytic only, and not parasitic.

It would be better to pluck off and destroy all leaves affected by this fungus, as the mycelium doubtless is more or less injurious to the leaf. Its presence may be taken as a sign that the plant wants manuring.

Soot-Mould.—The leaves of plants in a weak state of health are often covered with a black fungus, belonging to the group of *Perisporiae* commonly known as soot-moulds. This is found on both surfaces of the leaf in the form of more or less rounded patches, which may run together, covering the leaf to a considerable extent. In the one which occurs on the nutmeg, the black mycelium forms a much-branched network, and has a knotted appearance under the lens, caused by an abundance of short rounded branchlets. The fruit generally found towards the centre of the mycelium patch is in the form of minute globular sessile balls. A very similar plant grows on *Stephanotis*.

These soot-moulds are usually stated to occur only on the excreta of one of the coccids, or scale-insects, and to be harmless to the plant. In the case of the one on the nutmeg leaves, I have found no trace of insects on the leaves at all.

Eutypa erumpens, Massee.—This fungus is reported as causing the death of nutmeg trees as well as cocos and other trees in Trinidad and Grenada. It is probably a wound parasite. It forms irregular black patches on the bark, varying in size from ½ in. to 2 in. across. The patches have a dull rough surface, in which the perithecia of fungus are sunken, and only the ostioles project; they are short and beak-shaped. The asci are club-shaped, 8-spored, and borne on long stalks. The spores are unicellular and transparent (*Bull. Agric.*, Trinidad, 1909, p. 61; *West Indian Bulletin*, x. 3, p. 243).

The Eutypas have a habit of not appearing in the fruiting stage until after the tree is quite dead, sometimes not for a week or more. Nothing can be done when a tree trunk is badly attacked to save it, but the disease should not be allowed to spread by having dead trunks or branches about the estate, so that the fungus can develop its spores and infect other plants. All dead wood should be removed and burnt.

FRUIT GANGRENE

This disease of the nutmeg fruit is due to a fungus which attacks the husk and produces an opening of it before the seed inside is ripe. This disease has been studied by Dr. J. M. Janse, who published an account of it in the *Annales du Jardin Buitenzorg*, ser. ii. vol. 1 (1899), and the *Mededeeling uit S'lands Plantation*, xxviii. The splitting of the husk of the nutmeg is effected partly by the increased tension between the seed and the husk, the seed growing a little faster. This, however, ceases when the testa of the seed commences to harden. But the dehiscence is further continued by the growth radially of a special part of the husk in the form of a small plate just at the point where the nut is attached to the husk. The development of this causes the splitting of the husk. A third force consists in the developing tension of the husk itself.

The fungus attacking the husk interferes with the nutrition and produces as a result premature dehiscence. The more the nutrition is interfered with the sooner the husk opens, so that if the disease is bad the fruit splits before the testa becomes black, and mace and testa are still white, and these failures are known as white nutmegs and are valueless. If the fruit is affected later and in only one spot, the development may progress so far that the mace is red and the testa black, only showing a little brown spot not very hard, like the rest of the testa, at the base.

The disease is by no means uncommon, and appears as little brown spots on the husk. The white nutmegs are quite useless, but they should be destroyed, to prevent further spreading of the disease, by husk and all being burnt.

The life history of the fungus does not appear to have been described, nor can I find that it has been identified. The spot of decay does not penetrate deeply into the husk and might be considered too insignificant to account for the destruction of the fruit, but it is undoubtedly, I think, as Janse has shown, the cause of the premature dehiscence and production of white nutmegs.

The account of "Nutmeg Canker" in Penang, by

R. Little, in Logan's *Journal of the East Indian Archipelago*, in 1849, vol. iii. p. 679, seems to me to refer to the same thing, though his account of it differs in some points, and I certainly never saw the disease so bad as he describes it, but what he took for the same disease attacking the fruit-stalk and branches was probably something else. It is clear from his account that the disease was not due to any insect attack.

His account is as follows:—

The canker of the nutmeg attacks the fruit, fruit-stalk, and branches. When the fruit is attacked it appears dark-brown over nearly the whole surface, with deep fissures, which pierce the skin to the depth of an $\frac{1}{8}$ in., and in those parts where the fissures are the colour inclines to a brownish black. The fissures run in all manner of ways, crossing one another like the wrinkles in the palm of the hand. Where these fissures are the skin of the fruit is dry when cut, and presents the brown appearance of the outside for some depth. These parts of the fruit which to the naked eye are merely discoloured, when examined by a powerful Stanhope lens, are proved to be rough and elevated above the natural skin, as if some insect had crawled over it, broken the cuticle, and caused an exudation of the juice of the fruit. On examining a part a little darker in colour, incipient fissures are seen, but which penetrate the cuticle to a very slight extent. These fissures are seen on the flower-stalk and the bark of the branches and stem, which are rough and wrinkled, showing that the whole cuticular structure of the tree is affected. The moment the flower drops and exposes the young fruit, on it can be seen a slight trace of the disease, which increases with its growth, the brown appearance extending and the fissures deepening until the fruit prematurely opens, displaying the mace, white in most cases, and the nut fully formed, or before that stage arrives the fruit drops off, cut across by the deepening of the disease at the junction of the fruit with its stalk.

A few of the fruit go on to full maturity, opening with red mace and well-formed nuts. The quality of the nuts does not seem to be affected by this disease, nor generally the healthy appearance of the leaves. Some trees are but slightly affected, the brown patch of the fruit to the naked eye having no fissures, but the cuticle is always rough and wrinkled. The number so affected may be 1 per cent; the number affected in the severest type with this disease is not more on this plantation than $\frac{1}{4}$ per cent. In Penang, I understand, the disease is very prevalent, so as seriously to affect the crop.

The measures taken to eradicate the disease, and their failure.—"Three years ago, on first noticing this disease, and thinking it might owe its cause to the ordinary aphis which often attacks the trees, I ordered one in particular, about ten years old, to be limed by washing the branches and stem with lime-water. That failed.

2nd. "Thinking it might proceed from a stiff cold soil and defective nutriment I had the ground well dug all round the tree, a drain made to carry off any water that might have lodged round the roots, while I manured deeply and top-dressed with cow-dung and burnt earth; but that failed. The leaves put on a most healthy deep-green hue, the fruit were abundant, but as they matured the disease showed itself as before."

3rd. He scrubbed and washed the branches and stem with an infusion of Tuba-root mixed with sulphur and Bengal soap, but that had no effect.

4th. He tried cutting the tree down close to the ground, but when the plant recovered and fruited the disease reappeared in full force, and finally he cut down the tree, dug out the roots, and planted another one, which was healthy.

He notes that the disease is not contagious, as he has not noticed the trees adjacent to those affected to be in the slightest degree touched.

CULTIVATION AREAS

The home of the nutmeg and its earliest cultivation area lay in the Moluccas, as has been already stated in the history of the spice, and to this day a very large amount of nutmegs and mace is received from the Dutch islands.

Warburg gives the following figures of bearing trees in the Dutch East Indies:—

Banda	400,000
Sumatra	190,000
Minahassa	100,000
Java	50,000
Amboyna	80,000
Halmaheira	30,000
Total . .	850,000

and the following figures are taken from his table of the production of nutmegs and mace from the Moluccas in Amsterdam pounds :—

	Nutmegs shelled.	Mace.
1820 . . .	200,000 lb.	75,000 lb.
1830 . . .	195,348 ,,	58,357 ,,
1840 . . .	511,001 ,,	119,260 ,,
1850 . . .	557,434 ,,	128,345 ,,
1860 . . .	1,072,765 ,,	275,586 ,,
1871 . . .	946,000 ,,	232,000 ,,
1880 . . .	937,000 ,,	260,000 ,,
1890 . . .	1,028,000 ,,	272,000 ,,
1894 . . .	1,329,000 ,,	278,000 ,,

The Malay Peninsula.—The cultivations of Penang and Singapore commenced to show results in the markets of Europe in 1830. The exports are given by Warburg as follows in kilograms :—

		Nutmegs.	Mace.
1830–1839.	Penang . . .	26,000 kgs.	7,000 kgs.
1840–1849.	,, . . .	86,000 ,,	26,000 ,,
,, ,,	Singapore . .	15,000 ,,	4,000 ,,
1850–1859.	Penang . . .	263,000 ,,	70,000 ,,
,, ,,	Singapore . .	120,000 ,,	30,000 ,,
1860.	Penang . . .	391,000 ,,	131,000 ,,

Then followed the collapse of the nutmeg plantations in Penang and Singapore, from which the latter island never recovered. Penang, however, produced, in 1875 to 1885, 14,000 kilograms of nutmegs and 37,000 kilograms of mace, and in 1885 to 1894 the Malay

Peninsula gave 200,000 kilos nutmegs and 50,000 kilos mace.

West Indies.—The West Indian cultivation appeared first to influence the market in from 1865 to 1874, when 10,000 kilograms of nutmegs and 3000 kilograms of mace were exported; 1875 to 1885, 10,000 kilos nutmegs and 3000 kilos of mace; 1885 to 1894, 100,000 kilos of nutmegs and 25,000 kilos of mace. The increase of output in the West Indies then increased steadily, so that though the West Indian nutmegs are less hard and more liable to fracture than those of the East Indies, they seem to be gradually ousting the former.

Holmes, in tables given by Messrs. Evans, Gray, and Hood (*Pharmaceutical Journal*, 1909, p. 419), shows that the West Indian nutmegs have trebled in the last ten years, and the price has fallen, apparently in consequence of increased supply, to about one-third of the value ten years previously.

From an article in the American journal, *The Spice-Mill*, for November 1908, p. 677, extracted by the editor of the *Agricultural News*, vol. lx. p. 84, we learn that though the ordinary customer in this country (U.S.A.) never heard of or purchased British West Indian nutmegs under their name, still these articles are being sold to them mixed up with Singapore nutmegs. Owing to the small demand in the United States for the British West Indian nutmegs, because of their inferior quality, the importations are exceedingly light, amounting to 2000 barrels per annum. The nutmegs are shipped principally from Grenada, which island is the heaviest producer of the entire group of the British West Indies, to London. There they are graded as to size and mixed with Singapore nutmegs, then shipped to this market and sold as Singapore nutmegs. The import market value of British West Indian nutmegs is from 10 to 20 per cent below the import price of Singapore nutmegs, both as to size and quality.

To this the editor of the *Agricultural News* adds:—

The total production of nutmegs in the West Indies is so small that it is not taken into consideration in the preparation of statistics here or abroad. Not until the quality of British West Indian nutmegs is improved by cultivation can they be sold under their real names.

The cultivation in Grenada, however, cannot at all be considered as a failure. In the *Kew Bulletin*, 1891, we find that "about 10 acres of nutmegs at an altitude of 1100 ft. gave annual crops of nutmegs and mace valued at £1000 sterling. This, however, is very exceptional."

Mr. Gurney, in charge of Colonel Duncan's estate, says the cultivation is a great help to the island. Most people have a few trees and most estates have some areas of more or less established trees. The small-holders find it a source of weekly income, as he sells his crops to local dealers. An acre of trees at twenty-five years of age gave £25 profit and more. It takes, however, twelve years before the trees pay, and there is not much in the business under fourteen.

In India the cultivation has never been of much success. In Calcutta the climate was found too cold for it in the cold season. Better results were obtained in the neighbourhood of the Nilgherries, especially in Courtallum. On the damper side of the ghats, Goa, Canara, and Malabar, it was cultivated, on the northern dryer side it suffered from want of the sea-air. It gave good fruit farther south in Tinnevelly. However, the cultivation was neglected or abandoned, and no nutmegs are produced in India now. In 1870-1871, 355 kilograms, valued at 575 rupees, were exported from Bombay, and 2431 kilograms from Madras, valued at 3012 rupees.

In Ceylon, very little has been done in cultivating nutmegs. About 1853, according to Ferguson (*All about Spices*), a Mr. Anstruther, then Colonial Secretary, made long-continued and extensive efforts to make the cultivation of nutmegs successful, and about 25 acres were also planted on Sir John Wilson's estate in Nilambe, and kept in a high state of cultivation for many years. These cultivations and those near Mount Lavinia practically failed. The nuts were few and inferior in quality, notwithstanding every necessary care was bestowed on their cultivation. In 1883 as much as 230 acres of nutmegs were returned in the Ceylon Directory as cultivated.

The tree is recorded, however, as bearing freely in Ratnapura, and seems, by Dr. Trimen's Report, to have done well at Peradeniya. One writer in the *Ceylon Observer* mentions the failure of trees at Gala from their being planted "kabook," which is, I believe, a Ceylon term for laterite soil, in which they do very well in the Malay Peninsula. There seems, however, to have been at this time an idea in Ceylon that manuring was fatal to the tree, and possibly want of manure had much to do with this failure.

The cultivation seems by now to have quite died out. Indeed, it was always more of an experimental than a practical cultivation in Ceylon.

In Africa the nutmeg was introduced into Zanzibar by Sultan Sayyed, but though it grows well it is not extensively cultivated. It bears freely, I learn from Mr. Lyne. It has been also introduced from time to time into West Africa, but no cultivation of any importance has been made there. In Mauritius and in Bourbon it has received more attention, and in 1864 2500 kilograms of nutmegs and 4500 kilograms of mace were exported from Bourbon. In 1865 only 1365 kilograms of mace and nutmegs were obtained, and still less in 1871, after which the cultivation was abandoned.[1]

In *South America*.—Poivre sent it to Cayenne in 1772, and it was cultivated to a small extent from 1832 to 1836, but the greatest output was only 200 kilograms in 1835, after which the cultivation dwindled away. It was a long time ago introduced into Brazil, British and Dutch Guiana, but no extensive cultivation has ever taken place in any of these places.

[1] Simmons, *Tropical Agriculture*.

PRICES

Warburg, in *Die Muskatnuss*, gives a series of very interesting tables showing the prices of nutmeg and mace in different countries from the earliest times of which there is any record.

In England a pound of nutmegs cost in 1310, 3s., and mace as much as 7s., and the spices kept about this price till 1623. When the Dutch monopolised the spice trade, nutmegs cost in England from 9s. to 19s. (in 1805) and mace from 30s. to 90s. in 1806. With the breaking down of the Dutch monopoly they fell from 5s. a pound for nutmegs and 8s. for mace in 1805 to from 9s. to 1s. 3¾d. for nutmegs, and 1s. 4d. for mace in 1865. In 1874 and 1875 nutmegs fetched 2s. 8d. to 2s. 6d. a pound, but has been steadily declining ever since, except for a few large fluctuations. The average price of nutmegs now is about half what it was in 1898, or rather less. Thus 80s. limed are quoted at 6½d. and 110s. limed at 4½d. in 1909; mace 1s. 8d. to 2s. 4d. a pound, Penang mace being rather higher than Java.

This fall in price cannot be entirely due to over-production, as the exports from the Dutch East Indies show no great increase for that period. These are as follows:—

1898–1899	1889·772 kilos	1902–1903	2840·304 kilos
1899–1900	2670·431 „	1903–1904	2686·399 „
1900–1901	2861·518 „	1904–1905	3389·804 „
1901–1902	2391·072 „	1905–1906	2793·090 „

The Dutch East Indies are the principal producers of the spice, and there has not been any great increase in output in Penang (which, indeed, is rather declining) to account for the fall in price. It is suggested that the fall in value is due to a smaller demand consequent on a decreased consumption *per capita*.[1]

There is, I think, a tendency in Europe to use less spice for flavouring in everything in the way of

[1] *Spice-Mill*, 1908, p. 749, from the *Indische Mercuur*, quoted in *Agricultural News*, 1910.

confectionery, and possibly the increased use of artificial flavouring extracts may have had some effect on the use of the natural spice.

THE FRUIT

The whole fruit consists of three parts, all of which possess certain uses and values. These are the husks, the mace, and the seed or nutmeg of commerce.

THE HUSK

This is in some demand for making nutmeg jelly, a preserve needing only to be known to be appreciated. In Singapore there is a good demand for it, and the husks are readily bought by the Chinese and Malays. Indeed, there is often locally a greater demand for the unripe fruits for preserving than for the seed and mace. As a rule, the native nutmeg preserves are made too sweet for European tastes, but the following recipe by Mrs. L. E. Bland, published in the *Agricultural Bulletin of the Straits Settlements*, vol. ii. p. 23, will be found to give a delicious preserve.

Take twenty nutmegs and 4 lb. of sugar. Cut open the fruits and take out the seeds. Soak the husks in salt and water for about twenty-four hours. Wash about ten times in plain water. Leave the husks soaking in cold water while the water is boiling. When the water is boiled put in the husks and boil till quite soft. Drain and put in a basin of cold water. Peel outside and inner skin. Cut in neat slices and place in cold water. Boil the sugar and strain, and drop the fruit in, first drying it. Boil till the sugar thickens to a right consistency, and add a dash of brandy. Note, the fruit ought to be ripe when picked, or the preserve will be hard. It should be of a pretty red colour, and the flavour is exceptional.

Nutmeg jelly is made in much the same way as guava jelly, but the sliced husks should be first steeped in salt and water, and then thoroughly washed in plain cold water, as directed for the nutmeg preserve. The husks are somewhat acid, so that a good quantity of sugar is required. The jelly, when well prepared, is of a bright red colour, and quite clear and transparent. It possesses a very pleasant flavour of nutmegs.

The natives also slice the husk and salt it as an adjunct to curries, and also as a thirst stimulant, and in the lower class of drinking shops it is usually supplied for this purpose.

The husks vary in price, but usually sell in Penang for about 10 cents for a large basket.

MACE

The mace is detached from the seed with a knife in Banda, but it is easily removed by hand, by opening it from the top of the nut and reflexing it. It is only attached to the seed by the base, which is known as the heel of the mace. When fresh it is of a brilliant red colour, rather tough and leathery, and possessing a peculiarly turpentine flavour. It is taken off and dried by preference in one piece, "double-blade," or separated into two halves, "single-blade." The double blades have a better appearance, and seem to be more popular.

The mace after removal is flattened out by hand, or sometimes between two boards. In Banda the coolies tread upon it to flatten it. It is then dried in the sun in flat baskets or trays of bamboo, or on mats.

The Dutch planters sometimes sprinkle it with sea-water before putting it to dry, in order to prevent its being attacked by insects, but this is not necessary if proper care is taken, and can hardly be said to improve the mace, though it is said also to improve the aroma and to make the mace more supple.

In most cases it is necessary to expose the mace to the sun for four or five hours a day for a fortnight (Lumsdaine), but in good, dry weather the sun-heat should dry it sufficiently in two days. Before nightfall it must be brought into a drying-shed so as to avoid its being wetted by the dew. In Banda and Minahassa it is usually taken at night into the room used for smoking the nutmegs, but in places where the nutmegs are not smoked a drying-room, light and airy, should be provided. Smoking the mace is liable to make it spotted and spoil its colour, so that if owing to the dampness of the weather it should be necessary to use artificial heat, it should be dried over a smokeless fire of charcoal, or at least care must be taken not to allow the smoke to touch it.

Great care must be taken to prevent its getting mouldy, to which it is very liable, and which very much depreciates the value of the spice. Mace, at first of a brilliant red colour, gradually becomes orange, and finally yellow, after some months' drying.

A perfect sample of mace should consist of entire double blades, not broken, flattened and of large size, horny in texture and not too brittle, and of a good, clear, and bright colour.

VARIETIES OF MACE

Pereira (*Materia Medica*, 1850) gives three varieties of mace as distinguished by the London dealers in that day, and these three varieties seem to be known in commerce to the present time.

1. *Penang Mace.*—This is the most highly valued. It is more flaky and well spread than the others, and of good size and colour.

2. *Dutch* or *Batavia Mace.*—A fleshy form which fetches a lower price. Possibly he here refers to what is known as Macassar mace, the product of another tree, *Myristica argentea*, which occurs in more or less broken pieces of a brownish colour, and dull and opaque, with the surface often powdery white. The segments have very broad, rounded axils, and are fewer in number and widely separated. They are about $\frac{1}{4}$ in. wide at the upper ends. The flavour resembles that of the true nutmeg, has more of a sassafras tendency and is distinctly acrid.

3. *Singapore Mace.*—An inferior kind, probably one of the wild island nutmegs imported into Singapore, as mace is not produced on the island.

Banda mace is the aril of the true nutmeg, and is practically the same as Penang, though Penang mace is generally considered the best in the market. As met with in commerce it is pale orange brown or brownish yellow, flattened, $1\frac{1}{2}$ to $1\frac{3}{4}$ in. long, $\frac{3}{4}$ to 1 in. wide, the forked segments having rounded axils. The tips are usually folded over into a kind of cap. The surface is dull. The flavour like that of the nutmeg, but distinct, but there is no acridity.

Bombay mace is the mace of the Indian nutmeg *Myristica malabarica.* It is of little or no value, though it appears in commerce. It is longer than genuine mace, not flattened, of a deep reddish-brown, about $2\frac{1}{4}$ in. long, $\frac{3}{4}$ to 1 in. wide, and is cut up into numerous divisions, mostly with extremely narrow axils, and more forked at the tips. It has a polished surface and a sweetish taste, somewhat mucilaginous, with a very faint flavour without any pungency (E. M. Holmes, *Pharmaceutical Journal*, November 21, 1908, p. 652).

Bombay mace and such other maces are only used to adulterate true powdered mace.

PACKING

Mace is packed in casks containing about 280 lb. each. The casks are made of teak, and care is taken to seal up any cracks with dammar resin or any other suitable material, for the spice is apt to be injured seriously by any leakage of sea-water. If teak casks are unprocurable, any wood, not resinous, and sound, would do.

In packing, a man stands inside the cask and treads the mace down with bare feet, while another pours it in from a basket.

USES

Mace is chiefly used as a spice, occasionally only in medicine, and then more as a flavouring agent. It contains about 8·2 per cent of a volatile oil, consisting for the most part of macene. The oil is colourless and very fragrant, and is quite unlike that of the nutmeg seed. The percentage of oil varies in different samples. It is given as $6\frac{1}{4}$ per cent (Herrings and Co.), 8·2 per cent (Flückiger and Hanbury), and as much as 11 and 16 per cent by Schimmel.

There is always a good demand for it, and it usually costs more per pound than the nutmeg itself.

THE NUTMEG

The husk and mace having been removed, the seed in its thin, brittle outer coat, the testa, is to be dried, to be prepared for export as the nutmeg of commerce, and after drying the testa is to be removed before packing. The testa is not broken off till the seed is dry, or it would run a great risk of being attacked by beetles.

The seeds are often merely dried in the sun, being exposed in trays of basket-work every day till quite dry. But in Banda and other places, where large quantities of nutmegs are handled at one time, fire is used to dry them. The nuts are spread on gratings about 8 ft. above a slow charcoal fire, in a drying-house built for the purpose, and exposed to the fire for from six weeks to two months. Dr. Oxley preferred to have the stages 10 ft. above the fire, and urges that it is best to commence by drying the seeds at first by exposure to sun heat for an hour or two a day in the morning, and gradually increasing the length of the exposure, till in eight or ten days they rattle in the shell, and then transfer them to the drying-house to be finished.

Care must be taken not to raise the temperature too high, or the seed will shrivel and be less valued by the dealers.

When they are quite dry, the shell or testa must be cracked off. This is usually done by striking them on the end with a wooden truncheon. They must not be struck on the side or some of the oil cells will be ruptured by the bruise, and a black mark will be left, which mars their appearance. In Banda the seeds are spread on a flat kind of drum-head, where a man strikes them with a flat piece of board, so that several are cracked at a blow. Another man standing by sweeps them off as they are cracked, and supplies fresh ones. A man working in this way will crack more nuts without injury than half a dozen men with the truncheon.

A machine for cracking nutmegs was invented by Mr. John Rudder, a native of Barbados, about 1902, and was much in favour in Grenada. It consisted of a long, high, narrow box, within which revolves a wooden wheel, the rim of which is as wide as the box and is formed of a series of wide, deep sockets. The nutmegs are fed to the machine by a funnel-shaped box, into which they are dropped at the top and fall into the sockets, where they are dashed against the end of the box. The force with which they strike cracks the shell and the kernel and shells fall to the bottom of the box. The whole machine was made of white pine-wood, and cost £12 : 10s. It would crack a barrelful of nuts in two minutes. Most of the big exporters of nutmegs in Grenada used the invention, and one who exported 600 barrels a year said he could not do without it. Some, however, objected to it on the ground that it was apt to bruise the kernel. The inventor declared, however, that it only damaged nutmegs which were insufficiently cured or unhealthy.

After the seed is taken from its shell it is liable to the attacks of beetles, especially if it is left for any length of time in the store or godown. To obviate this, formerly at least, the Dutch used to lime the nutmegs. This was done either by sprinkling them profusely or rubbing by hand with powdered lime, or by dipping them in a mixture of lime and water. In Banda, Dr. Oxley says they are packed in wooden bins filled up with lime and water to the consistency of mortar. The nutmegs remain in the bins, which are carefully closed, for three months. After this they are taken out, sorted into grades, and packed in the teak casks. In the Malay Peninsula liming has never, I believe, been resorted to, and indeed with reasonable care to keep the store-rooms free of the godown pests, it is hardly necessary.

There are a number of beetles which attack nutmegs when stored in the godown. These beetles deposit their eggs in the seed, and the larvae bore holes in it, destroying it or at least reducing its value considerably. Mr. Hart, in a circular note published in Trinidad, gives a list of those found in godowns there destroying the nutmegs. They are all very small, the largest, *Trogosita mauritanica*, being only $\frac{3}{8}$ in. long. They are—

Trogosita mauritanica, Lam.
Tribolium ferrugineum, Fabr.
Carpophilus sp.
Loemophloes sp.
Hypothemenus sp.
Lasioderma sp., near if not identical with *L. testaceum*, the too well known cigar-beetle.

Mr. Blandford, who identified them, thinks that the first two are probably the really injurious kinds. All are well-known godown pests, destroying flour, meal, and all kinds of warehouse goods. In the account given by Mr. Hart, he states that imported horse and cattle food had been stored in a room which adjoined the one in which the nutmegs were kept, and the beetles were probably brought in with this food.

Grain and beans are very liable to the attacks of these little pests, and should be kept away from the nutmegs as much as possible.

Should the godown be infested with these insects, it should be thoroughly cleaned, and white-washed internally to get rid of them.

Sorting.—Nutmegs are valued according to size. The largest are about 1 in. long and $\frac{4}{5}$ in. in diameter, and weight is about four to the ounce. They are sorted, therefore, according to weight.

No. 1 grade gives 60 to 70 nuts to the pound.
No. 2 grade gives 75 to 100 nuts to the pound.
No. 3 grade gives 100 to 150 nuts to the pound.

Broken or worm-eaten nuts, and those too small to be worth selling whole, are used for making butter, as described below.

Packing.—The nutmegs are packed in casks which have been slightly smoked inside, and then treated to a thin coat of lime and water, or in chests. Care is to be taken that the cracks in the boxes are sealed up with dammar or other resin, to prevent the incoming of water. West Indian nutmegs are imported in barrels containing 1½ to 2 cwt., but sometimes in bags or even tea-chests. It is usual to sort them into sizes before packing, but this is not always done, the sorting being done on their arrival in Europe.[1]

USES

The main use of nutmegs is as a spice, and for trade purposes they are valued according to size, as has been stated above, and smoothness, light colour, and freedom from admixture with long nutmegs, which are found mixed with the oval form, not that the long form of the genuine nutmeg is any way inferior to the oval one, but it is liable to be confused with the wild long nutmeg (*Myristica argentea*) of Papua. Singapore nutmegs are frequently darker in colour than those of Banda, Penang, and Ceylon, but the West Indian ones occasionally show darker patches of colour.

Defective or broken nutmegs are used either by being ground to make powdered spice for seasoning sausages, or for making nutmeg butter.[2]

The nutmeg contains a quantity—about a fourth of its weight—of fat, which forms the nutmeg butter of

[1] E. M. Holmes, *Pharmaceutical Journal*, March 27, 1901, p. 419.
[2] *Ibid.*

commerce. Its volatile oil amounts to something between 3 and 8 per cent, and its odour and properties are due to a substance known as *Myristicin*, which acts as a narcotic on the cerebral functions in man, and less strongly on the lower animals. As pure myristicin is less active than a dose of nutmeg containing relatively less of that body, it is assumed that the nutmeg contains some constituents that make its absorption more easy.[1] The nutmeg is little used in medicine, though it has a reputation as a cure for dyspepsia.

Oil of Nutmeg.—The flavour and odour of nutmegs are due to an oil which can be obtained by distillation of pulverised nuts. These give from 8 to 10 per cent of a straw-coloured oil containing a substance known as myristicin. Oil of nutmeg is used for scenting soap.

Nutmeg butter, otherwise known as concrete oil of nutmegs, balsam of nutmegs, butter of mace, or banda soap, is obtained by crushing nutmegs and pressing out the oil. For this purpose small or broken nuts, or those that are more or less worm-eaten and unsaleable, are crushed to a paste. The mass is then enclosed in bags and submitted to hydraulic pressure between heated iron plates. The oil comes out at first liquid, but on cooling sets into a tallowy orange-brown or whitish mass, more or less mottled and marbled. It is made up in the form of bricks about 10 in. long and 2 in. square, and wrapped in palm or pandanus leaves for export.

The nuts give from 20 to 25 per cent of the butter. It is chiefly made in the Dutch East Indies and Penang, but of late years a good deal has been made in Europe. It is rather firm in texture, and has a pleasant odour of nutmegs and a greasy and aromatic taste. It melts at 45° C. and dissolves in four volumes of warm alcohol of ·800, is partly soluble in cold alcohol and the rest in ether, and consists of a vegetable fat known as myristin, which is composed chiefly of myristic acid.

[1] Dale Power, and Salway, in *American Journal of Pharmacy*, 1908, 80, p. 12. Power and Salway, Wellcome Research Laboratories, 87.

This substance is used for certain soaps, and as an outward application for rheumatism and sprains, and is an important ingredient in pitch plaster and other similar plasters. It has a certain amount of acridity, and will blister the skin after being rubbed in for some time.

The field for nutmegs as a spice is much larger than that as a material for oil, and the suggestion to make the oil and ship it from the West Indies, instead of the nutmeg itself, would hardly be worth trying. Messrs. Schimmel, in their semi-annual Report for October 1909, state, "the nutmeg oil remans unchanged at low prices. There has been no lack of cheap nutmegs suitable for distilling."

OTHER SPECIES OF NUTMEGS

There are several species of wild nutmegs in India, the seeds of which are used chiefly for oils and soaps.

Myristica canarica, Bedd., has a small seed like a marble, about 1 to 1¼ in. long. It is a native of Southern India. The seeds are only used in making locally used candles.

M. malabarica, Lam., has an oblong, tawny and hairy seed, longer than the true nutmeg, and as broad. The seed is 1½ in. long and ¾ in. through. The shell is black and wrinkled longitudinally, and the kernel is full of a red oily juice. The seeds are only used for the oil, made into an ointment for ulcers and rheumatism, and as an adulterant for the true nutmeg. The aril is also used for adulterating mace, and is known as Bombay mace. It is deficient in the aromatic essential oil.

M. Bicuhyba, Schott., and *M. officinalis*, Mart., and *M. sebifera*, Sw., from Brazil; *M. Otoba*, H. B. K. of New Granada; *M. guatemalensis*, of Guatemala; *M. surinamensis*, of West Indies; *M. angolensis*, Welw., of Gaboon; and *M. laurifolia*, of Ceylon and Malaya, have all been utilised as vegetable-fat producers. They have no value as spice, however, as they are usually deficient in myristicin.[1]

[1] D. Hooper, *Agricultural Ledger*, 1907, 3.

Myristica argentea, the long nutmeg of New Guinea, is often imported into Singapore from the Eastern islands for making oil or soap, and occasionally gets mixed with the genuine nutmegs as an adulterant. It can be distinguished by its long and rather cylindric form. It is only faintly aromatic, and valueless as a spice.

There are upwards of fifty kinds of wild nutmeg in the Malay Peninsula and adjacent islands, and of these hardly any have any aroma either in the seed or mace. The only one which is at all aromatic in the Malay Peninsula is the rather rare *Myristica cinnamomea*, and that is by no means strongly aromatic.

LITERATURE

Warburg, in his classic work, *Die Muskatnuss*, gives eighteen pages dealing with the literature of the nutmeg. A good many of the works quoted in this list contain mere passing notices by travellers, and others refer to scientific descriptions of species, or are works unnecessary for the planter.

The following list of books and papers of the more important class, from an agriculturist's point of view, may be useful.

WARBURG, O. Die Muskatnuss. "Über die nutzbaren Muskatnüsse." Pharmaceutische Gesellschaft, 1892, p. 212.

OXLEY, Dr. "Some Account of the Nutmeg." Journal of the East Indian Archipelago, vol. iii. p. 642. "The Banda Nutmeg Plantations," *l.c.* vol. i. (new series) p. 127.

LUMSDAINE. "Cultivation of Cloves and Nutmegs in Singapore," *l.c.* vol. v. p. 78.

LOW, Col. JAMES. "Notes on the Progress of Nutmeg Cultivation," *l.c.* vol. v. p. 470. Dissertation on the Soil and Agriculture of Penang, 1836.

LITTLE, R. "Diseases of the Nutmeg Tree." Journal of the East Indian Archipelago, vol. iii. p. 678.

COLLINGWOOD, Surgeon. "Nutmeg and other Cultivations in Singapore." Journal of the Linnean Society, Botany, 1869, p. 45.

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HOLMES, E. M. "Nutmegs of Commerce." Pharmaceutical Journal, March 27, 1909, p. 419.

CHAPTER IV

CLOVES

The cloves of commerce are the unopened flower-buds of the clove tree, *Eugenia caryophyllata*, Thunb.

This is a small tree belonging to the large order *Myrtaceae*, which contains a very great number of species of the genus *Eugenia*, natives of tropical and subtropical regions all over the world. Aromatic as many of the plants of this order are, none are as highly so as this species, and none are as valuable in commerce.

The clove tree is usually of no great size, generally about 12 to 20 ft. tall, but in some places they attain a height of 40 ft. The stem is usually forked, and has often two or three erect main branches. The smaller branches are usually sub-erect, and do not spread widely, so that the tree is bushy and more or less cone-shaped. The twigs are slender and rather brittle, with grey bark. The bark of the trunk is also grey, and somewhat smooth. The leaves are lanceolate-acute at both ends, or sub-acute at the tip, and narrowed at the base into a slender leaf stalk. Above, they are dark shining green; below, paler, thinly coriaceous. The nerves are numerous, but not very conspicuous. The blade of the leaf is 3 to 5 in. long and from 1 to 1½ in. wide. The leaves of trees grown in shade are thinner, less stiff, and larger than those grown in full sun. The young leaves when put forth are greenish yellow, with a pinkish tint, and as they develop gradually darken. The leaves are in pairs. The petiole is slender, ½ to nearly 1 in. long, thickened at the base. The leaves are very aromatic, being full of minute oil glands, just visible with an ordinary lens as green dots on the lower surface.

The presence of these oil glands makes the leaves very fragrant when crushed, and on a damp, hot evening

BRANCH OF CLOVE WITH CLOVE RIPE FOR GATHERING.

the scent of a clove tree can be detected a considerable distance away.

The flowers are produced in the latter half of the year, and are borne on the ends of the branches in small bunches, consisting of three angular peduncles, each of which bears three shortly-stalked flowers on the tip. There are small, linear, fleshy bracts to the flowers. The whole inflorescence is $1\frac{1}{2}$ in. long. Each

Clove Tree.

flower consists of a cylindric thick ovary, $\frac{1}{4}$ in. long, above which are four fleshy ovate sepals, and above this the four white rounded petals which form a ball in the bud and fall off when the flower opens, displaying a very large number of slender stamens, in the midst of which is the slender style. After fertilisation by some insect the stamens and style fall off, and the lower part of the flower, with the calyx, develops into a fleshy, dark-pink, one-seeded drupe, about 1 in. long and $\frac{2}{5}$ in. through in the thickest part, with a narrow base dilated upwards, obovate in outline. The sepals are reduced to short, fleshy triangular points. The seed is oblong, $\frac{3}{5}$ in. long, rather soft in texture, and grooved on one side.

Rumphius (*Herbarium Amboinense*, vol. ii. p. 1) describes three forms of clove plants. The first has the buds hardly red when ripe; the second, called *bugu lawan kiri*, is smaller and red when ripe, and chiefly occurs in Hitoe and Ley Timor; the third form is hardly red when fit for gathering, and the fruit is white,—this he calls female cloves.

HISTORY

The clove tree appears to be indigenous only to a small number of islands in the Moluccas, namely, Tidore, Ternate, Mortir, Machian, and Batchian, volcanic islands in the neighbourhood of Gilolo. It does not, however, appear to be wild in the last mentioned island.

The earliest record of this spice is in Chinese books dating from 266 B.C. to 220 B.C., wherein officers of the court are required to hold cloves in their mouths when addressing their Sovereign.

A spice which was probably cloves is mentioned by Pliny as occurring in India, and resembling pepper-corns, but longer and more fragile, and called Caryophyllum. The Greek word caryophyllon is supposed to be derived from *caryon* (a nut) and *phyllon* (leaf), and to refer to the ball-like mass of petals and stamens which terminate the bud; but as the word is also met with under the forms of Garophul, Karpophul, and Garofalo, it is probably a word of Asiatic origin Hellenised.

Rumphius, in the *Herbarium Amboinense*, gives the words karumpfel, calafur, or caraful as Arabic words from which caryophyllus may be derived.

It is indeed probable that the Arab traders, who doubtless introduced it to Europe, introduced the Arabic name with it.

Garcia da Orta, in the *Historia aromatum*, says that neither Dioscorides nor Galen mention it, but Kosmas Indicopleustes, in A.D. 547, mentions it as an import from China to Ceylon, and says it was thence imported to other parts of the world. It seems, therefore, that the Chinese, who traded much with the Eastern islands, were the first to discover and use the spice.

From the eighth century onwards it was regularly imported into Europe, but was very costly, being valued in 1265 at from 10s. to 12s. a pound.

Marco Polo, like other writers of his date, describes it as being obtained from Java, and also from Kaindu, a part of China.

Nicolo Conti, a Venetian merchant (1424 to 1448), was the first to discover the real source of the spice, saying that it comes from Banda; but more correct localisation was obtained by the Portuguese in the sixteenth century, and Pigafetta described the plant more fully in 1521. Garcia da Orta says that in his time it was not cultivated anywhere, but that it grew in the Moluccas, in Gilolo, and also in Ceylon and some other places, but it was not so productive anywhere as it was in the Moluccas. Probably, like Marco Polo, he mistook the ports whence it was shipped, Ceylon and the other places, for the home of the plant. It was exported to Malacca, as were the other Eastern spices, for shipment to Europe. The Portuguese held control of the Spice Islands till 1605, when they were expelled by the Dutch, and by this time the plant had been introduced into Amboyna, Ley Timor, and Uliasser islands. Still, however, comparatively few cloves were produced or exported till the occupation of the islands by the Dutch.

As in the case of the nutmeg, they attempted to form a monopoly of the spice by confining its cultivation to Amboyna, and by making periodical expeditions to other islands to exterminate it. Though they pursued this policy with great inhumanity, their attempts to keep the trade exclusively in their hands was not altogether successful. Large supplies reached England independently of their Government. Thus, in 1609, a ship belonging to the East India Company, the *Consent*, reached England with 112,000 lb. of cloves on board, on which duty to the amount of £1400, and an import tax of as much again was paid; the cloves sold for from 5s. 6d. to 5s. 9d. a pound.

The Dutch, however, maintained almost a complete monopoly of the spice trade till the eighteenth century, at the end of which time attempts were made to wrest it from them.

In 1770 M. Poivre, the governor of Mauritius and Bourbon, succeeded in procuring some living plants, both of nutmegs and cloves, and introduced these successfully into the island under his control, for the benefit of the French Government, and from these trees plants were sent to Cayenne about 1789 and onwards. William Urban Buée introduced them from Cayenne into the West Indies in 1789, obtaining one plant that year and fourteen more in 1791, and in 1793 managed with much expense and trouble to secure two boxes of seed; for exportation from French territory of plants and seed was forbidden. His first two trees fruited in 1795, and the produce was decided to be fit for any culinary purpose, and as good as any of the East Indian cloves.

Buée published an excellent *Narrative of the Successful Manner of Cultivating the Clove Tree in the Island of Dominica*, in 1797.

Plants were introduced also into Martinique about this time, and it is recorded that 300 lb. of cloves were sent to London in 1797. Some time later it was introduced into St. Kitts and St. Vincent, and samples of the spice were sent to England in 1880.

Meanwhile an Arab from Zanzibar had conveyed plants to his country from Mauritius, and laid the foundations of the important and extensive cultivations in Zanzibar and Pemba, which are carried on to this day.

On the founding of Penang by Captain Light in 1786, the East India Company took steps to break the Dutch monopoly of spices by sending Christopher Smith, their botanist, to the Moluccas to obtain plants of cloves and nutmegs, as described under the account of the introduction of the latter plant. Captain Light had already obtained clove plants from Mauritius, but in 1798 only a few, less than half a dozen, were alive, and these appear to have been of Smith's first sending, Light's original plants having previously died. In 1880 ? Smith sent 15,000 clove plants, and by 1802 there were 6,250 cloves in good condition in the East India Company's spice garden.

There were also several European plantations of some size. The trees, however, seem to have been mostly young, and when the Penang spice gardens were sold in 1805, there were only twenty-three bearing clove trees.

The cultivation went on somewhat slowly till 1821, when it rapidly advanced, over 50,000 trees being added between that date and 1836.

The cloves of Penang have always been the most highly valued, and have maintained their reputation for superiority from the commencement of the cultiva-tion to the present day.

The plantations now, however, have almost entirely passed from the hands of the Europeans into those of the Chinese, as did the nutmegs.

In Singapore, Sir Stamford Raffles, shortly after the foundation of the settlement, introduced cloves with nutmegs into the island, but the island does not seem as suitable a locality, and the trees suffer much from attacks of the parasite *Cephaleurus*. The plantations dwindled away and seem to have disappeared about the time of the collapse of the nutmeg industry in 1866, and it is curious that though there can (or until recently could) be seen old nutmeg trees about Singapore, chiefly in the older gardens, which were relics of the old nutmeg plantations, hardly one of the old clove trees remains to the present day.

In Sumatra, in the old days of the Bencoolen Settlement in 1823, there were a good many cloves planted, but after the settlement was handed over to the Dutch they soon disappeared.

NAMES OF THE PRODUCT

The English word cloves is derived from the French *clou* (a nail), from the resemblance of the dried bud to a nail, and the same idea occurs in the Dutch word *naghel*, the Spanish *clavo*, and the Italian *chiodo*. The French word *girofle* (*clous de girofle*) is derived from caryophyllon.

In Sanskrit the name is *laoanga*, whence the Bengali *lung* and Hindu *laung*, and this word also occurs in Malay as *bunga lawang*. It appears also in the name of the Indian clove bark *kulit lawang*. Rumphius gives the Amboinese name as *bugu lawan* and *bubu lawan*.

The common Malay name for the spice nowadays is *chingkeh*, which Rumphius perhaps correctly derives from the Chinese *theng lui*.

It is rather remarkable that the Malay names for this Malayan spice are Indian and Chinese respectively, rather confirming the idea that the Malays themselves did not value or use this spice to any extent, and that it was the Chinese who first appreciated the value of it, and made the first use of it.

Indeed, the Malays to the present day use it only to flavour gambir for chewing with betel-nut, and in certain medicines.

The fruits of cloves, in Latin *anthophylli*, *anto-*

fellen in Belgian, are known as mother-cloves in England.

Rumphius gives as Malay names *polong* and *ibu chingkeh.*

CULTIVATION

The plant is usually grown from seed, but can be propagated by layers. In Zanzibar the method of raising from seed is as follows. The seeds are first soaked in water for three days, and when germination has set in, they are planted out about 6 in. apart in shaded beds, with the bud end above-ground. It is usual to put two seeds together to provide against failures. If a large number of plants are put down the seeds are placed about 3 to 4 in. apart. The beds are about 6 ft. wide and of any length. They are shaded by a flat framework of sticks, over which is placed a layer of dry grass or coco-nut leaves. The framework is about 3 to 3½ ft. high. The young plants are watered morning and evening by the coolies, wherever the soil has become dry, water being sprinkled by hand from a jar. This is done as long as the seeds are not developed thoroughly. When the plants are above-ground it is done every other day; when 6 in. high every week or ten days. The plants are kept from nine months to a year in the beds. When they are about 6 in. tall they are gradually hardened off by partially removing the shading, and are then left in the beds exposed to the sun for a month or two before planting out.[1]

In Amboyna, either the seeds are taken and raised in beds, as above described, or young plants that are found about the estate are taken out and transplanted. The plants raised from seed, though luxuriant, are not thought to be as fruitful as self-sown plants.

In Bencoolen, Sumatra, the seeds were planted in rich mould 12 in. apart from each other, screened from the sun and duly watered. They germinate within five weeks, and when 4 ft. tall are transplanted to distances of 30 ft. apart, with a small admixture of sand with the

[1] *Consular Report*, Zanzibar, 1892, p. 266.

red mould peculiar to the locality, so as to reduce its tenacity.

Soil.—The selection of the soil and the position of the ground for the young plant is a matter of great importance. The most suitable soil is a dark loam with a substratum of dark yellow earth mixed with gravel; a clayey soil suits them well, and in Zanzibar a red clay soil is considered better than a lighter, more open soil. The finest trees were observed in Zanzibar to be growing on a red clay, or stiff dark red to a darker chocolate soil. In the Straits Settlements the black soil of the valleys, which overlies a stiffer clay, is suitable, but in Penang they are commonly grown on the same class of soil as the nutmegs. Some planters recommend a gravelly soil, but this must not be too hard or stony, and should have a good mixture of clay in it. Sandy soil is unsuitable, and still worse is wet, water-logged soil. Water at the roots is fatal to the plant. A number of trees were planted some thirty years ago in the Singapore Botanic Gardens in a locality of this nature. After growing slowly for many years, till they reached the height of about 12 or 14 ft., the greater number perished without flowering. Investigation showed that the roots of the trees had come to a water-bed, and, unable to grow further, had curled and bent in a remarkable way to avoid the water, but unable to get into dryer soil had decayed away, causing the death of the tree. In very stiff yellow clay, especially if exposed to the full sun, they rarely thrive, making but little growth and suffering from various pests.

The clove, like the nutmeg, appears to be an insular plant. It does not thrive usually at any distance from the sea, and it is commonly said that it requires sea-air. It is very noticeable how the plant has practically only been successfully cultivated in islands of the sea, *e.g.* Amboyna, the Spice Islands, Penang, Dominica, and other West Indian islands, and the Mascarene Islands.

In the matter of altitude, it requires and can grow at about the same elevation as the nutmeg, but it seems to be unable to grow well as high as that tree does. A few hundred feet above sea-level seems to be its limit.

The climate, temperature, and rainfall necessary for it are the same as for the nutmeg, and as it demands propinquity to the sea the area of its successful cultivation is practically limited to islands between the latitudes of 20° north and 20° south of the Equator.

Planting.—The young trees are planted out at a distance of 30 ft. apart. In Zanzibar this is done when they are about 6 in. tall. In Bencoolen, in Sumatra, it used to be the custom to wait till the plant is 4 ft. tall. This long delay does not seem to have anything particular to recommend it, and till it is from 6 to 10 in. tall is quite long enough to keep it in the nursery. After lining the plantation out the holes should be dug 2 ft. wide and as deep, and filled with good humus, leaf-mould, cow-dung if procurable, with burnt earth, all well mixed together.

In Zanzibar special care is taken to loosen the earth round the little plant with a specially made triangular-shaped spade. The plant is lifted with a good ball of earth round its roots, and put in the centre of two strips of banana sheath 3 to 4 in. wide and $1\frac{1}{2}$ to 2 ft. long. The strips are placed across each other, with a plant in the middle, and the four ends of the strip are taken up and fastened round the ball of earth by tying a piece of fibre round the neck. Plants packed up in this way can be carried easily and safely to their destination without dropping the earth from their roots. The plant is then put into a hole made in the earth which fills up the large hole, and the soil heaped up round it, and pressed firmly. The banana sheath is cut through, so as to free the plant, and the strips removed. This method of packing plants for transport is commonly used by natives for all kinds of plants, and can be used for any small trees, but care must be taken to straighten the tap-root, if it has been bent during the packing. In filling the hole, care must be taken to raise the mound

9 in. or 1 ft. above the level, to allow for sinking of the loose earth.

Buée describes and figures a planting machine in the form of a split cylinder with two handles which is put round the little plant and pushed into the ground as deep as it will go, the cylinder being closed round the plant and its soil. The earth outside the cylinder is dug away with a trowel till the bottom of the cylinder is reached, and the trowel being pushed beneath the base of the cylinder the whole is lifted. The cylinders are carried to the place where the plants are to be set and pushed into the planting-hole, the wire which closes the hinge of the cylinder withdrawn so that it partly opens, and it is then pulled out, leaving the plant in its place.

The objection to this system of plant shifting lies in its rather unnecessary complication. It would be considered too slow nowadays by the modern planter, who finds that by due care the small plants can be lifted from the bed, especially if not too closely planted, with a trowel only, with perfect success.

Tile pots made of two half cylinders of baked clay, or joints of bamboo split in two lengthways, may be used if the nursery is too far from the plantation. In using these, the half cylinders of tile or bamboo are tied round at the top and bottom with a piece of split rattan and filled with soil, in which a seed is inserted. The pots are stood in rows till the seed has germinated and grown to the required height, when it is transferred to the planting-hole, into which the cylinder is inserted, the rattans cut and the half cylinders drawn out, leaving the plant with its soil in its place.

Another method is to use sections of common tin piping cut in halves, lengthways, and fastened as before with split rattan. The plants grown in piping or tile pots are sunk in the ground, so as to keep them cool, or loose soil is banked up round them. Grown in this way they are very portable for planting out.

Cylindric or cone shaped baskets of split rattan or bamboo are often used in estates in which the nurseries are at some distance from the field. The plants can either be raised from seed in the basket or can be transferred to them and allowed to grow on, when they have attained the height of a few inches. The baskets are made by coolies at odd times, or during rain, when no work can be carried on in the field. When the clove tree is planted out it is not removed from the basket, but the whole thing is planted in the ground, where as the plant grows the basket decays away. These baskets are very portable, easy to make, and cheap. They do not interfere with the root growth, nor are they apt to retain the water and cause the plant to become water-logged if by chance it should be kept too long before it is planted out.

The young plant is, of course, watered when planted and afterwards as long as may be considered necessary according to the dryness of the climate at the time, and till it has well settled into the ground and begun to push out fresh leaves.

Manuring.—In most soils cloves require manuring during their growth, but in Zanzibar no manure is used other than the dead leaves lying about the estate, which are swept to the base of trees. In the Straits Settlements cow-dung is used if procurable, and the prawn-dust, as described under nutmegs, is commonly used. Mulching with cut grass is very beneficial to the young trees.

Shading.—In Penang, the clove like the nutmeg is cultivated on the exposed hills without any shading at all. In Amboyna it is, according to Rumphius, grown with fruit trees or coco-nuts as partial shade. He considered it a good plan to cultivate them under light shade when young, cutting out the shade trees as the clove trees grew. This method has much to recommend it, and is a way that works very well with many trees whose original habitat was the forest region. For most trees of this class, sudden exposure of the young plant to full sun does not favour its growth, and may kill it, or at least retard its development. Light shade, especially protection from the afternoon sun, suits the tree much better.

Trees growing in the partial shade given by the tree *Fagraea fragrans*, in the Botanic Gardens, Singapore, were more bushy and well developed, as well as being more free from the red-spot disease, than fully exposed trees, and in one case even the boughs of one half of a clove tree accidentally shaded on one side by a near-by tree produced flowers and fruit when the rest of the tree was quite barren. Rumphius pointed out that the shade must not be dense; under such shade the tree grows tall, and looks well and leafy and, as I have said, is less subject to red-spot, but it will not produce flower buds, and, according to Rumphius, when it does they are less aromatic, and are considered by the natives as wild cloves of little or no value. Trees grown under the shade of and close to a large Para rubber tree, produced no cloves for many years, although remarkably healthy-looking. By selecting a piece of wooded ground and thinning out the trees so as to let in a good amount of light, and planting the cloves among the light wood, gradually thinning away the forest trees as the spice trees develop, an excellent plantation would be obtained.

According to Rumphius, a walk in the clove wood when the trees are in bud or flower, is said to cause headache, but, as he points out, this season in Amboyna, viz. October and November, is a hot one, and this probably is the cause of the discomfort. It does not appear that the clove tree is regularly cultivated under trees anywhere except in Amboyna, but it is said that in Zanzibar many are grown by the slaves among fruit trees and other similar plants.

Pruning.—Pruning the trees does not seem to be common in any place where cloves are cultivated, but as the tree has a tendency to throw up its branches very close together, it is often advisable to cut out some of the inner ones. In the Straits Settlements the tree usually attains a height of 12 to 15 ft. only, and it is not topped, but in Amboyna and other parts of the Eastern Archipelago, where it grows to 20 or as much as 40 ft. in height, it is advisable to top it so that the buds can be easily reached by the pickers. Besides this work there is little to be done to the plantation except weeding where necessary when the plants are young, and cleaning the trees of parasitic mistletoes, and of moss and epiphytic ferns, to which they are rather liable, destroying borers and other pests, and manuring, until the trees commence to produce the flower buds.

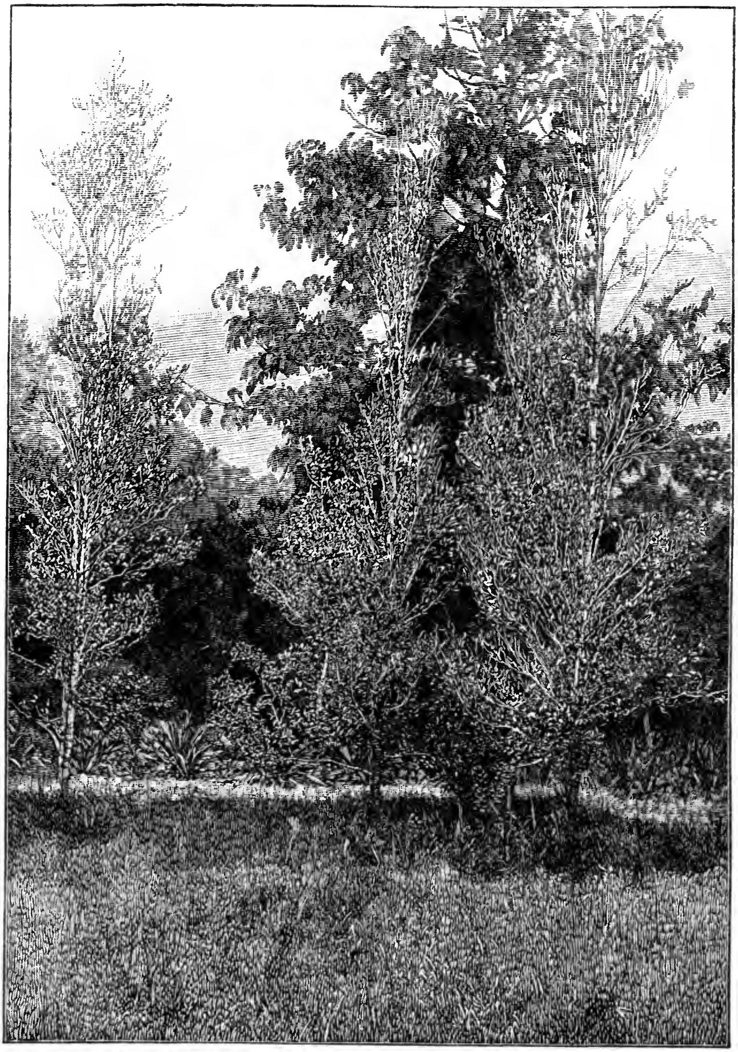
PESTS AND DISEASES

There are not many recorded diseases of the clove tree, but one of those known is a very troublesome and destructive pest. It is a parasitic alga known as *Cephaleurus mycoidea*, Karsten, or "Red-spot."

The attack of this parasite appears to the naked eye as a dark red spot visible on both surfaces of the leaf, more or less rounded or oval in outline, and from about $\frac{1}{20}$ in. across to $\frac{1}{5}$ in. in diameter. Commencing quite small, it increases gradually in size; eventually the spot becomes hard and black in the centre, with the oil glands much enlarged and swollen, and at last the centre becomes dead, greyish in colour, surrounded by a black and outer red ring. The dead portion falls out, leaving a circular hole in the leaf. The spots are scattered over the leaf usually nearer to the edge than to the centre, and frequently run into each other. The leaf is often attacked when it has just opened, and before it has attained its full green colouring, and in many cases it appears that the bud is attacked and quite often destroyed. In any case the attack seems to commence in the early stages of the opening of the leaf. At length, when the leaf is getting yellow and dying, the alga commences to fruit on the under side of the leaf. In the blackened spot can be seen with a lens some fine white hairs, tipped with yellow. On examination with the microscope these hairs are seen to be fine filaments, bearing at their ends a number of short arms, usually from 3 to 9 in number, all nearly equal in length. At the end of each arm, which is abruptly decurved, is a yellow rounded body, the *zoosporangium.* These zoosporanges open by a minute hole at the top and let out a number of zoospores, which swim in drops of water by the aid of two minute hairs or *cilia,* and are thus carried from leaf to leaf by the rain, and probably also these, or another form of zoospore, are dispersed while in the resting stage by wind.

The pest was identified for me by Mr. Massee as the alga *Cephaleurus mycoidea,* Karsten (*Mycoidea parasitica,* Cunningham), which is known as a destructive parasite on many kinds of thick-leaved trees, in the Straits Settlements, Malay Islands, and Ceylon. It attacks among other trees camellias, tea, mangosteen, and similar trees. Full accounts of it are published in the *Transactions of the Linnean Society,* 1880, by Cunningham; by Karsten in *Annales du Jardin Botanique de Buitenzorg,* vol. x. p. 24; and by Marshall Ward (*Trans. Linn. Soc.,* 1881, vol. ii. p. 87).

The plant forms a kind of crust, the thallus, on the leaf, and pushes down root-like processes into the tissue of the leaf, destroying it, apparently mainly by using up its water supply. The leaves turn yellow and fall sooner than they should, giving the tree a bare appearance. Many of the boughs are leafless nearly to the top, and the whole appearance of the tree is weak and shabby, with scanty foliage. Some trees in the Botanic Gardens at Singapore were badly affected by this alga, and the treatment of washing them with Bordeaux mixture was tried with marked success. The mixture was syringed on to the trees with a bamboo squirt till the foliage was conspicuously blue. At the next putting forth of leaves it was noticed that the young leaves which came out were not attacked by the parasite, while the trees that were not syringed were as bad as before, the leaves being all spotted with the fungus, and many buds blackened and dead.



Clove Tree attacked by *Cephaleurus*.

The worst attacked trees are those on bad, stiff, yellow clay soil, exposed to full sun. A tree growing beneath a large Para rubber tree was but little damaged, though the parasite was present. This tree, however, appears to be over-shaded, as, though quite an old tree, it has, as far as I know, never flowered. The soil it grows in is, however, better and richer than that in which another tree about 50 yards away is growing, and which is in a bad state from the attacks of this alga. At the same time it must be mentioned that trees exposed to full sunlight, though growing in fairly good damp soil, are badly affected, and that manuring with cow-dung, though producing a good renewed growth of leaves and buds, does not seem to have any permanent effect in restraining the growth of the pest.

I am inclined to think that the actual shading of the tree has more to do with the check of the pest, as young seedlings planted under shade in lines in a wood partly cleared for the clove plant seem quite free from the disease.

The fungus is very destructive to seedlings, and I have lost a great many at times, though care was taken to disinfect them from time to time with copper sulphate. These seedlings were not only grown in beds or nurseries, but also in flower-pots, but when put out in exposed hot positions the buds were soon infected with the disease, and very soon the little plant died.

Badly infested trees do not flower, and are therefore from a planter's point of view valueless. I noted at one time that in the case of a tree badly infested with this pest, no flowers were produced on any part of the tree except on a branch that happened to have grown into the branches of a shade tree (*Sterculia elata*), whose large leaves protected the clove branch from the full heat and light of the sun. This branch for some years produced flowers regularly in February and March, but by some chance the protecting bough of the *Sterculia* was cut away, and since then no flowers have appeared.

This destruction of the bud leaves and the growing point of the branch seem sufficient to account for the failure of this tree to produce flowers when badly attacked. The fine clove trees of Penang and Province Wellesley are not grown under shade, but fully exposed to the hot sun and its brilliant light, being cultivated in the same way and in the same positions as the nutmeg, but they are hardly at all attacked and are not, as a rule, injured by the parasite. I attribute this phenomenon to the action of the sea-air, as I have noticed that where the clove trees in Penang are away from the sea by the configuration of the ground, so that the sea cannot be seen from where they are growing, these trees are attacked and die; and again, trees planted in various parts of the Botanic Gardens, and in other districts of Singapore where no sea-air can possibly reach them, soon become badly affected and die. This was notably the case in an estate of nutmegs and cloves planted inland some years ago, where when the clove trees had reached the fruiting stage they died without flowering at all. Badly diseased trees may live for many years before they actually succumb. Trees over thirty years old in the Singapore Botanic Gardens are still alive, though most have never produced flowers. The appearance of a sick tree is quite striking. Instead of being densely covered with rich dark-green leaves it is thin; many boughs bear only a few leaves at the end; the whole tree has a birch-broom-like appearance (see plate).

The saying that the clove tree must see the sea is probably based on its requirements of sea-air, for without this the plant is almost always a failure. It cannot be said to have ever been a great success in the rather flat though undulating inland of Singapore, nor have I ever seen it well-grown elsewhere inland at any distance from the sea breezes. In such spots it seems always to succumb to the *Cephaleurus*, sooner or later.

In mild cases spraying with Bordeaux mixture is decidedly beneficial, but this treatment needs to be repeated or the alga will return, and in unsuitable localities inland the pest becomes hopeless.

In some cases there is persistent death of the terminal buds, which turn black when hardly $\frac{1}{5}$ in. long and die. Usually, if the tree is strong, a side bud is produced, grows for a time, and dies; then another axillary bud is produced and the same thing happens, until the branch dies away altogether. In some cases the production of lateral buds is so extensive that the ends of the boughs form a kind of brush or small bush. In all the cases I have seen such trees are infected with *Cephaleurus*, but I am not quite certain that this is the cause of the destruction, as I have not been able to get good specimens of the pest fruiting on the buds. The treatment with copper sulphate advised for the one would, however, in any case, be suitable for the other. In looking over various trees and shrubs of other species for the *Cephaleurus*, I did not find it upon tea bushes in the neighbourhood of the cloves, nor on *Calophyllum* or other coriaceous leaved plants except on the cassia bark, *Cinnamomum cassia*, but it does not seem to be very injurious to this plant.

Borer-Caterpillar.—This pest is not uncommon in Penang, where I saw it seriously damaging trees at Penara Bukit. The caterpillar was black, with yellow rings, and covered with rather sparse long hairs. It is about $1\frac{1}{2}$ in. long when nearly adult.

It bores into the branches, more rarely the main stem, tunnelling up the centre and eventually killing the branch. Two or three may occur in one branch. The entrance to the burrow is protected by a web enclosing the small pellets of excreta. These boring caterpillars are very difficult to rear, and I failed to get them to develop into the moth. The usual Chinese treatment for this pest is to cut into the branches and hack out the caterpillar, but this is very injurious to the tree. The simplest method of dealing with this insect would be to spear it in its burrow by passing a thin wire up. This is not difficult, as the tunnel is usually straight and not very long, and not choked up with excreta, as in the tunnels of longicorn beetles and such insects, or some insecticide might be injected into the burrows, but this is less easy.

Small boughs bored may be cut off. The adult insect has never been identified, but is undoubtedly some species of moth.

In Zanzibar, a leaf-eating caterpillar is recorded, which attacks the trees in the dry weather and denudes the tree of its leaves. The tree, however, is said to recover during the rains. The termites are also said to attack the roots occasionally (*Consular Report*, 1892, p. 266). No further details, however, are given.

I have no record of termites attacking clove trees in the East Indies. A case of the sudden death of a clove tree from termites once referred to me proved to have been due to the attacks of a root fungus, the termites having merely commenced to destroy the already dead parts of the tree.

Blights.—I find a species of *Mytilaspis* attacking the stems and the leaves of young plants, later causing distortion of them. It is a small, white, mussel-shaped coccid, which attacks many plants, especially seedlings, and is described elsewhere in this work.

Root Fungus.—In the Botanic Gardens in Malacca, in 1894, a fine young clove tree suddenly died when just coming into fruit. This was supposed to be due to the attacks of termites, as there was a great mass of galleries thrown up at the base of the tree, but on digging away the soil it was discovered that the whole of the bark above the roots was black and putrid, and some of the larger roots covered with a white mildew. The tree must have been attacked some time previously by this fungus, only dying when the destruction was absolutely complete. This fungus was never identified. It probably spread underground, as these parasites often do, as a number of trees were destroyed.

In the case of a root-fungus like this appearing on an estate, the trees should be at once destroyed and burnt, the roots being carefully dug out and burnt. The ground should be treated with lime, and trees should not be replanted there for some years. The disease, however, appears to be rare, and I have never come across another instance of it.

Loranthi.—The mistletoes attack the clove tree as they do the nutmegs (which see), and in Penang I have seen also the parasite *Cassytha* strangling the branches. It is a yellow, wiry, leafless plant, belonging to the order *Laurineae*, but having more of the appearance of a dodder. This plant only grows on the sea-shore, so that it is not of frequent occurrence in a clove estate, and its presence on a clove tree is evidence of gross neglect.

The clove tree in damp spots, or where too closely planted, is very apt to be covered with mosses and hepatics, which grow on the branches as epiphytes. These, though not parasitic, as the mistletoes, but only growing on the outside of the bark, are not beneficial to the tree, but appear to be rather injurious, often interfering with the growth of the twigs and causing the death of the smaller branches. These mosses should be pulled off and the tree cleaned of all such epiphytic growths.

CROPPING

The clove tree commences to produce flower-buds in the fourth or fifth year after planting, in Penang and Zanzibar. If the soil is inferior it is said to take longer, from six to six and a half years. In the Moluccas from six to eight years is the period given. The buds are ready for gathering in August to December in Zanzibar, and about a month later, that is to say, from November to January, in the Straits Settlements. In the Moluccas the harvest takes place twice a year, namely in July and December.

Just before the buds are produced there is a fresh flush of young leaves put forth, and soon after this the buds begin to appear. They are green at first, then become yellowish with a pink tint, and finally dull blood-red, when they are fit to gather. As the buds are not all ripe at once, it is necessary to go over the trees twice or thrice during the harvest season.

The buds are usually gathered by hand, hooked sticks being used to pull down the branches. In Amboyna they are partly gathered by hand and partly knocked off the branches with bamboos. As all parts of the trees are not accessible from the ground, step-ladders are used to enable the coolies to reach the buds. The branches are rather brittle and care has to be taken not to break them, as rough treatment may prevent their bearing well for some years.

The buds are then spread out to dry on mats in the sun. In some places they are scalded with hot water before drying. This is not common, however, and is apt to spoil the appearance of the finished produce.

In Amboyna they are first dried on a framework over a slow wood fire, which gives them a brown colour, and then are finally dried off in the sun, which produces a black colour. Some of the finest cloves I have seen were dried on zinc plates over a fire. These were prepared for an Exhibition at Penang, and were remarkably plump and well-coloured.

In Zanzibar, after the cloves are gathered the slaves pick the clove buds from the stalks and spread them out to dry on mats in direct sunlight, taking them in at night to avoid their becoming wet with dew. The drying is continued for six or seven days, during which they lose about 50 per cent of their weight, or sometimes as much as 60 per cent. The Zanzibar cloves are drier than those of Pemba when shipped, but lose 8 per cent more in weight by shrinkage in transport to Europe.

Mr. Thomas Burt urges, in the *Shamba*, that the cloves should be separated from the stalks, and the leaves, stalks, and waste bits thrown away at once, and that the cloves should not be left in piles or baskets over night, as if this is allowed they heat, much to their injury. The cloves should be spread out on mats, if possible on a concrete floor, and not laid on the ground. He also points out that in gathering the buds should be picked in the best condition, neither too young nor too old.

The Zanzibar cloves are small and often shrivelled, and of a poor colour, much inferior to Penang and Amboyna cloves. This may be due to the slow method of drying or to carelessness of the native workman.

It is probable that careful drying by heat would give finer results than can be obtained under the best circumstances by sun-heat, and in the tropics one can never depend on having good drying days when the cloves are ripe for gathering. In any case it would be as well to have a good drying-room available for use in wet weather, in which the temperature could be raised, or a series of good drying ovens.

The average weight of cloves produced by each tree in a season in Amboyna is given as 5 lbs., in Sumatra 6 or 7 lbs., in Penang 5 lbs., while in the Moluccas 4½ lbs. is given as the usual crop.

Allowing 100 trees to the acre, and that two-thirds of these are in full bearing condition, an acre will produce 375 lbs. of dry cloves.

Consul Pratt of Zanzibar, in a Consular Report, estimates the produce of a tree much higher. He says a ten-year-old plantation should produce an average of 20 lbs. of cloves to a tree, and that trees of twenty years should give upwards of 100 lbs. each. This seems certainly to be exaggerated.

PACKING

Cloves are usually exported in gunny bags, but in Zanzibar double mat bags are used in preference. They are very liable to injury from sea-water, so that it is essential that the bags be sound and stored in a safe place on board. The best cloves are large and plump, but little wrinkled, and of a light purplish brown with a purplish bloom on them. If gathered unripe or too soon they become small and shrivelled. If insufficiently dried they are apt to go mouldy, and if they are too rapidly dried they become black, brittle, and wrinkled. These small black shrivelled cloves find indeed a market, but at a much lower value than full-sized, plump, brown buds.

Though Zanzibar and Pemba produce quite two-thirds of the total crop for the year, they do not produce the finest cloves, which are those of Penang.

METHODS OF CULTIVATION IN ZANZIBAR AND PEMBA

I give here the accounts of cultivation of cloves in plantations known as shambas in Zanzibar and Pemba. These accounts were published in the Zanzibar periodical, the *Shamba*, and in the *Annual Report of the Agricultural Department of Zanzibar*, and are reprinted in the *Tropical Agriculturist* in 1900. They are both of interest, as showing not only the methods of culture, but also the approximate cost of cultivation and returns.

The first article is entitled "The Story of a Clove Plantation." The author, whose name is not given, commences as follows :—

The shamba (estate) in question is known as Kizimbani, about half an hour inland from Weti, Pemba. It was selected by Canon Key as a missionary site chiefly because of its situation on the Suka Road, one of the arteries which feed Weti from the north. Kizimbani contains in all 1,100 clove trees, 950 of which are bearing, the other 150 being unproductive. R.1,132-8-0 were paid for the clove shamba, originally two, and R.155 for three patches of waste land adjoining, in all R.1,287-8-0. Occupation was entered into in January 1898, and clove picking began on October 29, lasting until February 21, 1899. Three pice a pishi was given to pickers, the legal measure being used. Arabs in the locality also gave 3 pice per pishi, but used the native wooden measure, always used in the plantations for clove picking, both in Zanzibar and Pemba, and which contains a little more than the metal one used by the shop-keepers. Canon Key gave his people 2 pice per pishi daily, and banked the other pice for them till the season was finished, an arrangement which they apparently appreciated. From twenty to forty pickers were employed, and two overseers at R.14 a month each.

In all 520 fraslas were obtained from the 950 trees, an average of $19\frac{2}{5}$ lbs. of cloves per tree, and a return, after paying export duty of 25 per cent, of R.1,965. Add R.38 for 43 fraslas stems, and the gross returns are R.2,003.

From this total there are several charges to be deducted: 8 pice per bag for cloves and 5 pice for stems, amounting to R.29, were paid for conveyance to the beach on donkeys, and R.76-0-0 for freight to Zanzibar, landing charges, sorting charges, import declaration, and scale fees:—

520 fraslas cloves	1,965
43 fraslas stems	38
Total	2,003
Two overseers, four months	112
Picking 528 fraslas	466
Conveyance to beach	25
Freight, etc	76
Balance profit	1,324
Total	R.2,003
Balance profit	R.1,324

Thus the purchase money of the shamba, R.1,287, was more than recovered the first year. After paying for digging the shamba (100), baskets, bags, drying mats, bakshish to overseers, etc., the year's profit was reduced to about R.1,000. The former owner used to make R.200 to R.400 a year out of this shamba, and Arabs now attribute these good results to "the blessing of God," though the Canon thinks that they may be accounted for largely by the fact of his having dug the shamba over.

It would be misleading to generalise from these results, because doubtless Canon Key had much in his favour: proximity to a large village and a comparatively large supply of labour, a good shamba, and a prolific season. The record is that of a prosperous year, and stands as such for what it is worth. Still, in our opinion it is worth much. The bad years that now and then occur in clove plantations, and which have contributed to their disparagement, may be accounted for by the habit of the clove trees and vicissitudes of seasons, but they may be also due to improper cultivation, or, at any rate, partly so. If clove trees will yield so roundly after years of casual management and two years of extreme drought, what may not be expected from them if properly cared for?

An interesting comparison may be drawn from the results at Kizimbani, and those at Machui, as published by the *Report of the Agricultural Department* for last year:—

	Kizimbani.	Machui.
1. Yield per tree lb.	1925	$6\frac{1}{2}$
2. Cost of picking and delivering per frasla	R.1-4, 3-10	R.1-$5\frac{1}{2}$
3. Return per frasla net . . .	R.2-7	R.3-4
4. Return per tree net	R.1-5, 3-5	R.0-$9\frac{1}{4}$
5. Approximate price obtained per frasla	R.4-15, 1-5	R.6-3, 9-10

(less duty and disregarding stems).

The comparison is, on the whole, distinctly in favour of Kizimbani, even when allowance is made for the fact that at Machui a quarter of the crop was abandoned for want of labour. The large quantity of cloves to handle at Machui made it necessary to employ a staff of spreaders, while at Kizimbani this work was done by the pickers at no extra cost. In calculating the yield and return per tree the good and bad trees are all counted together at Machui, but at Kizimbani the unproductive trees have been neglected.

Still, when all these deductions have been allowed for, the superiority of the Pemba trees remains very evident. They date from prehurricane days, and are therefore older and larger, and the soil at Weti is stronger than at Machui.

Canon Key concludes his Report by some very interesting remarks, which we append:—

Clove Culture.—The Arabs plant 6 or 7 trees together; these often unite in a wonderful way, and form one tree, but knowing that several trees were planted together, you can see how and where they join, and the numerous branches, each "tree" having the same number as a single tree would have. In a shamba of young cloves that I bought I rooted out all except one, with the result that the young trees have gained strength.

Pruning.—I have found that many trees have overgrown their strength, hence reducing their branches has added to the strength of the rest of the tree. We made a mistake in the first instance in cutting away the middle branches, which, of course, cannot bear many cloves, but this divided the tree, making it difficult to climb. Lateral branches are wanted in clove trees; the upward-growing branches should be cut off, otherwise the tree in time will grow to wood, and only bear on the sides and the top.

My own shamba I cleaned once before last clove season. Leaves and grass were dug in for manure, and the rain was able to soak into the ground, instead of running off the top. Nothing flourishes under cloves, as the small roots spread out like a net on the top of the soil; the trees would probably be the better for their being cut. The shamba next to mine I foolishly offered to pick; but the cloves were small, and many dropped off before becoming mature, which made difficult work for the pickers. We made R.100, but lost more by being compelled to neglect our own shamba. Clove trees seem to die in some parts of the shamba, from some cause I do not know. I have noticed that trees on the outside of a plantation suffer most. [May not this be due to the outside trees receiving the brunt of the sun's rays, while the inside trees shade one another? Ed., *Tropical Agriculturist.*] Many, too, have died in the valley from want of drainage. But most trees have recovered in a wonderful way. Arabs talk of the crop this year as half of that of last, but I hope to make two-thirds, as our shamba is doing well ("Shamba," *Tropical Agriculturist*, January 1, 1900, p. 450).

REPORT OF THE AGRICULTURAL DEPARTMENT, ZANZIBAR

Marseilles Shamba.—In addition to the Dunga plantation, which this year came under our management, we have had charge of two of H.H. the Sultan's shambas at Machui—Marseilles and Kitumba. The former is situated on the second range of hills which runs longitudinally through the island. The soil is a brick-red mixture of sand and clay, which gets very hard in dry weather. It is, however, superior in quality to the corresponding outcrop on the Masingini range of hills to the westward. Kitumba is in the low alluvial district of that name, which spreads out to the eastward of the Machui range. The soil is generally a red loam, overlying clay. As these two shambas adjoin and were as far as possible worked together, they may be counted as one.

Cost of Clove Picking.—Clove picking began in Zanzibar in the latter end of October. At Machui we departed from the usual method of picking, and instituted a system of payment whereby we could ascertain the total cost of clove-gathering. The shamba people who, according to the new sheria, should have given their labour four days in the week, were paid for each operation. Under these circumstances picking proceeded from the first more briskly with us than with our neighbours, and we were able to gather a much larger proportion of cloves. The men and women of the shamba were rated as follows:—

1 Nkoa or headman . .	27	pice for every 400	pishi	brought in.
2 Wakadammuor headmen, 23 pice each . .	46	,,	,,	,,
1 Storekeeper and caretaker	20	,,	,,	,,
2 Women cleaning sweepings	15	,,	,,	,,
Total . .	108	pice per 400 green pishi.		

Pickers 3 pice per pishi, and 3 pice per day (that is, one pishi gratis) for spreading out and taking in the cloves in the morning and evening, and in showery weather.

Wa-geni pickers, or outsiders, 3 pice per pishi.

The number of wa-geni pickers varied from 60 to 100 a day early in the season, dropping to 40 as gathering became general. The cloves were conveyed to the custom-house for sale on donkeys at the rate of 24 pice per bag of 20 dry pishi, equal to 40 green pishi.

The total cost of gathering, not including the overseer's wages, may therefore be calculated as follows:—

Per 400 green pishi:—

Nkoa, etc.	108
Picking at 3 pice per pishi	1,200
25 spreaders daily at 3 pice each; reckoning an average of 400 pishi picked per diem . .	75
Transport (10 bags)	240
Total pice . .	1,623

1623 pice at 68 pice per rupee, the local rate of exchange, are equal to Rupees 23 pice 59.

Reckoning now that 20 green pishi will when dry weigh one frasla, we have:—

Total cost of gathering and conveying to market:—

Rupees 23 pice 59 per 20 frasla (400 green pishi), or Rupee 1, pice 13, per frasla.

Quantity picked per Day.—"Picking" includes the actual gathering and subsequent stalking. Pickers stop gathering at a quarter to three o'clock, and bring their loads in stalk, after which the cloves are measured, stalks not being counted. Stalking and measuring will sometimes go on up to half-past six. The average quantity picked (and stalked) at Machui in a day was about 6 pishi per head. Our best picker was a woman, who gathered 9 and 10 pishi regularly, though she lost from an hour and a half each day in taking the cloves in and out.

Our heaviest day was November 24, when we picked 874 pishi with 135 men, an average of 6·4 pishi per head. At Dunga our average was much less, by reason of there being fewer cloves; besides, having to visit more trees the people never became so expert. Our best picker brought 6 and 7 pishi, while our average was between 3 and 4 pishi per diem.

Approximate Yield per Tree.—The number of clove trees at Marseilles was stated to be 5,000, but on recounting we found there were 7,500 bearing trees at Marseilles and 1,000 at Kitumba—together 8,500. On December 31 we had gathered, approximately, 1,300 fraslas, and might, I think, safely count upon another 300, making a total of 1,600 fraslas. This gives an average yield of over 6½ lbs. per tree. A good proportion, about ¼, was left upon the trees ungathered through lack of labour. With sufficient labour we should, I think, easily have reached 2,000 fraslas; the approximate yield per tree is, therefore, brought up to over 8 lbs. The trees at Dunga were just as heavily laden with buds, but they never ripened properly; at least half the crop failed. We reached about 350 fraslas, which from 3,000 trees gives an average of 4 lbs. per tree.

Returns.—Our actual sales at the end of December amounted to 873 fraslas, which realised 5,535 rupees, while we had on hand at the custom-house unsold and in the plantation godown an estimated quantity of 424 fraslas which, valued at the current rate at 5½ rupees a frasla, was worth 2,332 rupees. Our gross returns up to December 31 may therefore be taken as R.7,867. Our expenditure to that date was 1,725 rupees, or about 22 per cent of the gross returns, and our net profit is shown as R.6,142.

Account Statement to December 31

873 fraslas sold	. . . . . .	R.5,535
424 ,, (approx.) on hand	. . .	2,332
1,297 fraslas	Total . .	R.7,867
Expenditure to December 31	. . .	1,725
Net Returns	. . . .	6,142
	Total . .	R.7,867
	Net returns . .	R.6,142

This is equal to a net profit of 4 rupees 11 annas per frasla.

The amount, 1,725 rupees, as the actual cost of gathering 1,297 fraslas, works out to 1 rupee 22 pice per frasla, and differs slightly from my first estimate of 1 rupee 13 pice. This discrepancy may be accounted for by the alteration in the rating, which was at first per 300 pishi. I wanted the headmen, etc. to receive a fair, but not an excessive wage; as the season advanced I found that I had under-estimated the daily pick, which was about 400 instead of 300 pishi, so I altered the rating accordingly. The spreaders were allowed 3 pice each per day, but at Kitumba, where the quantity of cloves to handle was proportionally much less, the spreaders were paid at a higher rate. This would introduce another slight error into the first calculation. The whole of the Kitumba staff of headmen, etc. should in reality have been rated differently, but this would have led to confusion in the accounts, which were kept by an Arab who, admirably as he did his work, was not familiar with European methods of book-keeping. For the same reason I abandoned at Machui the idea of paying the pickers at the rate of 4 pice for every pishi picked after the first 6. Where supervision is difficult, as it is in clove picking, this system would most certainly have led to imposture by the people. It would, for instance, have been easy for two or three to have united their day's gatherings in order to make up the required quantity for the extra pice. At Dunga, which was, I believe, the only place where the system was adopted, we had got a sufficient amount of cloves to judge of its efficacy.

The net returns to December 31 are then shown to be R.6,142. Allowing now for the estimated 300 fraslas still to pick, and valuing them at 5 rupees a frasla, the price to which cloves subsequently dropped, the total net returns are increased to R.7,245.

Account Statement for the Season (Approx.)

Net returns to December 31	R.6,142
300 fraslas at R.5	1,500
Total . .	R.7,642
Cost of gathering 300 fraslas	397
Balance profit	7,245
Total . .	R.7,642
Balance profit . .	R.7,245

Rupees 7,245 from 8,500 trees is equal to an income of $13\frac{1}{2}$ annas per tree.

The waste upon the trees, which I have estimated at $\frac{1}{4}$ of the crop, would, if collected, have sufficed to pay for the entire expenditure. My object here, however, is to compare our actual expenditure and receipts, and to arrive at a fair estimate of what a clove plantation may be expected to yield. The unpicked surplus is, therefore, left out of account. Treated thus it will help to neutralise the effect of basing our calculation upon an abnormally large crop.

Our cloves were not subjected to the usual 25 per cent export drying.

This reduces the income per tree to $9\frac{1}{4}$ annas; or R.54 (£3:12s.) per acre with 90 trees to the acre.

Cost of working a Clove Plantation.—Beyond purchasing drying mats and paying the harvesting expenses, the Arab spends little or nothing upon his clove trees. He employs his available labour, for the most part, in growing manioc, sweet potatoes, and bananas for food and for sale. Thus the resident Arab in charge of Marseilles, when we took it over in May, was expected to make 34 rupees a month by the sale of fruit and annuals, and was in consequence compelled to keep his men cultivating the open spaces, and to leave the trees alone. This is a fair sample of Arab practice; it is a policy of looking after the pence and neglecting the pounds. The weeds on this shamba were half-way up the trees, in some cases climbing completely over them; many were dying, and 1,000 have been killed outright. It cost us R.5 per acre to clear the land, reckoning 90 trees to the acre. We let out contracts, giving 4 pice for each space between 4 trees. When the land has been once or twice thoroughly weeded over, the cost of cultivation will be much reduced. In addition to cleaning the land we hope this year to dig round each tree, at a contract price of probably 1 or 2 pice per tree. At Dunga we are now doing this work with two mules and a plough. Drying mats cost 30 rupees per 100, and baskets 3 rupees per score; 800 of the former and 100 of the latter were purchased for use at Machui, but at least half of these will be available for use again next year. There are no other outgoings to note beyond the overseer's wages, the purchase of a few dozen hoes, and items such as thatching and repair of houses and sheds, always incidental to the management of an estate. It seems to me, indeed, that clove planting as an industry has been somewhat unworthily discredited. Over-production and the labour crisis have brought about the stagnation of all enterprise, but I believe that clove planting in Zanzibar would respond to European management and proper cultivation. The production of cloves must decrease as years go on, as no young plantations are being made to supply the waste among the old trees. Such a year as this must exact a heavy toll; the enormous yield, coming as it has done in a year of drought, will exhaust the trees, while the drought itself will have killed off many thousands. It will always be to the interest of Zanzibar, if not to over-produce, at least to keep the markets well stocked, in order to keep out opposition and preserve the monopoly. As long as the monopoly is maintained the clove industry will never hopelessly degenerate, in the way, for instance, that sugar planting has.

Maltreatment of the Trees.—The rough handling which the trees receive during picking is a very serious evil, and one difficult to check. The shamba people are as bad as, if not worse than, the outsiders, and seem to have been trained upon careless and destructive principles. To be too strict in the matter is to run the risk of your wa-geni pickers deserting to other shambas, where they will not be molested. It is the buds upon the tops and the lateral extremities of the boughs that are so difficult to reach, and at Machui we were compelled to leave those. At Dunga, where we had sufficient labour to keep half a dozen ladders going, we did not succeed in thoroughly clearing the trees. Three men working one ladder will bring in 6 pishi a day; it would therefore have been unprofitable to have diverted the labour, where it was scarce as at Machui, from the accessible buds to the ladders, where three men could only pick the equivalent of one.

Another fruitful source of trouble is the ravages of the maji moto ants, which weave their nests in the branches and are sometimes so bad that pickers cannot climb the trees till they have first smoked them out by lighting a fire underneath. When this takes place the lower branches of the trees are frequently singed, and the trees sometimes fired altogether. The ravages of maji moto ants can be kept under by weeding. Well-weeded shambas are seldom troubled much with ants.

Experimental Drying of the Cloves at Dunga.—Both Mr. Robertson and myself have given a good deal of attention to clove drying. We studied the Arab methods, and found that they almost invariably heaped up their green cloves in the godown the first night after they are picked. If the weather is showery, preventing drying, the heaps remain for several days, growing larger with each day's picking. Fermentation is in this way set up, the cloves emerging a rich brown colour. It occurred to us that as this colour approached the rich tan colour so desirable in the dried clove, that a properly controlled system of fermentation might be beneficial. But our experiments showed this idea to be erroneous; cloves should be spread out immediately upon being measured in; heated cloves turn black. We trained our people to separate the burst from the good buds while stalking. It can be done at this time with little trouble, and with no extra cost, but the invariable custom is to let good and bad all go in together. Before finally sending to market we passed the cloves through a riddle, to remove the small immature buds. By these means, which is only the old story of attention to detail, we produced what, for Zanzibar, was a fairly good sample, though falling short in the size of the buds. This was a defect which we could not remedy; most of the cloves this year have been small.

Practically no difference is made in the local market between good and ordinary, so I was induced to send a small trial lot of 140 fraslas to be sold separately in London, to test the value of our work. Early in the year I had sent home to Messrs. Gray, Daws, and Co. an experimental sample of cloves that had been dried last season, and Mr. Hugh Garden of that firm reported on them as follows:—

"As regards the cloves this is, of course, the finest sample of Zanzibar ever shown, and buyers who saw it valued it at 7d. to 8d. There is still a considerable difference between this and Penang, which somehow appear to retain their reddish brown colour. A very fine sample was bought in at auction at 11d. or 11½d., and was being held for 1s. The market apparently makes the same difference between Penang and your sample—in value—as between your sample and ordinary fair Zanzibar, but this, too, you must understand, is only for very limited quantities."

These cloves were dried under glass after having been specially picked. More depends upon the picking than upon the drying. It is impossible for us here to pick the buds singly, because of the quantity to handle; they must be picked in bunches, as they grow, and the small and over-ripe buds sorted out afterwards. In order to test the efficacy of glass we erected a small house 30 ft. long and 14 ft. wide, with galvanised iron walls and a glass roof. The heat of the sun was in this way increased 25° beyond what it was in the open air. This increase of temperature did not hasten the drying process so much as we expected, unless the cloves were first raised upon shelves. The heated air was then able to act from below and above, and cloves could be dried in two days in cloudy weather with only short intervals of sunshine. All our cloves were finished off in the glass-house. I don't think that the elevated temperature to which they were exposed contributed so much to the improvement in quality as the sorting and riddling. We shall try and arrange next year a system of shelves to increase the drying area of the clove house.

Our experiments have, however, shown that cloves must be exposed to the direct heat and light of the sun; if dried in the shade they turn black.

The glass-house has been the means of saving labour, as the cloves, once spread out in it, could be left to dry. Much time is lost, at a time when every available man is required for picking, under the present system of taking the mats in and out morning and evening, and in showery weather. At Marseilles this became most serious, as we had between 400 and 500 mats to handle each time.

The Clove Crop Generally.—The magnitude of the clove crop may be judged by the returns of November and December. In those months Pemba sent in more cloves than in any previous month of the years tabulated, while the total for the two islands for December, namely 121,858 fraslas, exceeds all previous returns. The Zanzibar crop was late, hence the total of 60,365 fraslas for the year is the lowest since 1890, though the report for December, namely 32,399 fraslas, is the highest on record for Zanzibar in one month. Still, a heavy loss has taken place upon the trees. The dry weather of December, the rainfall for which was the lowest on record, following upon an unusually dry year, caused the trees, especially in the districts where the crop was very late—Dunga, Kitumba, and the north end of the island—to shed starved and immature buds, and labour was diverted from picking to sweeping up the fallen cloves under the trees. A quantity has been gathered in this way, though a far greater quantity has been lost. Picking in these districts never really got into full swing.

In the Machui district the crop was abundant and well forward, but the labour was totally inadequate to cope with it. The trees look as heavily laden now with ripening mother of cloves as they did in the beginning of the season with buds, and the proportion picked must be quite insignificant to that which was left. In the South Mwera country the crop was earlier and lighter, and was comparatively well gathered. Pemba seems to have suffered less from the effects of the drought than Zanzibar. The soil of Pemba, having more clay than ours, is more retentive of moisture, and therefore better able to resist the effects of drought. The Pemba trees, too, are older, and their roots will consequently have reached deeper levels for their food supply (*Annual Report of the Agricultural Department of Zanzibar*, 1899; *Tropical Agriculturist*, January 1, 1900, pp. 447, 517).

AREAS OF CULTIVATION

The clove tree has been at one time or another introduced into nearly all parts of the tropics, experimentally at least, but comparatively few attempts have been made in most tropical countries to cultivate it on a large commercial scale. The Dutch, in the early days of cultivation, held the monopoly of this spice, as well as that of nutmegs and pepper, and it was this that induced the British to make strenuous efforts to break down the monopoly and to establish plantations elsewhere. The history of this has already been given.

The clove is, however, a tree which requires an insular maritime climate, and did not prove to be suited to all places in which it was introduced. It was also of comparatively slow growth, and its produce was only in limited demand, so that a very extended area of cultivation was not required to stock the world's markets.

It is probably due to these causes that the cultivation is practically limited to a comparatively small number of countries within the tropics.

Malay Archipelago.—The clove has been successfully cultivated for commercial purposes in the Moluccas, its original home, and in Sumatra and Java.

It is difficult to get any clear idea of the export at the present day from the Moluccas, but the amount exported thence seems to fluctuate largely. In 1846 it was stated that the four islands, Amboyna, Haruku, Saparua, Nusa-laut, in which the clove is cultivated, produced 1,913,399 lbs., but only 197,826 lbs. in 1849, and in 1854, 1,123,972 lbs.

In Java the cultivation never seems to have been very large. Spon's *Encyclopedia* gives only 12,266 lbs. in 1879-1880, and 464,547 lbs. in 1878-1879, and in 1871, 186,226. It is probable that most of these were re-exported from the Moluccas.

Zanzibar and Pemba.—The clove was introduced into Zanzibar from Mauritius by an Arab in the latter end of the eighteenth century, and has become the source of the largest part of the supply of cloves in the world, although its produce is the lowest priced of the three classes in commerce at the present day, viz. Penang, Amboyna, and Zanzibar. The cultivation attained its maximum before 1872, when its export was 10,500,000 lbs. of cloves. In this year, however, a disastrous hurricane destroyed most of the trees in Zanzibar, but those of Pemba, situated on the west side of the island, were more protected and escaped better.

The cultivation is chiefly in the hands of the Arabs.

Zanzibar cloves are very dry, and larger and redder than Pemba cloves, hence they are known as "Zanzibar red-heads." The Pemba cloves are smaller and blacker and less dry. They are disposed of as soon as possible, as otherwise the buyer has a loss in weight from drying. The Zanzibar cloves lose about 8 per cent in weight on the passage from Zanzibar to Europe. The local trade weight is the "frasla," equivalent to 35 lbs.

The exports from Zanzibar in 1890 are given as 124,929 fraslas, *i.e.* 4,372,515 lbs., and from Pemba 385,981 fraslas, or 13,509,335 lbs., altogether nearly 18,000,000 lbs. In 1891 Zanzibar produced 62,017 fraslas (2,160,595 lbs.), and Pemba 326,986 (11,564,510 lbs.). Besides the cloves, clove-stalks are shipped from Zanzibar in immense quantities.

The cloves are shipped to Bombay, and also direct to Hamburg and the United States, and also, in less amount, to the Red Sea ports.

They are sold at about 9 dollars for 35 lbs., about 6d. per lb.

Mascarene Islands.—The cultivation in the Seychelles was practically abandoned in 1902 on account of the scarcity of labour and the irregularity of crops.

In Réunion the tree was introduced in 1772 by Intendant Poivre, and cultivated well till a few years ago, but the produce was irregular in amount, and the frequency of destructive cyclones discouraged the planters. In 1820, 150,000 kilos (330,000 lbs.) were exported, but shortly afterwards many trees were destroyed by cyclones and not replaced. In 1904, 11,502 kilos (25,304 lbs.), valued at 6,902 francs, were exported, all being sent to France. The returns of the estates were very irregular. A tree one year would give 10 kilos of cloves and next year only 2, and the planter could only reckon on one good year in five. The cultivation is now practically abandoned. Madagascar exported in 1904, 77,501 kilos, valued at 10,440 francs; in 1905, 48,124 kilos, valued at 86,915 francs.

There were then 409 hectares (about 900 acres) in cultivation, of which 152 only were owned by Europeans, the number of trees, young and old, being 113,350. Nearly the whole of the cultivation lay in the isle Ste. Marie, and the produce was exported to France.

Malay Peninsula.—The cultivation of the clove tree is practically limited to Penang and Province Wellesley, and in the latter province mainly to the large hill known as Bukit Mertajam. The plants are usually grown with or close to the nutmegs (which have been already described), on steep clay hills overlooking the sea, or in the winding valleys leading up from the coast. As the hills are often steep they are terraced, each terrace following the contour of the hills, and being just wide enough to carry one row of trees. Blocks of stone and sticks are used to keep up the edges of the terraces when necessary, and the ground is kept clean by weeding. No shade is used, the trees being exposed to the full sun. Formerly this cultivation was in the hands of Europeans, at least to a large extent, but it has passed for some years now almost entirely into the hands of the Chinese. During the last year or two there has been a little falling off in the cultivation, but the class of cloves produced seems as good as ever.

In Singapore the cultivation died out at the same time as that of the nutmeg, about 1866, but I doubt if it ever was as successful as in Penang. The parasite *Cephaleurus* is too pertinacious, and a recent re-opening of clove cultivation in the island was practically finished off in a few years by this pest.

I am indebted to Mr. W. C. Kün, the Acting Registrar of Imports and Exports, for the following figures as to the trade in cloves in the Straits Settlements :—

Imports

	Pikuls.	Value.
1875	882	S'pore $6,446
1880	734	32,561
1885	3,884	35,836
1890	2,907	51,959
1895	3,925	74,464
1900	2,974	62,874
1905	3,960	124,267

Exports

	Pikuls.	Value.
1875	1,478	S'pore $54,085
1880	613	25,602
1885	4,496	110,301
1890	3,036	112,325
1895	4,096	82,155
1900	3,234	89,183
1905	3,867	134,313
1909	4,000	

The pikul is 133⅓ lbs., and the present value of the dollar is 2s. 4d.

USES

The primary use of cloves is as a spice, and those most preferred and highly valued are large, full, not wrinkled or brittle, of a good red colour with a purplish bloom. These high-class cloves are chiefly obtained from Penang, and fetch a better price than any others. They are used when whole cloves are required, as for inserting into hams, etc., and other such more or less ornamental purposes.

In former days it was the fashion to stick an orange all over with cloves, so as to make a kind of pomander, to be held in the hand and carried about for the perfume.

Powdered cloves are also used as a spice, but are very apt to be adulterated by the addition of ground clove-stalks and other substances.

Cloves are used also for chewing, to sweeten the breath, and are used by betel-nut chewers as an addition to the betel-nut, sirih leaf, etc. They have also long had a reputation as a cure for toothache.

A large proportion, especially of inferior cloves, are used for the manufacture of clove oil.

Oil of Cloves.—Few plants are as rich in oil as the clove, and the oil is of considerable value. It was first obtained by distillation in the fifteenth century, and is manufactured to the present day in considerable quantities chiefly in England. The cloves are distilled either whole or ground up, and according to the method of distillation whether by water or dry steam, the light oil or the heavier one containing much eugenol is obtained. The oil, as collected in receivers, partly sinks and partly floats in water. The light oil of cloves is a sesquiterpene, and is separated either by the method of distilling or by distilling the crude oil. The heavier oil is an oxygenated oil, chiefly consisting of eugenol. Normal oil of cloves is a mixture of the two oils.

The crude oil is colourless or yellow, darkening with age and exposure to the air.

The amount of oil obtained from the clove buds varies considerably in amount. It is estimated that Amboyna cloves produce as much as 19 per cent of oil, Bourbon and Madagascar 18 per cent, Zanzibar 15 to 17·5 per cent. The oil of Madagascar cloves is specially favoured by French perfumers, as having a particularly agreeable perfume.

The Zanzibar and Pemba cloves, however, are the ones almost exclusively used for the oil.

Uses of Clove Oil.—Clove oil combines well with grease, soap, and spirit, and is thus used for perfumery and articles for the toilet.

Essence of cloves, used for flavouring confectionery, liqueurs, etc., is made by dissolving 4 oz. of clove oil in one gallon of spirit.

In medicine clove oil is now but little used, except as a flavouring, and in making pills. Cloves are aromatic, carminative, and stimulant, and are used in cases of dyspepsia, gastric irritation, and in cases of vomiting in pregnancy. The oil is used in decayed teeth, and for toothache generally.

In microscopy it is commonly used for clearing sections.

For these purposes the mixed oil is generally used, but it is also largely used in the form of eugenol, the lighter oil being removed. The amount of eugenol in crude oil of cloves varies from 76 to 85 per cent, and especially fine samples contain as much as 90·64 per cent.

By the addition of permanganate of potash eugenol can be converted into vanillin, and several patents have been taken out for the processes of this nature. Vanillin is the artificial vanilla used now largely as a substitute for the more expensive natural vanilla (see Vanilla).

OTHER PARTS OF THE TREE USED

The flower stalks, separated from the cloves when drying, are in some places not wasted. They are dried and exported, chiefly from Zanzibar and Pemba to Bombay and New York, and from the former port are exported to England for adulterating powdered cloves, and for making clove oil. They are moderately aromatic, and yield 5 to 6 per cent of oil of cloves on being distilled, as against 15 to 19 per cent from ordinary clove buds. The stalks are known in Zanzibar as *Vikunia*; in French as *Griffes de Girofle* and *Pédoncules de Girofle*; in Italian as *Fusti* and *Bastaroni*; in German as *Nelkenstiel.* They always fetch a low price, only a few pence a pound. In 1873, 4,200 packages of clove-stalks were sold in London at 3d. to 4d. per lb.

Oil from stalks was distilled as early as the sixteenth century, and at the beginning of the nineteenth century they were commonly mixed with clove buds and distilled, in order to cheapen the price of clove oil (Gildenmeister and Hoffmann, *Volatile Oils*).

Mother-Cloves.—These are the dried fruits of the clove. They contain less clove oil than the buds, but are occasionally exported to Europe for making clove oil. 1,050 bags were sold in England in 1873 at 2d. to 3d. per lb.

In the old days of clove cultivation in Penang most of the mother-cloves went to China, the Chinese having a fancy for them for medicine. The planters had an idea, however, that the production of mother-cloves exhausted the tree, which is possible. As a rule, the planter naturally gathers his whole crop of flower buds, so that no mother-cloves are left on the trees, except those required for propagating, but frequently in picking a certain number of flowers are left here and there, which develop into mother-cloves. There is nothing to be gained by leaving them to fruit, however, as there is a better demand for the clove-buds than for the mother-cloves.

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CHAPTER V

PIMENTO OR ALLSPICE

PIMENTO or allspice consists of the dried unripe fruits of *Eugenia pimenta*, DC. (*Pimenta officinalis*, Lindley), belonging to the order *Myrtaceae*, and to the same genus as the clove tree. The spice takes its popular name from its resemblance in perfume and taste to a mixture of cinnamon, cloves, and nutmeg. It is also known as Jamaica pepper.

In French, *Piment des Anglais*, *Toute-épice*, *Poivre de Jamaïque*; in German, *Nelkenpfeffer*, *Nelkenköpfe*.

The word pimento is derived from *pimienta*, the Spanish word for peppercorns, which the spice resembles. It was called by Redi, *Pimienta de Chiapa* (*Chiapas* in Mexico) and *Pimienta de Tabasco*.

It seems first to have been imported into Europe about 1601, or a little later, and, according to Parkinson, substituted for round cardamoms. Ray, in 1693, distinguished it as a Jamaica spice under the name of sweet-scented Jamaica pepper or allspice.

DESCRIPTION

The plant is a tree from 20 to 30 ft. tall, occasionally attaining the height of 40 ft. It has a slender, straight, upright trunk, much branched at the top and covered with a smooth grey bark. The leaves are polished green, opposite oblong-lanceolate, tapering to the petiole, blunt, and somewhat emarginate at the top;

entire, dark-green above, paler and gland-dotted beneath, with a prominent mid-rib 4 to 6 in. long. They are very aromatic when fresh, abounding in essential oil. The flowers are in trichotomous panicles on the ends of the branches. They are very small, white, and fragrant. The calyx has four rounded lobes. The petals are four, rounded and greenish white. The stamens are very numerous, longer than the petals, and white. The fruit is a black or purple one-seeded drupe, about the size of a pea, from $\frac{1}{5}$ to $\frac{3}{10}$ in. through. When ripe it has a sweet pulp, but then loses much of its aromatic property, and thus is gathered before fully mature.

DISTRIBUTION

Allspice is a native of the West Indies, occurring on calcareous soil near the coast on the islands of Cuba, Hayti, Trinidad, Domingo, and more or less in all the islands of the Caribbean Sea, but it is most abundant in Jamaica, which island produces the greater part of the commercial spice. The tree occurs also in Mexico, Costa Rica, and Venezuela. The Mexican spice is, however, inferior, larger, but less aromatic. It is believed to be the produce of a distinct variety of *Pimenta officinalis*, and is known as *Pimienta de Tabasco.*

It does not appear that the tree has been successfully cultivated in any part of the world, except where it is indigenous, though attempts seem to have been made in most of the tropical colonies. In the Botanic Gardens in Singapore there were a few trees of this plant for many years, and though they flowered regularly they never produced any fruit. Nor does it seem to have done any better in Ceylon, where it is said to have been introduced as early as 1824.

Bernays, in *Cultural Industries for Queensland*, mentions a fruiting tree in the Brisbane Botanic Gardens about 15 ft. tall and fifteen years old, but it does not appear that there was any extension of the cultivation.

CULTIVATION

The tree is raised from seed. The ripe seed is washed to free it of the pulp of the fruit, which, if not removed, becomes hard and dry, and prevents the germination. However, most of the Jamaica plantations have been formed by clearing the bush and allowing the seedlings, which spring from seed carried about and dispersed by birds, to grow. The best results have been obtained when the trees are planted 20 ft. apart.

The soil may be poor, so long as it is fairly light and well drained. Mr. W. Bancroft Espeut, in a lecture on the timbers of Jamaica, describes the method of cultivation thus:—

> It is only necessary to dig the soil in order to loosen it and remove old stumps and roots, to lay, say, 1 in. of leafy mould and sand in equal parts on the surface, water it well if the weather is dry, and scatter, not bury, the quite ripe fresh-gathered pimento berries, and cover the land with straw or some other shade-yielding material, and keep it moist. In a very short time, three or four weeks, thousands of young seedlings will make their appearance. These should be thinned out, the surplus seedlings being transplanted to other land suitably prepared. Care must be taken not to remove the shade stuff too suddenly, but gradually, so as to harden off the young plants.

The trees can be grown to an elevation of about 3,000 ft. in the West Indies, and commence to flower when they are from seven to ten years old. The crops of berries increase each year till the tree reaches maturity, that is to say, when it is about eighteen or twenty years old. It will continue to bear, if properly treated, for a great number of years, longer, indeed, than the average life of a man.

Mr. Adam Roxburgh, in an account given in Cundall's *Jamaica in 1905*, states that growers of allspice distinguish between fruitful or bearing trees and unfruitful or so-called "male" trees. The two trees are much alike, but experienced planters can distinguish them apart.

"It is held by botanists," he says, "that the so-called male trees are not necessary to the fructifying of the bloom of the bearing trees, and that they are simply barren trees of no use to the grower, and except where they are useful as shade trees are better out of the way. Many growers, however, find it difficult to reconcile this theory with actual experience, holding that when the male trees are cut out the yield of the other trees is not so great."

The pimento is certainly not a unisexual plant like the nutmeg. Being allied to the clove, it has much the same structure of the flower. It is not likely, therefore, that the flowers are, strictly speaking, male and female respectively, but possibly the so-called male flowers possess some defect in the stamens which prevents their fertilisation. Plants in the Singapore Botanic Gardens, though flowering freely, never set a single fruit, on account of some such defect. It should not be difficult to discover the cause of this production of "male" trees in the West Indies.

CROPPING

The berries grow in clusters, and are in the best condition for spice when they are full but not ripe, in July and August, while still green. When fully ripe they are black, glossy, sweet, and spicy. The unripe berry is more spicy, and somewhat peppery in taste. They are about the size of a black currant. They are gathered by lads, who climb the trees and pull down the branches with a hooked stick, breaking off the twigs which bear the branches of fruits. The boughs are thrown down, and women and children gather them up, pick off the berries into baskets, throwing away the stems and leaves. Ripe berries are kept separate from green ones. This breaking of the branches does not injure the trees, but, on the contrary, acts as pruning, which is necessary in order to make the trees crop regularly. A good picker can fill a 70 lb. bag a day.

We have no record of any disease or pests of the allspice tree. In fact, very little has been written about the tree at all. It appears to be of easy cultivation in Jamaica, though it seems to have failed elsewhere. It is reported to be doing well in Fiji.

The area under cultivation in Jamaica varies a good deal, but exclusive of wild plants, the acreage for different years has been returned as the following:—

1871	717 acres
1874	1,392 „
1875–1876	2,363 „
1879–1880	969 „

CURING

The pimento, after gathering, is carried in baskets to the barbecue, which is a large paved court, divided into compartments by a low bank, so that pimento gathered on one day and partly dry may not mix with fresher gathered berries. The berries are spread out in the sun and turned over with a wooden rake, so that they may be heated and dried on all sides by the sun. They take from three to twelve days to dry. A good dry breeze naturally helps. Tarpaulins are required for every range of barbecues, so that in case of rain the spice may not get wet. Sometimes an American fruit evaporator is used to dry it, especially in wet weather.

Damp spoils the spice by affecting the bright brown colour, which is the chief point looked to by the buyers.

The fruit is known to be dry when it rattles with a sharp, dry, crisp sound when a handful is shaken close to the ear. The spice is then stored till the crop is finished, when it is all passed through a machine which fans out dust and bits of leaves, and then it is placed in bags for shipment.

CROPS

The average annual export from Jamaica is 75,000 bags, weighing 145 lbs. each, or 11,275,000 lbs.

The trees vary in yield, but some give as much as 150 lbs. of fresh, or 112 lbs. of dried berries. The returns are considerably affected by the weather during the fruiting season. Thus in 1906-1907 the crops were short, owing to heavy and destructive rains while the fruit was forming, and the next crop was short again from a prolonged drought.

This raised the price from the average of 15s. per 100 lbs. to 21s., but it has run higher than this, frequently being 25s. to 28s. per 100 lbs. weight, and Roxburgh quotes it as selling at one time at 40s. The sale price in England is about 4d. to 6d. per lb.

Plantation pimento fetches a higher price than that from wild trees, as more care is taken in its preparation.

The highest export of late years has been 6,857,830 lbs. in 1870-1871, valued at £28,574; in 1877-1878, 6,195,105 lbs., but it has been higher even than that, as mentioned above, within the last few years. The maximum export from Jamaica is given as of the value of £78,900 in 1906.

About one-third of this goes to North America, the remaining two-thirds to England.

The following table gives the exports for a series of years, showing its comparatively steady demand :—

	lbs.		lbs.
1789	438,000[1]	1865	2,864,960
1804–1805	2,257,000	1871	6,857,838
1826	2,000,000[2]	1875	2,914,000[3]
1827	2,235,350[2]	1862	3,362,216
1828	2,269,545[2]	1863	3,278,016
1829	3,599,268[2]	1864	5,142,080
1830	3,528,104[2]	1866	2,223,768
1831	1,810,616[2]	1867	5,465,376
1850	2,289,280[2]	1868	1,814,248
1855	5,927,200	1869	2,300,144
1860	2,240,000	1870	2,284,912

[1] Value £22,000 (Browne, *History of Jamaica*).
[2] Import into Great Britain only. [3] Value £40,250.

OTHER USES

The allspice is chiefly used for flavouring confectionery, pickles, and other such foods. The ripe fruits are used to make a native drink known as "pimento dram."

Allspice is used in medicine as an aromatic, in the form of pimento-oil or a distilled water—*Aqua Pimentae.* It is administered for flatulency, or for overcoming griping in purgatives, and locally in rheumatism and neuralgia.

Oil of pimento is a yellow to brownish oil containing eugenol, and with practically the same qualities as clove oil. The berries contain 3 to 4½ per cent of oil, which sells at about 6s. a pound.

Most of the oil is contained in the pericarp, but the seeds are also aromatic.

PIMENTO STICKS

In Jamaica, saplings of pimento were so highly valued as walking-sticks and for umbrella-sticks that some alarm was felt lest the dealers in sticks should uproot all the young trees. An article in the *Scientific American*, quoted by Bernays in *Cultural Industries of Queensland*, says that in that year half a million of umbrella-sticks were awaiting export at Kingston, Jamaica, to England and the United States, all or almost all being pimento. The average returns for five years showed that 2,000 bundles of sticks were exported from Jamaica annually, and the first three-quarters of 1881 showed an export of over 4,500 bundles, valued at 15,000 dollars. The bundles contained 50 sticks each. These sticks were valued at from 1½d. to 3½d. each.

Espeut (*Timbers of Jamaica*), after referring to the destruction caused by the stick gatherers, urges planting pimento for the stick trade. He estimates that an acre planted for sticks would yield £300 in five years.

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CHAPTER VI

CINNAMON

THE cinnamon of commerce is the bark of the tree *Cinnamomum zeylanicum*, Breyn, of the aromatic order of *Laurineae*. The tree is a native of Ceylon, occurring in moist low country to an elevation of 2,000 ft. (Trimen, *Flora of Ceylon*), and is said to occur also in Southern India, Burma, and the Malay Peninsula. I have seen no specimens from the Malay Peninsula, undoubtedly wild, but the allied tree *Cinnamomum iners*, Bl., is one of the commonest low country trees, and so closely resembles the true cinnamon that, except for the taste and odour of the bark, I find it very difficult to separate the two plants botanically, and it seems probable to me that the true Ceylon cinnamon is a very aromatic form of *C. iners*. The bark of this latter varies a good deal in its aroma, but is never as highly flavoured or scented. The Malays use it, however, in medicine and as a spice, though only to a small extent and as a substitute for true cinnamon, which they much prefer.

Curiously, although so similar the two trees do not flower and fruit simultaneously, for when *C. iners* is in flower (all trees in the neighbourhood flowering at one time), *C. zeylanicum* is not to be found in flower or fruit, the flowers usually appearing later.

DESCRIPTION

The tree when full grown is usually about 20 ft. in height, but occasionally reaches 40 ft. It has a stout trunk, much branched low down, about 1 or 2 ft. through, with thick grey bark. The whole tree is very bushy, with strong branches forming a fairly compact and large head. The form and size of the leaves is varied. In some cases rounded ovate and quite obtuse, in others ovate-lanceolate to obtuse; the base is rounded, the apex more or less acuminate, but blunt. In the round-leaved form the apex is often quite rounded and not at all acuminate. In texture and colour they are firm, coriaceous, deep green, paler beneath, rather brittle. They have three or five conspicuous nerves joined at the base of the leaf, and running to the tip, paler green or almost yellow. The length of the leaves varies from 3 to 7 in., the width from 2 to 4 in. The petiole is $\frac{1}{4}$ to 1 in. long. The flowers are borne in lax panicles on long peduncles from the upper axils of the branches, or from the ends of the branches, on long pubescent peduncles 2 or 3 in. long. The branches of the panicles are $\frac{1}{2}$ in. in length, lengthening in fruit. The flowers are small and yellow, $\frac{1}{4}$ in. long. The perianth tube is campanulate; the segments, six in number, oblong lanceolate acute, pubescent. Stamens, nine complete, the outer six opposite the six perianth lobes. They have a hairy filament and a four-celled anther (the cells opening by valves), and a pair of glands at the base. There are three staminodes, or barren stamens. The ovary is superior, one-celled, and one-ovuled. The fruit is ovoid, a black fleshy drupe, with the enlarged perianth lobes at the base forming a cup.

HISTORY

Cinnamon seems to have been one of the earliest known spices, but it appears to be doubtful whether the spice mentioned in the earlier writings was cinnamon or cassia bark (*Cinnamomum cassia*). This latter was undoubtedly imported into Arabia in very early days from China, whence there was an extensive commercial intercourse from the earliest historic times. Both cinnamon and cassia were valued in Biblical times, and are often mentioned in the Old and New Testaments. A spice-bark supposed to be cassia is mentioned as imported into Egypt with other Eastern products in the seventeenth century B.C., and cinnamon and cassia are recorded among offerings to Apollo at Miletus by Seleucus II. in 243 B.C.

There is, however, no record of cinnamon being produced by Ceylon in the annals of China, though there was a constant commercial intercourse between Ceylon and China, nor in the ancient Singhalese writings till A.D. 1275, when it is mentioned by an Arab writer Kaswini, as a product of Ceylon, and in 1292 by a friar, John of Montecorvins, who writes that "a great store of its bark is carried forth from the island near by Malabar." Ibn Batuta, the Mohammedan traveller, in 1340, and Nicolo Conti, a century later, mention it as a Ceylon plant, and describe it.

In 1505, the Portuguese circumnavigating the Cape of Good Hope discovered Ceylon, and occupied the island in 1536 for the sake of the cinnamon.

The finer quality of the Ceylon cinnamon, as compared with that of Malabar, known as *Canella trista*, was pointed out by Barbosa, and Garcia da Orta says that while 100 lbs. of Ceylon cinnamon was worth 10 gold, 40 lbs. of the Malabar bark was only worth 1.

The Ceylon cinnamon at this time was all derived from wild trees, the Portuguese compelling the Singhalese kings to bring it as a tribute. A peculiar caste of Indians, known as Chulias, became the collectors of cinnamon, and were cruelly oppressed by the Portuguese and later by the Dutch, who took Ceylon from them about 1656 and made a monopoly of the spice. In 1770 De Koke started the cultivation of the tree, and the Dutch, from the territory which they had annexed, obtained 400,000 lbs. of cinnamon yearly, completely ruling the trade, burning the cinnamon in Holland when the supply was too large and the price fell. The English in 1796 took Ceylon from the Dutch, and the

Honourable East India Company possessed the monopoly of cinnamon till 1833. When the monopoly was abolished and the Government ceased to be the sole exporters, the trade passed into the hands of the merchants of Ceylon. There was, however, so large an export duty, viz. from one-third to a half of the value, that the cultivation began to fall off, especially as it had to compete with cinnamon raised in Java and cassia from China. This duty was removed in 1853.

The cultivation of the plant was introduced into Java by the Dutch in 1825.

NAMES OF CINNAMON

The oldest name for the spice seems to be the Greek *κιννάμωμον*; Chinese, *Tienchu Kwei* (*Kwei*, cassia; lit. Indian cassia); Persian, Arabic, *Darchini* (China bark), also Hindustani; Malay, *Kayu Manis*, from which Garcia derives the word Cassia; Arabic, *Querfaa* or *Querfe* (Garcia); Singhalese, *Cuurdo* (Garcia), *Kurundo*; Malabar, *Cameaa*; Tamil, *Karruwa puttay*; Telugu, *Sanalinga putta*; Dutch, *Caneel*; Portuguese, *Canela*; French, *Cannelle*; German, *Kaneel.*

CULTIVATION

Soil.—A rather elevated situation is most favourable to the cultivation of cinnamon, and a sandy loam mixed with decayed vegetable matter is recommended as that in which it flourishes best. Like many other cultivated plants, it is reported to grow best near houses. This is doubtless due to the waste and refuse thrown out from the houses acting as manure to the plant.

In the Straits Settlements the plant seems to grow readily and well in most soils, not too wet, even flourishing in stiff and inferior clay; red and dark brown lateritic soils, so long as the ground is not rocky or full of stones, has proved quite satisfactory.

In one of the largest gardens in Ceylon, at Marandun near Colombo, "The surface is a pure white sand, under which is a deep stratum of rich mould. In some parts of the island, where this earth is deficient, the trees are barren and not worth cutting. In marshy places they thrive no better, but become decrepit, and the bark acquires a bitterness which destroys its sweet and aromatic qualities."[1]

An experienced Ceylon cinnamon planter writes in Ferguson's *All about Spices* :—

Cinnamon is not found growing wild to any great extent in the drier parts of the low country; whatever may have led the Dutch to choose sandy plains for its cultivation, such lands are certainly not its natural habitat. It is most commonly found as a forest tree at from 1,000 to 2,500 ft. above sea-level, and in those angles of the mountain zone that face the monsoons. It is said to have been found growing at a height of 5,000 ft. [Ferguson adds:—we have seen plants at 7,000 ft., the clove odour in the leaves pungent enough, but the bark having scarcely a tinge of true cinnamon]. As the plant has only been cultivated to any considerable extent in the sandy plains of the Western Province, sand has of course acquired the name of yielding the finest spice; the only other land on which it is cultivated being the common cabook (laterite) gravel of the low country, on which it grows most rapidly, but produces a coarser article than on the sand. Whether a fine spice can be produced in a wetter and colder climate by cultivation remains to be tested by experiment. Till this is done we must continue to believe that the best cinnamon is grown on the poorest sand, where there is an average temperature of about 85° and an average rainfall of 1 in. for every degree. This is about the climate of the 50 miles of the coast of the Western Province; farther south we do not find the sandy plains, and farther north we get into too dry a climate.

With the rise of price, he says that the villagers planted much in low swampy ground, which produced an inferior quality with a great deal of waste wood.

Another writer in the *Journal of the Eastern Archipelago* says, that besides sandy places, a mixture of sandy with red soil free from quartz, gravel, or rock

[1] Gardiner's *Ceylon.*

is suitable; such land in a flat country is preferable to hilly spots. The soil that is rocky or stony under the surface is bad, as the trees would neither grow fast nor yield a remunerative return. E. Boddam, in the *Mysore Gazette*, condemns any but siliceous soils. He says that besides inferiority in smell, taste, and colour which invariably mark plants grown in any other soil, another disadvantage is this, that while the stumps of plants grown in siliceous soils shoot forth rapidly, and are fit to be peeled a second time within a period of four or five years, producing bark superior in quality to that peeled at first, those grown on a hilly or marshy soil require a time of 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 off at first.

All seem to agree that the best cinnamon is that grown on sandy, loose soil, at a low elevation. There is no doubt that the plant itself will grow luxuriantly in damper, more argillaceous soils, and in such soils it has established itself as a wild plant about Singapore and elsewhere. But the ease and luxuriance with which the plant grows does not at all prove that it will be successful as a giver of good bark. In damp shady spots the tree seems to be much less aromatic, and probably contains much less oil, passing towards the wild *Cinnamomum iners*, which is hardly at all aromatic and is so common in damp low-lying spots in the Malay Peninsula. The planter should be sure that his soil is suitable for the plant, and that the product obtained would be up to the standard of first-class quality, before embarking extensively in the cultivation.

As far as climate is concerned, the rainfall should be adequate, 85 to 100 in. a year, and the temperature averaging 85° or little higher or lower. Prolonged, dry, rainless spells do not suit this plant at all.

Raising from Seed.—The cinnamon tree is usually grown from seed. The seeds are gathered when ripe, and heaped up in a shady place, till the outside pulp rots and turns quite black, when the seeds can be freed of the pulp by trampling on them, or otherwise removing it. They are then well washed in water and dried in the air without exposing them to the sun, which soon would destroy them. Seeds that float in the water are to be rejected.

The seeds are either planted at stake or raised in a nursery, and then transferred to their future position in the estate when sufficiently well grown.

Planting at Stake.—The ground in which the plants are to be grown is first prepared by being cleared of brushwood and small trees. Some large trees are left as shade, at distances of 50 or 60 ft. apart. The lines are drawn out, and the holes for the seed dug at from 6 to 12 ft. apart. A square foot of soil is dug up, stones and roots removed, and the ashes of the brushwood and felled trees, which have been previously burnt, are spread over the spots dug. Holes are made in each space with a a dibble, and from four or five to a dozen or more seeds put in each hole, and covered up with about 1 in. of soil; over this is laid a covering of branches to prevent the earth from being parched and to shelter the seedlings when they appear. The seeds germinate in ten or twelve days. In damp weather most of the seeds germinate and form quantities of cinnamon shoots. But if the weather is too dry they are apt to refuse to germinate, or the seedlings when they have made some growth may die off, and supplies must be available to replace the losses.

Planting in Nurseries.—Nurseries for raising cinnamon seedlings are made by selecting a piece of good rich soil and digging it well over to break it up, removing stones, roots, etc. The beds are made 3 ft. long, with suitable drainage channels round, and these beds are lined 6 in. apart, and at every 6 in. along the line half a handful of seed is dropped and covered 1 in. deep; over the beds is put a platform of sticks to support the kadjang, or pandanus-leaf roof, or whatever roofing may be conveniently obtained. The beds are watered from time to time in the dry weather, until in twelve months they are ready for transplanting. The system of planting a quantity of seeds together seems to have been derived from the idea that some would fail and vacancies would have to be supplied, but this with care need not be, it being better to plant the seeds along the lines singly, about 9 in. to 12 in. apart, or even less.

The shading should remain till the plants are 6 or 8 in. tall and sufficiently strong to stand the sun, or it may be gradually lightened so as to accustom the plants to the full light. The shading in all nurseries must not be too dark. Broken light and shade is always better and more natural for seedlings than excessive shading. Many transplant the seedlings earlier than twelve months, viz. at three or four months. This really depends on the strength and size of the seedling.

Propagation from Cuttings.—The cinnamon can also be propagated by cuttings, which is a quicker way than raising from seed. The shoots selected for cuttings should be very young, not having more than three leaves, or they will not strike. They should be taken from old trees and stuck in nursery beds, shaded, and continually watered.

Layering has also been recommended. The cinnamon bush lends itself to this method, for the side branches of the bush are easily pressed down upon the ground. Being pegged down they will put out roots and can be eventually cut off as young plants.

Transplanting Old Stumps.—This is much approved of, as these old stumps when transplanted yield shoots of the usual size twelve months after they have been placed in the ground. The greatest care is required in removing them, as if any of the roots, even those of $\frac{1}{10}$ in. in diameter, are injured, the stump, it is said, will die. Before removing them all the branches should be cut down to within 6 in. of the ground, with one stroke of a sharp knife, to avoid splitting. Then the stump should be carefully dug round and lifted. After transplanting they should be well covered with earth, and watered. They should be planted from 8 to 12 in. apart, and require some amount of shade. The poorer the soil the closer they should be planted.

Planting Out.—The plants are taken out of the beds with a ball of clay round the roots, for planting, but before this is done the ground must be clean of weeds, hoed and holed. Lining is important, as it saves time eventually both in getting about among the trees, and also in weeding, and it is also easier to block out portions of the estate so as to give the coolies task-work in cutting. The ground is then marked out with pegs 6 ft. apart. In native cultivation the plants are often put so close together that the whole is nearly a dense mass of cinnamon bushes, but it is better to allow sufficient space to move easily about between the bushes. The small plants are often planted singly, in holes 1 ft. wide and as deep, in which leaf-mould, dead leaves, etc., are mixed with the soil dug out. The plant is put in the centre and the soil firmly pressed down. Cultivation from seed in this manner and planting singly is slow, the first crop taking from two to three years before it can be harvested. Most planters, therefore, urge planting several seedlings together in one hole. A Ceylon planter, in the *Ceylon Observer* (April 1, 1881), condemns single planting very strongly. "The plant," he says, "would be fit for cutting in three years. Each stock would then have put out a couple or so of suckers, which in their turn would be fit for cutting in a couple of years. The clumps or bushes would thus be gradually pruned and would take ten or twelve years before the cinnamon would pay for the cost of weeding."

An experienced planter, in the book *All about Spices*, however, demurs to planting a number of plants together on the ground that there are several useless varieties which, getting into the estate, could not be removed if intermixed with the good plants. There are two varieties especially common, called respectively the *Korahedi* and the *Velli*. They occur on all estates and on some they amount to a serious evil, tending greatly to the diminution of the output. The *Korahedi* is distinguished by quick growth, but before the sticks are old enough for peeling the bark becomes rough and scaly, the cuticle thickens, becomes corky, and splits down to the inner bark or true cinnamon. It is very difficult to deal with if peelable at all, and the coolies will not cut a stick of it as long as there is anything else to cut. The *Velli* grows quicker than any other kind of cinnamon, being often at two years' growth 4 or 5 in. in girth and 8 or 10 ft. tall, but it can very seldom be peeled and only makes a very coarse spice, or the least valuable kind of chips. As these two cinnamons are oftener left to go to seed on estates than the good kind, there is greater difficulty in getting the good kind, and these poor varieties often get accidentally planted. It is easy to eradicate them if the plants are planted singly, but if mixed in a bush they must be allowed to remain.

Weeding.—During the growth of the bushes it is advisable to attend to the weeding of the ground, and to hoe out any weeds, and especially climbing plants, which may interfere with the growth of the plant by turning round the stems. The plantation will usually require weeding three or four times a year for the first two or three years, after which twice a year should be sufficient, as the plants should by then have formed bushes sufficiently large to check the growth of the weeds to a large extent. The weeds dug out should not be removed, but either burnt and the ashes restored to the ground, or buried in holes between the bushes. The leaves, twigs, and other waste should not be placed at the base of the bush in this or any other cultivation of the same kind, but in a middle row between the bushes. The growing part of the root is the one which wants feeding, and that is at the farthest point from the tree. The roots spread widely and soon reach the underground rubbish pit, absorbing nutriment from it. The farther the roots spread, the better the development of the bush. Manure of any kind put at the foot of a tree causes the development of roots in a mass close to the trunk instead of a large spread of feeding roots, and retards the growth of the stems.

Manuring.—Some planters have said that cinnamon does not require manuring, except that of mulching with weeds, fallen leaves, etc. I can find very little experimenting with manures on cinnamon recorded anywhere, but the experienced cinnamon planter quoted before urges that though, as a matter of practice, planters are not in the habit of giving any other manure than a mulch of weed refuse, cinnamon grows stronger and quicker where there is plenty of organic matter for its roots to feed on. He quotes a Mr. Gabriel Cross, who affirms that he has doubled the produce by the application of coco-nut poonac. Cow-dung, if not too heavily supplied, is always a safe manure for a bush of this description, and indeed any vegetable refuse might be well used on the ground.

Growth.—In favourable situations the shoots attain a height of 5 or 6 ft. in about six or seven years, and a healthy bush will then give two or three shoots fit for peeling. In good soil from four to seven shoots may be cut every second year from one tree, and shoots of four years' growth are also often fit for cutting.

From seedlings no crop is obtained earlier than the second or third year, when the solitary stem is cut down to within 4 or 6 in. from the ground, and covered with fresh earth. The second crop will be three or four times as large as the first, the number of shoots increasing each year, till in the seventh or eighth year the bushes have grown so big that there should be hardly room for the peelers to get between them.[1]

Flowering and Fruiting.—Adult trees flower in May, or earlier, the fruit ripening in July or August. The birds are very fond of the fruit, and often devour nearly the whole crop before it is ripe, so that it is frequently necessary, in the Malay Peninsula at least, to

[1] T. B. Dunedwelle.

enclose it in cloth bags to protect it, in order to obtain the seed.

PESTS

The chief pest recorded as attacking cinnamon is a boring caterpillar, which attacks the shoots. It does not seem to be very injurious. A similar one attacks adult trees in the Malay Peninsula, not only of *Cinnamomum zeylanicum*, but also of *C. iners*. It is of a pinkish red colour, and bores into the trunk often quite low down, the entrance to the burrow being usually protected by a web full of the frass of the grub. The insect does not appear ever to have been bred to maturity by entomologists, but it is the larva of a moth.

Another pest recorded in the *Ceylon Observer*[1] is the larva of a little moth, *Metisor plana*, Walker, of the family of *Psychidae*. It appears to attack many trees and shrubs in the neighbourhood of cultivated land in Ceylon. The larva constructs a portable silken case, more or less covered with bits of stick and leaf of the food plant on which it lives and undergoes its transformation. It eats the leaves and tender tops of the plants, owing to which the cinnamon cannot be peeled. It is difficult to deal with these bag-worms, as they are commonly called, as they are so well protected by their silk case that poisonous liquids thrown on them do not affect them. Mr. Green, who identified them, suggests that washing the trees with lime-water, or syringing with soft-soap and tobacco water might induce them to depart. The "experienced planter" already quoted mentions a minute beetle which breeds in the leaves, and sometimes does a good deal of injury by retarding the growth and rendering the wood unhealthy and unpeelable.

The larva of what is probably one of the *Tortricidae* moths I have frequently seen in the leaves of adult trees, both of *C. zeylanicum* and *C. iners*. It spins two leaves together, feeding on the epidermis and de-

[1] *All about Spices*, p. 226.

stroying the leaves. Though abundant on wild or full-sized trees, it would probably do little harm in the cultivated state of the plant; as the shoots are constantly being cut on an estate, insect and fungus pests have less chance of establishing themselves than in a tree, where the leaves are left on for a long time.

Cattle, goats, and squirrels are also recorded as occasionally doing damage by eating or nibbling the shoots.

Galls.—Doctors W .and J. van Leeuwen-Reijnvaan, in the *Annales du Jardin Botanique*, vol. xxiii. p. 120, plates xxiv., xxv., figure and describe cinnamon leaves infected with galls due to a mite known as *Eriophyes doctersi*, Nal. The animal seems only to attack the true cinnamon, and it appears to occur in many parts of Java. The galls generally appear on the lower side of the leaf, rarely on the upper side, but they are also found on the leaf-stalk and twigs; when the plant is badly affected the terminal and axillary buds are attacked, and the whole shoot is twisted up. They seem to be most injurious to young plants. The galls are in the form of blunt, hollow cones, and are often densely crowded upon the leaves, quite destroying them. This class of gall, very abundant in the tropics, is very troublesome to deal with. Infected leaves should be removed and burnt, and badly attacked seedlings should be destroyed.

Fungi.—Pestalozzia cinnamomi, Raciborski. This minute leaf fungus is described in the *Bulletin Institut Botanique de Buitenzorg*, vol. vi. p. 13, as attacking twigs and leaves of cinnamon. No account of the injury caused by it is given.

Corticium javanicum.—This fungus, which has obtained more notoriety as a pest on the Para rubber tree than on any other plant, occasionally attacks cinnamon shoots, as it does all manner of woody plants, in the wet season. It forms a pale pinkish-white crust on the stems of plants, destroying the cambium layer and causing the death of the shoot or twig. This fungus is most likely to appear in overcrowded plantations, where during the rainy season the air can never get dry, and the too dense bushes remain permanently wet. It may be taken as a sign that the plants are too close and require thinning.

The fungus is apt to spread through an estate, but irregularly, and frequently disappears as soon as the weather is dry. All twigs or shoots attacked by it should be cut off below the fungus and burnt, and should it appear to be abundant, spraying with copper sulphate solution, or Bordeaux mixture, will destroy it.

CUTTING

The cutting and peeling season is supposed to commence in May and November, but often later, according to the rains. The flush follows the first rains of the season, and continues a longer or shorter time, according to the quantity that falls. As the flush or young red leaf assumes the normal dark green, the sap begins to circulate between the wood and the bark, and while this circulation continues the sticks peel freely, and these are the periods for cropping. It is best if the crop can be got out at one cutting, but this does not often happen. If the season is not a good one the bushes may have to be cut over two or three times. After every cutting one or more young shoots spring from every stump, and as there are two cuttings a year there is a succession of young wood of different ages in the stocks. The bulk of the crop is the wood of two years' growth, but if the whole two years' growth is not cut, in consequence of a bad season or insufficient labour, the sticks that promise to peel at next cutting are left, but in pruning every stick older than two years is cut out, whether it will peel or not. It takes about two hours for 150 men to cut over a 10-acre block.

The shoots selected are usually from 3 to 4 ft. long and $\frac{1}{2}$ to $\frac{3}{4}$ in. thick. To see if they are fit for cutting the peeler makes a small cut obliquely into the bark with a small chopper, and opens the cut to see whether the bark separates readily or not. If it does not he leaves it for a future time. Some shoots never arrive at a fit state for peeling.

The shoots fit for peeling are cut down and the tops and branches cut off, and the sticks collected, tied in bundles, and carried to the peeling shed. The bits left on the ground should not be removed, but used with a mulch of weeds, etc. to manure the ground, as already described.

PEELING

This is done with a specially made knife, small and round-pointed, with a projecting point on one side for ripping the bark off. The peeler, sitting down on the ground beside the bundle of sticks, takes one in his left hand and makes a longitudinal slit from end to end, working the knife between the bark and the wood till he has raised it $\frac{1}{2}$ in. wide. Then turning the stick he makes a parallel slit, and working the knife on that side detaches the slip of bark. Sticks that do not peel freely he rubs with a piece of hard wood.

From time to time the slips are packed together, the convex side of one to the concave side of the next, till about 8 or 9 in. wide and about $1\frac{1}{2}$ ft. long. The packs are piled in a small enclosure of sticks, and when the day's work is done the heap is covered with scrapings and a mat is tied over it. This is called "fermentation" by some people, but hardly amounts to that. The object is to keep the bark moist for the next operation.

PIPING

On the morning of the second day three sticks are driven into the ground at such an angle that they will cross each other about 1 ft. high, and tied firmly at the point of crossing. They are used for supporting one end of a fourth stick, the other end of which rests on the ground. The operator sits down on the ground, places a strip of bark on the stick, and holding it firm with his foot, scrapes off the outer skin with a small curved knife. The operator then takes a bundle of prepared slips and sorts them into different qualities, selects a slip suitable for the outer cover of the pipe, trims it and cuts the end square with a pair of scissors, and on a board 3 ft. long, prepared for the purpose, proceeds to pack as many of the smaller pieces as it will hold; when dry, he adds another slip, and goes on till he has got the proper length. The pipes or quills are arranged on parallel lines stretched across the shed, where they are left till they are firm enough for handling.

After this the pipes are finished off by pressing in the edges of the outside pieces and dressing the ends. Then they are spread out on stages in the sun, but covered with a mat, as the direct rays of the sun are apt to warp them. First-class pipes are of uniform thickness, colour, and quality, the edges neatly joined in a straight line from end to end; the joints of the pieces that compose the outer cover are close and neat; the ends resemble a roll of paper, and the whole pipe will be firm and compact.

The sizes of the pipes vary according to the quality, finer sorts running from 15 to 20 to the pound, inferior sorts 10 to 15. They are eventually made up into bundles of 100 lbs. weight, covered with gunny cloth. The bark of good cinnamon is then often no thicker than stout paper, light brown, dull and faintly marked with wavy lines, showing here and there marks of the points of attachment of leaves or buds, slightly flexible, breaking with a splintery fracture. It has an agreeable, aromatic taste, and is slightly sweet. When chewed it becomes soft, and seems to melt in the mouth.

The bark of large shoots or thick branches is coarse. That of the young shoots is thin and of a light straw-colour, with very little flavour. Shoots exposed to sun during growth are more acrid and spicy than those grown in shade. Cinnamon grown in marshy land is spongy and coarse grained, with very little aroma.[1]

The best cinnamon is said to come from the middle of the shoot, that of the upper end being of second quality, and that from the base or thickest end the most inferior.

The bits trimmed off are known as "cinnamon chips," chiefly used for oil, and a thick bark derived from older stems is known to the trade as "cinnamon bark." It occurs in flat or slightly channelled fragments, as much as $\frac{2}{5}$ of an inch thick. It is also used for manufacturing oil.

The bales of cinnamon which arrive in London are always repacked in the dock warehouses, and in this handling there is a certain amount of breakage. The broken bits are kept separate and sold as "small cinnamon." It is often of excellent quality and used in pharmacy.

CINNAMON CHIPS

This is the name given to the coarsest and most inferior cinnamon that cannot be quilled, and the prunings and waste bits obtained in trimming and peeling. Till 1867 it appears that in Ceylon this was used for extracting the cinnamon oil locally, and not shipped to Europe. It was then, however, found profitable to export chips wholesale, which resulted in an excessive export of cinnamon in the two forms. The rubbish sent from the island brought the chips into disfavour, and the price of the spice fell.

Then followed great discussions as to the advantages to be gained by the planters by preventing the shipping of chips altogether. A native Representative Association agreed in 1883-1884 to give up the preparation and export of chips, but this does not seem to have had much effect, and chips are shipped to the present day.

The amount of chips in proportion to the quills was very large in 1880, over one-third of the amount of

[1] Experienced planter, and E. Boddam, in *All about Spices.*

cinnamon exported. The demand in London for them was always brisk and steady, and a large portion of them was used as a substitute for the quills.

AREAS OF CULTIVATION

Ceylon has held the cinnamon market for very many years, probably from the time at which it was first discovered. The plant has, besides, been cultivated in many other parts of the world, but with, however, less success.

India.—The south of India has for a long time produced cinnamon in the form known as Malabar or Tinnevelly and Tellicherry cinnamon. For some reason this is inferior to that of Ceylon, though some planters have taken a great deal of trouble to turn out a good article. It is interesting to note that as early as 1593 Garcia da Orta says that the Malabar cinnamon was very inferior to that of Ceylon.

Java Cinnamon.—This has been cultivated in Java since 1825, and for some years, though the product was of inferior quality, the Dutch there held their own against Ceylon on account of the Ceylon export duty handicapping the Ceylon planters. The produce is said to rank in value between Ceylon and Tellicherry cinnamon.

French Guiana.—The Cayenne cinnamon is almost as thin and long as the Ceylon form, but is paler in colour and more feeble in flavour and odour, and the oil is more acrid.

Brazilian cinnamon is very inferior, the bark being spongy and nearly scentless.

Straits Settlements.—A good deal of interest was taken in the cultivation of this spice in Malacca in 1851, by Mr. I. Ferrier, Resident Councillor of Malacca. A number of trees were found which, it was said, had been planted by a previous Resident Councillor, Mr. Salmond, at Pringit, near Malacca town, and with the aid of some Singhalese convicts (professional cinnamon peelers), about 25 lbs. of quills were sent home for report. The report was favourable, considering that the bark had been cut at the wrong time of year and from trees which had been quite neglected. The bark was valued at from 2s. 6d. to 1s. a pound.

The cultivation, however, was not carried on, probably on account of the low price of cinnamon in later years.

USES

The bark is mainly used as a spice. It is also used in medicine as a cordial and stimulant, and in the manufacture of incense.

Cinnamon oil is chiefly made in Ceylon from inferior pieces of bark, and broken quills, chips, etc. reduced to coarse powder and macerated in a saturated solution of common salt for two days, and then submitted to distillation. The yield of oil varies very much, according to the quality of the bark, from ½ to 1 per cent. As imported into London it varies from yellow to cherry red, and it varies also much in value, the paler varieties being most highly valued. When received in London the druggists often redistil the oil, obtaining two yellow oils, one lighter than water, the other heavier. The principal constituent of cinnamon oil is cinnamaldehyde.

Essential oil of cinnamon leaf is a brown, viscid, essential oil of a clove-like scent. It closely resembles oil of cloves and pimento, containing a large proportion of eugenol. It is chiefly exported from Ceylon.

Oil of cinnamon root is a yellow liquid, lighter than water, with a mixed odour of camphor and cinnamon. It is described by Garcia da Orta as early as 1563. Solid camphor may also be obtained from the root, it is said. This, however, seems to be rarely made or used.

Oil from the Fruits.—A fatty oil from the fruits is mentioned by Garcia and other early authors.

Trimen (*Flora of Ceylon*) says that what is known as "cinnamon suet" is obtained from the ripe fruit, and is or was used to make scented candles for use in Roman Catholic Churches.

TRADE

Import into United Kingdom

	lbs.	Consumption.
1827 . . .	267,444	14,451
1828 . . .	337,483	15,696
1829 . . .	544,225	29,720
1830 . . .	464,175	...
1831 . . .	225,869	23,172
1867 . . .	859,034	...
1869 . . .	2,611,473	...
1870 . . .	2,148,405	...
1871 . . .	1,015,461 [1]	...
„ . . .	56,000 [2]	...
1872 . . .	1,015,461	...
1876 . . .	1,339,060	...
1887 . . .	1,109,973	...
1888 . . .	1,222,300	...

Comparatively little is used in England, the greater quantity received being re-exported.

EXPORTS OF CINNAMON

The following tables give the export of cinnamon from Ceylon for some years :—

	lbs.	Value.		lbs.	Value.
1841 .	317,919	£24,857	1873 .	1,160,754	£58,037
1842 .	121,145	15,207	1875 .	1,500,000	...
1843 .	662,704	66,270	1876 .	1,356,901	67,848
1844 .	1,067,841	105,784	1879 .	1,407,726	...
1845 .	405,669	40,821	1880 .	1,870,018	...
1846 .	401,656	40,165	1881 .	1,641,178	...
1847 .	447,369	44,836	1882 .	1,992,604	99,630
1848 .	491,687	49,168	1883 .	2,236,431	111,821
1849 .	733,755	73,378	1884 .	2,238,605	111,930
1850 .	644,864	64,485	1885 .	2,145,257	107,263
			1886 .	2,365,038	118,252
1871 .	359,327	67,966	1887 .	2,046,153	102,307
1872 .	1,267,953	64,747	1888 .	2,040,589	102,029

[1] From Ceylon. [2] From other countries.

Cinnamomum Tamala, Mes., *Tajpat.*—A cinnamon tree growing in the Himalayas, East Bengal, Khasiya Hills, and Burma, which supplies one of the barks known as *Cassia lignea* or cassia cinnamon, and its leaves are also used as a spice by the natives of India under the name of *Tajpat.* The leaves were known as a drug under the name *Tamal patra* very early, and are described and figured by Garcia, *Historia aromatum* (1693).

Cinnamomum obtusifolium,[1] an allied plant, is also known by the same native name and used for the same purposes. Dr. Watts says that *C. Tamala* is most likely to yield the taj or tajpat of the North-West Provinces and Punjab, but in Bengal the leaves and bark of *C. obtusifolium*, Nees, bears this name.

Mukerji describes (*Handbook of Indian Agriculture*) its cultivation in Bengal. He says that though it is a native of the Himalayas, at 3,000 to 7,000 ft. altitude, it grows very well at Sibpur in shady localities, and the tree is worth growing in moist and well shaded localities, as the use of tajpat as a spice is almost universal in India. A couple of small trees supply all the tajpat needed for one family. The tree should be propagated from seed imported from Sylhet. Seedlings should be grown in seed beds, and in two or three years transplanted into fields 10 ft. apart.

The leaves can be plucked after the fifth year, and the tree goes on yielding for fifty or a hundred years. But as the shed leaves are just as aromatic, if not more so, than the green leaves, stripping off green leaves, which weakens the tree, is not necessary.

The leaves are used as a spice in India in curries, and those of *C. Tamala* are also employed in calico printing in combination with *Myrobalans.* The bark is also used in dyeing in Chutia Nagpur, as an auxiliary with *Mallotus Philippinensis.* About 33 tons of leaves and

[1] *Cinnamomum obtusifolium*, Nees, is believed by some botanists to be the wild plant from which the Chinese cassia, *Cinnamomum cassia*, is derived by cultivation (see under Cassia Bark).

24 tons of bark are annually exported from the tract between Ramganga and the Sarda. The outer bark yields on distillation an essential oil. From 1 cwt. of bark $\frac{3}{4}$ lb. oil is obtained. The oil has a pale yellow colour and a smell of cinnamon oil, although very inferior to it in quality. It is chiefly used in the manufacture of soap, especially what is called military soap.[1] Bark and leaves are both used in native medicine for colic, diarrhœa, and other bowel ailments.

[1] Piesse and Lubin, in Watt's *Dictionary*.

CHAPTER VII

CASSIA BARK

There are several barks of an aromatic nature known in commerce as Cassia bark or Cassia lignea. They all belong to the one or more species of *Cinnamomum*, and are natives of the Eastern Asiatic Archipelago or China. The species of the Malayan Archipelago are not cultivated, but the bark is derived from forest trees.

That of China is cultivated by the Chinese, and is exported thence to Europe and other parts of the world. This species is

CINNAMOMUM CASSIA, BL.

This is a large evergreen tree, attaining a height of about 50 ft. with a girth of 5 ft. The bark is grey and smooth, thick in adult trees.

The leaves are oblong, dark, shining dark-green, with three prominent nerves, about 6 in. long and 3 in. wide, the petiole short and thick. The inflorescence is lax and spreading. The flowers are small and borne on short stalks, arranged in threes, and forming small cymes in branches at the end of the panicles. They are yellowish white in colour. The whole flower pedicels and peduncles are finely tomentose. The perianth is deeply divided into six oblong short blunt lobes, and bears nine stamens and three staminodes or barren stamens. The anthers have four cells, which open by little valves or lids, as in all plants of the laurel tribe. This pistil is in the centre of the flower, oval, with a stout short style and a small bilobed stigma. The fruit resembles that of the true cinnamon, but is rather smaller. It is black, pulpy, and aromatic, elliptic in outline, and seated in a cup lobed at the edge, the remains of the perianth. It contains a single seed.

The flowers are fertilised by flies chiefly, and the seed is dispersed by birds, which swallow the pulpy fruit as soon as it is ripe. The dried fruits are known as Cassia buds.

HISTORY

Cassia has been known from the earliest times as a spice. It is mentioned constantly in the Bible, and by many of the early Greek authors, and in Chinese herbals as early as 2700 B.C. A great part of this early recorded bark was undoubtedly the Chinese Cassia, especially as the Arabian and Persian name for the bark is *Darachini*, from *Dar*, wood, and *Chini*, Chinese. At the same time the Indian Tamala, or Tajpat, and the Malay barks may have been also among the oriental imports into Europe and Arabia under the name of Cassia.

The origin of the Chinese bark, however, was unknown till 1882. Mr. Ford, Superintendent of the Botanical and Afforestation Department of Hongkong, made an expedition to the West river, Canton province, to report on the cultivation of the plant. His account was published in a Report to the Hongkong Government, and also in the *Linnean Society's Journal*, vol. xx. p. 19, by Mr. (now Sir) W. Thiselton Dyer, in a note on the origin of *Cassia lignea*.

Cassia was known in Western Europe as early as the seventh century, and is mentioned in medical books in England before the Norman conquest. It was sold as Canel in England in 1264 at 10d. per lb., and in the fifteenth century was mentioned in the *Boke of Nurture*, by John Russell, as resembling cinnamon, but being inferior.

CASSIA BARK OR CASSIA LIGNEA

The most valued Chinese cassia bark approaches nearly to cinnamon from Ceylon. It is sold in simple quills, not inserted one within the other. They are less straight, even, and regular, and darker brown, and though some are extremely thin, others are much stouter than fine cinnamon. In fact, it is less uniform. The outer coat is removed with less care. It is imported in small bundles about 1 ft. in length and 1 lb. in weight, the pieces being bound together with bits of bamboo.

Good cassia has the flavour of cinnamon, and is as sweet and aromatic, though it is often described as less fine and delicate in flavour. It is probable that by more careful preparation and selection, after the methods in use in the cultivation of cinnamon by the Ceylon planters, a form of cassia might be turned out which would be nearly or quite as good as true cinnamon. The plant might be cultivated in many places where cinnamon would not be satisfactory, as it seems to be less particular as to soil and climate. The returns of trade show that there is a good demand for it, though at the same time this is probably due to its being cheaper than the finely turned out Ceylon cinnamon, for it appears to be chiefly used as a substitute for the latter.

CULTIVATION

Mr. Ford gives the area of cultivation as follows :—

> There are three chief districts where the cassia is cultivated, viz.: Taiwa, Lat. 23° 34′ N. and Long. 110° 18′ E., in the Kwangsi province; Lukpo, in Lat. 23° 6′ N. and Long. 112° 24′ E.; and Loting, Lat. 22° 51′ N. and Long. 111° 8′ E., both in Kwantung province. These are the market towns of the district, but the cassia is cultivated over a large area of country, stretching to considerable distances from the town.

The cultivation was found to be very extensive, especially at Loting, where one of the largest cultivators said there were about 1,000,000 maus (about 52,600

English acres) under cultivation, and that the area was increasing every year. The cultivation had been carried on for twenty-five years. In Toshing the low prices obtained had caused a decrease in production, but this was the only place found by Mr. Ford where there was any decrease, though it was said that the low price of the Javanese bark was cutting out the Chinese trade.

It appears that the plant *Cinnamomum cassia*, though cultivated from time immemorial, does not appear to be indigenous in China. In Cochin-China, however, it appears to be wild, and was perhaps introduced thence into China. The tree is botanically very closely allied to *Cinnamomum obtusifolium*, Nees, of Khasiya and Cochin-China.

Mr. Ford's account of the cultivation is as follows:—

When the trees are about six years old the first cut of bark is obtained. The season for barking commences in March and continues till the end of May, after which the natives say the bark loses its aroma. The branches, which are about 1 in. thick, being cut to within a few inches of the ground, are carried to houses and sheds in the vicinity of the plantations, all the small twigs and leaves being cleared off. A large-bladed knife, with the cutting edge something like the end of a budding-knife, is used to make two longitudinal slits and three or four incisions at 16 in. apart round the circumference through the bark. The bark is then loosened by passing underneath it a slightly curved horn-knife, with the two edges slightly sharpened. Pieces of bark, 16 in. long and half the circumference are thus obtained.

The bark, after its removal and while it is still moist with sap, is then laid with the concave side downwards and a small plane passed over it and the epidermis removed. After this operation the bark is left to dry for about twenty-four hours, and then tied up in bundles about 18 in. in diameter, and sent into the merchants' houses in the market towns.

The leaves which are cleared from the branches that are barked are carefully preserved and dried, and are used for distilling cassia oil. A large quantity of leaves are sent to Canton, where I was told that the operation of distilling is employed.

The twigs are removed from the cut branches at the same time as the leaves, and are sold for native uses. Cassia-buds are the immature fruits. They are gathered when about one-eighth grown. "Buds" and the seeds required for sowing are obtained from trees ten years old and upward, that are left standing about 50 or 100 ft. apart amongst the trees which are cut down every six years for their bark. These seed-bearing trees are not cut unless there is some demand for the very thick bark on their trunks, when some of the trees which can be conveniently spared are sacrificed.

The cultivation, we gather from this account, much resembles that of the cinnamon already described as practised in Ceylon.

The trees are cultivated in China on hill-sides, terraced for the purpose from altitudes of 300 to 1,000 ft. above sea-level; apparently it is not cultivated on the plains, because what level ground there is, is required for rice and vegetables. The soil selected is that bearing the thickest growth of trees and ferns.

I cannot find that any Chinese cassia has been cultivated elsewhere except in China and Indo-China. Mr. Ford distributed seeds of the plant he found in China, and most tropical gardens received some. A row of trees planted in the Singapore Botanic Gardens about 1884 have now developed to a large size. They were planted about 12 ft. apart, and are about 50 ft. tall and 2 to 5 ft. in girth. They flower and fruit every year, but the seeds are constantly carried off by birds unless protected by muslin bags when ripening. Some of them are growing in stiff, yellow, clay soil, others in a lower, more swampy soil, rich in humus, and damper, but the ones in the wettest soil are inferior, and it is clear that they do not do as well where the soil is damp.

I cut one down some years ago, intending to try how far it stooled well, and if it shot up strong peelable shoots; it did stool as strongly as cinnamon, and could obviously be grown and treated in the same way.

The Singapore plants are very aromatic, and the leaf-stalks especially have a strong flavour. The shoots are stout and slightly pubescent, but I did not find them to peel very easily.

OIL

Mr. V. Cayla, in the *Journal d'agriculture tropicale,* (June 30, 1909, p. 164), gives some further account of the Chinese cassia under the name of *Le Cannelier.*

He says: "All parts of the plant—bark, flowers, branches, peduncles, and leaves—produce essences of which the properties are nearly exactly the same, and the cinnamic aldehyde (which ought to compose 73 to 90 per cent of the essence) varies but little. The essence distilled and exported to Hongkong from China usually comes from a mixture of these parts.

"A great deal of the Chinese cinnamon comes as bark to Canton, whence it is shipped to Europe.

"The leaves are chiefly used for distilling, flowers and peduncles are not separately collected, and the bark detached goes in with the leaves.

"The still used consists of a metallic recipient fixed in a brick furnace for boiling the water; a cylinder half full of leaves and branches stands above the receptacle; all is covered with a cap of a special form, furnished at the base with a pipe in which is collected the essence, afterwards cooled by passing through receptacles arranged in stages. With more care improvements could be made on the Chinese method and product. The receptacle is often made of lead, which has this disadvantage, that some of the cinnamic aldehyde becomes acidified and acts on the lead, forming cinnamate of lead, which makes it necessary for the extract to be purified before its use in pharmacy."

The Chinese adulterate the oil with cedar-wood oil and other similar oils, and for ten years used a mixture of resin and petroleum, which was detected at length by Schimmel Bros.' firm. The adulterated essence preserved the density of the pure essence, but possessed a disagreeable odour. It would, of course, be easy to procure nowadays cheap and convenient iron or copper stills, such as are used for citronella and lemon-grass distillation, and make a good pure extract of cassia.

The oil somewhat resembles cinnamon oil, but has a less pleasant taste.

It is exported to London from the south of China, to the extent of 47,517 lbs. in 1869; in 1870, 28,389 lbs. was exported there.

Hamburg also takes much of this oil; thus in 1895 that port received 30,000 lbs. from China and 10,000 lbs. from England; and in 1896, 3,900 lbs. from China and 17,000 lbs. from England.[1]

CASSIA BUDS

These are the dried unripe fruits of the *Chinese Cassia*. After flowering the sepals of the cinnamons swell up and form a cup in which the small, black, olive-like fruit sits, like an acorn in the cup. These are what, I presume, Cayla, previously quoted, refers to as flowers, as the real flowers are too small to be separated for distilling. The "buds" are taken from the Chinese tree when comparatively young; in the Malayan cassias when adult.

They are used in confectionery in place of cinnamon, and, according to Dr. Masters, in the *Treasury of Botany*, the Germans and Russians prefer cassia to cinnamon for flavouring chocolate, as it is stronger in taste.

Simmonds's *Tropical Agriculture* states that the average quantity of cassia buds imported in the thirteen years ending in 1842, was 4,023 lbs., and the consumption about 6,700 lbs.

He gives the following data of imports:—

	lbs.	Value.
1867	7,355	£467
1868	50,676	3,565
1869	38,861	3,000
1870	29,321	2,226

No later returns are procurable.

The earlier exports from China were larger, but decreased. Rondot gives them as 53,333 lbs. in 1848, 31,066 lbs. in 1866, 22,000 lbs. in 1867.

[1] Flückiger and Hanbury, *Pharmacographia*, p. 532.

Cassia buds are popular among Oriental nations, and a fancy for the Malayan kind may have reduced the output in China.

TRADE

The imports into Europe and the United States of cassia bark generally include all the different kinds, so that it is not easy to form any idea of the amount of each kind required.

We have a few figures of the Chinese exports from Canton and Hongkong, which give, however, some idea of the trade.

Simmonds gives the following :—

	Piculs.	Value in Dollars.
1862	7,683	13,030
1863	8,374	139,175
1864	13,851	228,874
1865	23,514	398,776
1866	23,960	455,113
1867	24,660	440,885
1868	36,055	721,098
1869	40,686	...
1870	61,220	...
1872	76,464	...

The imports into India are given by Dr. Watt as follows :—

Imports

	Cwt.	Value in Rupees.
1880–1881	19,660	4,68,576
1881–1882	9,705	1,90,891
1882–1883	13,240	2,61,543
1883–1884	19,917	3,84,491
1884–1885	14,769	2,48,344

Exports and Re-exports

	Cwt.	Value in Rupees.
1880–1881	4,487	1,18,248
1881–1882	3,865	94,408
1882–1883	2,211	45,921
1883–1884	5,365	1,05,310
1884–1885	4,692	81,394

Imports for 1884–1885

	Cwt.	Value in Rupees.
To Bombay . . .	13,308	2,01,944
To Bengal . . .	2,226	41,460
To Madras . . .	235	4,940
	14,769	2,48,244

Of this China sent 13,557 cwt., valued at 2,24,805 rupees, and the Straits Settlements 1,212 cwt., valued at 23,536 rupees (this latter was probably Malayan cassia).

The bark, re-exported, went to Persia, 2,785 cwt.; Arabia, 980 cwt.; and Turkey in Asia, 715 cwt. Thus at least the greater part of the cassia bark in commerce is derived from the Chinese *Cinnamomum cassia.*

In French Indo-China some interest has been taken in this bark by the French colonists. M. Eberhardt and Professor Perrot published recently an article on "Les Canneliers d'Indo-Chine," in the *Bulletin des sciences pharmacologiques*, in Paris. They come to the conclusion that there is only one type of cassia bark tree, and that is *Cinnamomum obtusifolium*, Nees, the cassia bark of Cochin-China (*C. Loureiri*, Nees) and the Chinese cassia (*C. Cassia*, Bl.) being only varieties of the Annamese (*C. obtusifolium*).

There is one fairly extensive plantation of the tree in Quang N'gai (Annam) of 1,000 trees, a few plants in the Tea Gardens of M. Lombard, near Tourane, and some native cultivations in Bink-Na.

The different sorts of Annam cassia are valued by the Chinese buyers according to appearance and source. The most highly valued is the "Cannelle Royale" of Thank Hoa, which is valued at more than its weight in gold.

It is obtained exclusively from wild trees. The writers estimate that a tree, 15 to 16 metres tall, giving this class of cassia, brings 1,200 to 1,500 francs to the owner. Mr. Crevost (*Bull. écon. Indo-Chine*, No. 77, 1909, p. 150) states that the average price of the bark of Thank Hoa cassia ranges from 202 to 337 francs a kilogram, according to quality. The average price of cultivated Annam cassia is only about 80 francs the kilogram.

M. Eberhardt found the tree growing pretty nearly all over Indo-China, and a general consensus of opinion that Annam cassia was the best. He is doubtful as to whether the cultivation would ever pay the European, as the age to which it requires to develop before exploiting is great. It could, however, be well utilised as an accessory cultivation.[1] It is very probable from these researches that the Chinese cassia, which is not known in a truly wild state, is an introduction from Annam, or other parts of Indo-China, by the Chinese, and that it is a cultivated form of *C. obtusifolium*, a plant of rather wide distribution. As mentioned in dealing with cinnamon, these aromatic barks vary much in value according to the strain or variety, and according to climate and soil. It might be well worth trying if the fine strain of Thank Hoa would not keep true under cultivation, and if it could not be cultivated in Indo-China by the same method as cinnamon is in Ceylon.

OTHER CASSIA BARKS

There are several other species of *Cinnamon* which grow wild in the Malay Peninsula and Islands, of which the bark is collected by natives and sold in the local markets, or used locally. None, however, so far as I am aware, are at present cultivated, and indeed even yet but little is known as to the origin of some of these barks, or the habits of the tree.

Cinnamomum iners, Reinw.—*Kayu Manis hutan* (Malay, lit. wild cinnamon) is a very common tree in low swampy ground in the Malay Peninsula. It is closely allied to, if not actually a form of, the true cinnamon, but is much less aromatic. The bark is used in curries, but is not much sought after.

Cinnamomum Kulit Lawan, Bl.—The clove bark,

[1] *Journal d'agriculture tropicale*, May 1910, p. 158.

Kulit Lawang of the Malays (*Kulit*, bark; *Lawang*, clove), is a native of the Malay Islands and Peninsula. It has a strongly aromatic bark, and is one of the cassia barks of commerce. The calyces of the fruit of this plant are sold in Singapore under the name of *Bunga Lawang* (clove bark flowers). They are small stalked cups, curiously lobed, about $\frac{1}{2}$ in. across, black when dry, with a slender stalk. They are expensive, costing about a cent apiece, and highly valued in native medicine, and for curries.

Cinnamomum Sintoc, Bl.—The Sintok of the Malays is a large tree occurring in Java and the Malay Peninsula. It has also a very aromatic bark, which is collected and sold.

These jungle cassia barks are usually thicker than the Chinese cassia barks, probably being taken from the trunks of old trees only. Sumatra produces a considerable quantity of one of these cassia barks, probably *C. Sintoc.*

From Padang was exported, in 1871, 6,127 piculs of cassia bark, of which a large portion was shipped to America (Flückiger and Hanbury).

Large quantities are shipped from Java, Timor, and other islands to Europe. They are variable in form and thickness, from the thickness of cardboard to more than $\frac{1}{4}$ in. They vary also in colour, some being of a pale cinnamon colour, others deep brown.

It may be doubted if any of these Malay cassias would be worth cultivating, though no doubt the bark produced thus would be of a much finer quality than that from the jungle, for they are mostly inferior to *Chinese cassia*, which would be as easy to cultivate.

MASSOI BARK

This bark is the product of a tree of large size occurring in the forests of New Guinea. The bark which is taken from old trees in the jungle is thick and aromatic. The natives seek the tree in the forest, and cut off the bark as high as they can reach, according to Dr. Schlechter, who made some inquiries for me about this little known cassia bark; it is not cultivated, nor is the bark of the twigs or shoots taken. The tree is at present very little known. Blume referred it to the genus *Cinnamomum*, but Dr. Beccari, who saw some poor scraps collected by D'Albertis in New Guinea, affirmed that it was not of that genus, but made a new genus for it under the name of *Massoia*. No description of the plant has yet been published, however; massoi bark, or meswi bark, as it is called in Singapore, is reported to be very rich in eugenol, but at present is too expensive to be a source of this. Though the plant is not yet in cultivation, I mention it, as there are often inquiries about it.

CHAPTER VIII

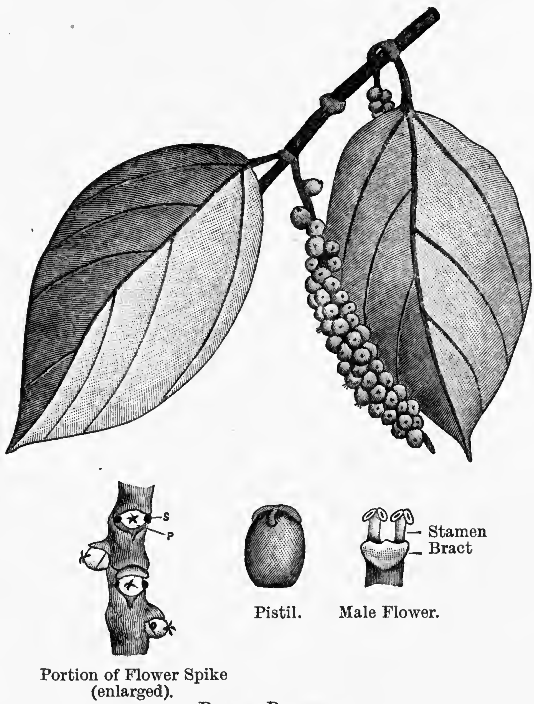
PEPPERS

THE true peppers all belong to the genus *Piper*, order *Piperaceae*, the plant producing cayenne, or red pepper, being not a true pepper, but belonging to the order *Solanaceae*, and the genus *Capsicum*, under which name it will be described. Among other spices to which the name pepper is applied are Jamaica pepper, a name for allspices or pimento, and Melegueta pepper, a name for Grains of Paradise (*Amomum melegueta*), which will be found under their proper headings.

The genus *Piper* contains a very large number of plants, nearly all climbers, scattered over the tropics, but most of these, though possessing more or less of the aromatic biting taste characteristic of black pepper, are too weak or ill-flavoured to be used as a spice. By far the most important of all these plants is the black pepper (*Piper nigrum*, L.), and next to this comes the long peppers (*Piper officinarum* and *Piper longum*); African pepper (*Piper Clusii*) is used to a small extent, and cubebs (*Piper cubeba*), in early days used as a spice, has for many centuries been valued more as a drug. Bakek (*Piper miniatum*), with long, slender, pungent spikes, is used for chewing with betel-nut by natives, as are the leaves of the betel pepper (*Piper betle*). *Piper sylvaticum*, Roxb., is an Indian pepper used chiefly as a drug by natives, and a few others in different parts of the world are used by natives only, for spices or drugs. The kava (*Piper methysticum*), used to make an intoxicating liquor in the Polynesian Islands, belongs to the same genus.

BLACK PEPPER

Black pepper is the dried fruit of *Piper nigrum*, L., a native of the Malabar coast of India, whence it has been diffused in cultivation in many parts of the world,



BLACK PEPPER.

but chiefly in the Malayan and Cambodian regions. White pepper is obtained from the same plant, being merely ripe seed of the black pepper freed from the outer coat of skin and pulp.

DESCRIPTION

Piper nigrum, L., is a woody climber attaining a very considerable length in a wild state. The stem, at first purplish or dark green, eventually attains a thickness of $\frac{1}{2}$ in., with a greyish bark. It is flexuous and swollen at the nodes, from which are produced numerous short roots by which it clings to a tree or other support. The leaves are alternate ovate or lanceolate, ending in a short point, rounded or slightly narrowed at the base, smooth, dark green, paler beneath, coriaceous, with four or five prominent nerves ascending towards the tip; the leaf-stalk or petiole is short, usually $\frac{1}{2}$ in. or less long, and at first sheathing with a narrow marginal sheath which soon becomes black and falls off. In size the leaves vary considerably, from 4 to $10\frac{1}{2}$ in. long and $2\frac{1}{2}$ to 5 in. wide when fully developed. The flowers, which are very minute, are borne in very slender, yellowish green, hanging spikes, or more correctly catkins, as the whole inflorescence when withering falls off together, and the separate flowers do not fall off as they do in a true spike. The catkins vary from 1 to 6 in. long in flower, lengthening as the fruit ripens. They are borne on the nodes opposite to the leaves. The minute flowers are of very simple structure. Below each is a small fleshy bract, ovate and usually acute, which more or less enfolds an oval pistil bearing on its top a four or five-lobed stigma. This is white at first, but soon becomes brown or black. It is only functionally active while it is in the white stage; on either side are two or three stamens, with a short filament and a pair of minute oval pollen-sacs. In some forms the bracts of different spikes contain either pistils only or stamens only. In fact, the spikes are unisexual. In the hermaphrodite flowers the stamens do not appear till after the stigmas have become brown, *i.e.* are withered. Until then they are immature and hidden beneath the bract, so that a pistil cannot be fertilised by its own stamens.

In wild forms Barber[1] states that the plant is unisexual, having only male flowers or female flowers

[1] "Varieties of Cultivated Pepper," *Report Madras Dept. Agriculture*, vol. iii. 56, p. 125.

on each vine. In the cultivated forms usually the spikes are hermaphrodite, having stamens alongside of the pistil. The presence and abundance of stamens in the spikes is of the utmost importance to the planter, for if the supply of pollen is not sufficient the spikes will be partly sterile, and the crop of pepper small.

The fruit of the pepper is a nearly globular drupe, about $\frac{1}{5}$ in. through when ripe, at first of a dull green colour and crowned at the top with the starlike stigmas, but eventually becoming red. When ripe it has a thin red skin, beneath which is a thin pulpy layer which encloses the round white seed. The fruits do not all ripen at the same time on the spike, and one can see them in a single spike in all stages of development, some apparently healthy having made no growth, others half grown. In good spikes, however, nearly all are approximately of the same size, when nearly ripe.

Good spikes are 4 in. long, and when ripe about $\frac{1}{2}$ in. through, and bearing about fifty peppercorns, but the size of the spike and number of fruits varies according to the variety cultivated.

Exactly how the pollen is transferred to the stigmas is not certain. Barber points out that flushing takes place in India in the heavy driving rains of the monsoon, and suggests that rain and wind are necessary to dash the pollen from the male flowers to the female pistils. The flowers, however, are produced in the dryer parts of the year in the Straits Settlements, and it is more probable that the wind is the fertiliser. Ants, however, may often be seen running about all over the spikes, and may carry the pollen as well.

The number of flowers in a spike is estimated by Barber as between 75 and 100. He estimates the number of pollen grains in a hermaphrodite spike as 30,000 to 40,000, and as one pollen grain is enough to fertilise each stigma, there is an ample reserve of pollen for the hundred stigmas. Still, it is very common to see blanks in the fruit spike where for some reason the pistil has failed to be fertilised.

Barber's description of the fertilisation, as observed in India, is as follows :—

> Each new leaf is followed by a spike in the pepper at the flowering time, the spike arising at the same joint as the leaf, but on the opposite side. In the course of a few weeks the spike is seen to be elongated, and to be covered with the little, white, starlike stigmas. These are very delicate, and in the continued showers become covered with the wandering pollen from more advanced spikes. A further lengthening will then show the stigmas faded and the small pollen-sacs peeping out on each side of the ovaries, ready to burst and scatter their pollen to other later flowers.

[According to ~~this~~ one view of the fertilisation of the pepper flowers, a long hot spell after the monsoon's commencement would cause the stigmas to dry up before fertilisation could be effected, and many spikes would drop off, for any unfertilised flower is quickly thrown off by plants. The life of the male element is short. On the other hand, a succession of short spells of rain and sunshine would be beneficial, since sunshine is necessary for the growth of the leaves and especially for the maturing of the fruits.

It is probable too, that very heavy rainfalls, especially on plants not sufficiently densely grown, would be injurious by washing away the pollen.]

VARIETIES OF PEPPER

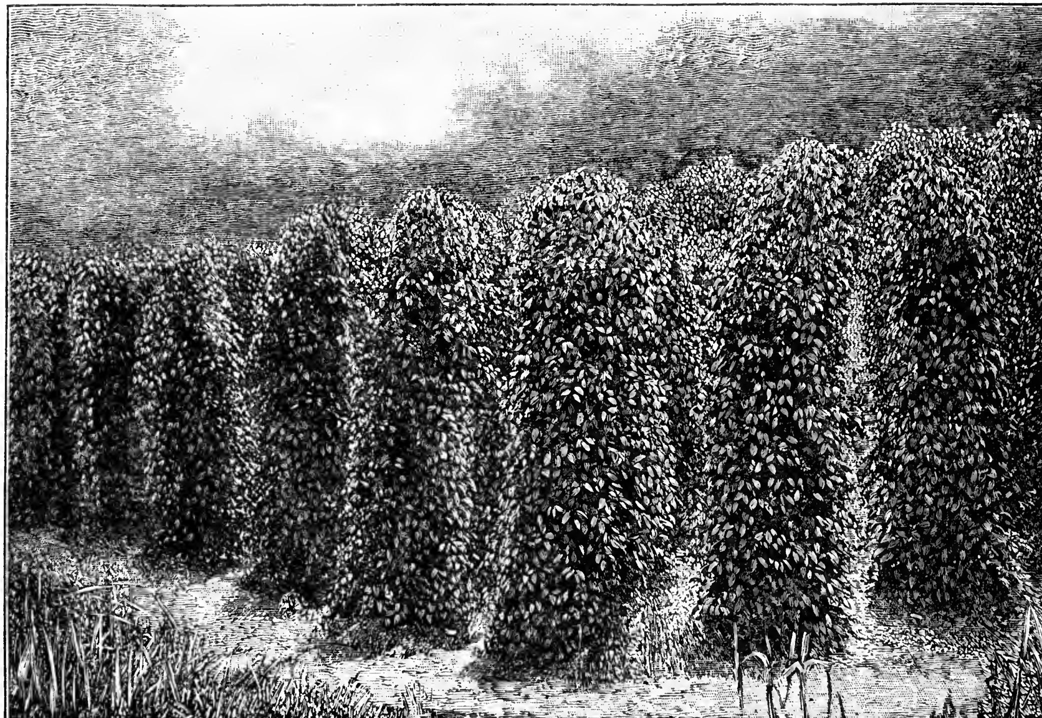
The pepper cultivated in the Malay Peninsula is, so far as I have seen, of one variety only. It is the variety from which the above description of the pepper plant is taken. It possesses deep green leaves with strongly marked veins and straight edges. The leaves are not as large as in the big forms of Southern India, and the spikes are not very large, but the plants are always hermaphrodite with plenty of stamens, so that they are heavy fruiters, and in good strong plants the spikes contain a fruit for every flower. The peppercorns when dried are not as big as in some other varieties, but are of moderately large size, and give large sized seeds, that is to say, supply fine samples of white pepper. The finest form in this region is the Trang pepper, in which the seeds are much smaller than ordinary pepper, but fetch a higher price. Barber, in the paper above quoted, gives an account of the varieties of pepper cultivated or wild in Madras, from which I take the following notes.

Balamcotta.—This may be regarded as all round the best pepper of the district. It is very widely distributed and appears to be the main Tellicherry variety. Its leaves are the largest of all peppers. They vary, however, a good deal according to age, those bearing spikes being very much smaller and narrower as well as lighter in colour than the older ones. The general colour of the vine is light green, being lightest at the time of flushing. The leaves when full grown are twice as long as broad, $10\frac{1}{2}$ in. long and 5 in. wide being an ordinary size. They are oval to ovate, broadest at the middle, where there is a distinct bend, giving the leaf almost an angular appearance; one side is broader than the other. The flowering branches are drooping and the internodes long. The leaves are flat, the veins not strongly marked, tips straight. The spikes are long, sometimes as long as 6 in., the flowers distant, the spaces between them three times as long as the flower. It is usual for this variety to flush all over at about the same time, and the crop can be gathered at one time. A strong variety and heavy bearer.

Pure males of this variety have been met with. The foliage in hermaphrodite plants is variable in form and size, and any uniformity in the Balamcotta variety may be looked on with suspicion, as in all probability a vine of this character is devoid of stamens.

Two varieties of Balamcotta pepper are described, the leaves of which are more uniform than those of the typical form. These are known as the wavy-leaved Balamcotta and the small-leaved Balamcotta.

The first has distinctly wavy edges to the leaves,



Pepper in Borneo.

and more prominent veins. The leaves are less flat. It is deficient in stamens.

The small-leaved Balmacotta has small, uniform leaves, and the whole plant is covered with an immense number of short flowering spikes. These are largely devoid of stamens.

Kallivalli Pepper.—This has a reputation for a heavier crop than that of Balamcotta, and is more valuable. It has the defect that it flushes irregularly. It is said that fresh spikes appear at intervals during the year, so that the crop is extended over a long period. The leaves are fairly uniform in length, varying in width according to age; the young leaves are oval, with equal sides, the mature ones practically circular with a sharp sudden point twisted to one side. The general colour of the foliage is dark green, contrasting with the Balamcotta vine in this respect. The leaves are more deeply impressed with nerves. The flowering branches are much stronger and stand out stiffly from the standard, and the joints are closer together. The spikes vary a good deal in length, but are not so long as in the Balamcotta varieties. They are often branched, few vines being without one or two branched spikes. Sometimes the spike is tassel-like in appearance, with a dozen or more branched spikes at the base of the main spike. The flowers are much closer together than in Balamcotta vines, their distance apart being equal or double the length of the flowers. The spike is therefore closely packed with berries which are said to be smaller and heavier than in Balamcotta. The spikes are abundantly supplied with stamens. The plant stands heat well and is easy to propagate. The main varieties of the Kallivalli type are the ivy-leaved forms distinguished by their wavy edges.

Cherikadi is a well marked dwarf form under 15 ft. in height; the leaves are uniform, narrow pointed, 6 to 8 in. long, and 3 to 4 in. wide, dark green, and strongly veined, more so than in the two former varieties. The leaves are arranged uniformly overlapping, so as to hide

Pepper from Borneo.

the spikes. The spikes are small, 1 to 2 in. long, and densely crowded with fruit. The flowers are less than their diameter apart. The stamens are abundant, and the plant is very fruitful and flushes early. Intermediate forms between this and the other two forms occur.

Mr. C. P. Kaunan Nair (in *Tropical Agriculturist*, June 1906, p. 562) describes four varieties cultivated in Malabar. *Sadharana valli*, a common form and a good cropper.

Kallivalli already described, the best kind. *Utharam valli*, easier to propagate than either of the preceding. It has thicker shoots, and broader leaves. The peppercorns larger and lighter, and the yield small.

Koltavalli, so called because the stems interlace like a basket. It grows easily without care, but the yield is poor.

Short-leaved pepper has light-coloured, uniform, short, broad, flat, oval leaves, 4 in. long, 2½ in. wide, with indistinct veins, the vines tending to high growth with a very large number of small spikes, all exactly of the same stage of maturity. The branches stick out and branch dichotomously. The whole vine has a thinly-clad appearance. The spikes are 2 to 3 in. long, very numerous, apparently without stamens.

The plant cultivated in the Malay Peninsula and Borneo resembles the short-leaved pepper, as far as description goes, in many respects. It is not a tall pepper, and is only cultivated up to about 12 ft. height. The leaves are oval, or lanceolate, dark green with prominent nerves; the spikes numerous and short, not branched; the flowers about twice their length apart, fully hermaphrodite; the stamens in pairs or solitary on each side of the pistil; the fruit spikes full, the peppercorns not large.

Some other forms are mentioned by Barber as occurring on the Madras estates, and two jungle peppers have found their way into the cultivated area. The *bigberry*, unisexual vines, as in most wild forms; the females with small, dark green, flat, narrow, hard leaves, and hairy spikes; males resembling the ivy-leaved form, but the leaves not markedly wavy, the spikes brown, red, and hairy. Apparently a hill form which has crept down into the lower estates.

Pouched pepper resembles the bigberry, but the bracts are developed into pouches or cushions, on which the male and female organs are situated. It is a distinct species, and known as *Piper trichostachyon.* It is remarkable for the fragrance of the young spikes, which are thick and whitish yellow.

In Borneo, Sarawak, Mr. Hewitt found two forms in the Chinese pepper gardens, a small-leaved and a large-leaved form. The latter has many of its leaves resembling those of the small-leaved variety, but some few are considerably larger. The small-leaved one is more prolific and is preferred. In most gardens there are one or two male plants. They are indistinguishable from the small-leaved form till they fruit, when they only produce a little fruit. Some of the Chinese gardeners look with favour on the male vine, and one man affirms that if there were no males in the garden, a plant of the *Betel pepper* (*Piper betle*) was cultivated in the garden to act as a male. However this may be, it is usual to find one betel pepper or more in a Chinese pepper garden.[1]

Trang Pepper.—This is the name of a variety cultivated in the most northern of the Siamese western states, known as Trang. An account of a visit to this region by Mr. R. Derry is published in the *Bulletin of the Straits Settlements* in 1909 (vol. viii. p. 240), the object of the expedition being to secure plants for cultivation in the Malay Peninsula. The plant possesses a more decided fruiting season than the other peppers. In April not a spike of flowers or fruit was to be seen. The fruit is produced in the dry season only, and therefore does not run the risk of damage from rain. The peppercorns are the smallest of all varieties, the spikes being about 3 in. long, but the fruit possesses the

[1] J. Hewitt, *Agricultural Bulletin of Straits Settlements*, vol. vii. p. 189.

fullest and most pungent aroma of any. Trang pepper, too, stands the milling process in London better than any other; the local Malay Peninsula varieties being apt to break up, being too brittle, and for these reasons Trang pepper always obtains the highest price in the market.

Sumatran Varieties.—Marsden, in *The History of Sumatra*, mentions three varieties cultivated by the natives, *Lada Kawur*, *Lada Manna*, and *Lada Jambi*. The first of these, also known as Lampoon (Lampong), is the strongest he says, and bears the largest leaf and fruit, is slower than the next in coming to perfection, but of much longer duration. The fruits of the second variety, Lada Manna, are somewhat smaller, and its peculiarity is that it bears soon, and in large quantities, but seldom passes the third or fourth year crop. The Jambi, which had, he says, fallen into disrepute, is the smallest in leaf and fruit, very short-lived, and not without difficulty trained to its post.

Dwarf Pepper.—A non-climbing pepper of erect habit, and dwarfed, is described by Mr. W. E. Broadway, the Curator of the Botanic station in Grenada, West Indies, in the *Agricultural News* (vol. ii. p. 69). He says that this form never fails to produce a good crop, and its low habit is very convenient for gathering the fruit, while the climbing pepper fruits irregularly. Though this is an interesting variety, and might, under special circumstances, be used profitably, one would hardly be inclined to recommend it for cultivation. It is obvious that this dwarf pepper, however closely packed on the ground, could not give as big a return from an acre as a good vine growing from 12 to 20 ft. tall.

HISTORY

Pepper is one of the earliest known spices in the world, and was formerly the staple commodity of trade between India and Europe. It is mentioned by Theophrastus in the fourth century B.C., who mentions two kinds, apparently black pepper and long pepper.

White pepper is mentioned first by Dioscorides, and, generally speaking, it was supposed in the early days that white pepper was produced by a different plant from that which produced the black pepper. Pliny states that in his time long pepper was worth 15 denarii a pound, white pepper 7 denarii, and black pepper 4.

In the *Periplus of the Erythroean Sea*, dated A.D. 64, we find it stated that pepper was exported from Barake, a shipping port of Net Kunda, where it is said to grow in great abundance, and where alone it occurs. These places are identified with localities between Mangalore and Calicut in Madras.

In about 540, Cosmas Indicopleustes visited the Malabar coast, and gives an account of the plant as a climber, sticking to high trees like a vine. This appears to be the first account of the plant producing the spice.

Marco Polo mentions pepper as being produced in Java in 1280, and Nicolo Conti, a Venetian traveller, saw it in Sumatra in the fifteenth century, but there is no evidence of its being in the Malay region earlier, and the supplies were mainly, it seems, brought from the Malabar coast before this. Garcia da Orta says that in his time it grew on the Malacca coast, and in the islands near, Java and Sunda and Cuda (? Kedah). The pepper of these parts was inferior to that of Malabar, where it was widely spread from Cape Comorin to Cannanore. During the Middle Ages pepper was the most valued spice, and Venice, Genoa, and other European cities owe much of their wealth to the importation of the spice. Taxes and tributes were often paid in pepper. Thus in the siege of Rome by Alaric, king of the Goths, the ransom of the city was 5,000 lbs. of gold, 30,000 lbs. of silver, and 3,000 lbs. of pepper, and after the capture of Cesarea by the Genoese in 1101, each of the conquering army received 2 lbs. of pepper and 48 soldi as a share of the spoils.

The first mention of pepper in England is in the Statutes of Ethelred (978 to 1016), where the Easterlings coming to trade with London were required to pay a tax of cloth, 5 pairs of gloves, 2 barrels of vinegar, and 10 lbs. of pepper, as a tribute at Christmas and Easter.

Later, in parts of England pepper rents were established, by which the tenants had to supply their lord with a stated quantity of pepper, usually 1 lb.

A pepperer's guild existed in the time of Henry II. (1154 to 1189), the traders being known as Pepperers (Piperarii), or in French Poivriers or Pebrieres. This guild was later incorporated with the Grocers. The price of pepper was very high in the twelfth and thirteenth centuries, being valued at 1s. (equivalent to 8s. of modern times) per lb., and between 1250 and 1360 it rose to 2s. per lb. In France, in 1370, it cost 21 francs 30 cents, and in 1542, 11 francs per lb.

The demand for this spice, and its costliness, were the main inducements to the Portuguese to seek for a sea passage to India. The Venetians and Genoese had practically a monopoly of the spice, but when the Portuguese found the sea route in 1498, the price of pepper fell, and in spite of the efforts of the Venetians to retain the traffic, it passed out of their hands into that of the Portuguese, who retained it till the seventeenth century.

Under the Portuguese Malacca became the great emporium for pepper. The cultivation spread to the islands of the Malay Archipelago, and the trade on the Malabar coast fell off. When the Dutch got control of the Malay Islands, they attempted to control the export and cultivation as they did with the other Oriental spices, but pepper was cultivated to too large an extent in countries not controlled by them, to permit them to form a monopoly, as they could with nutmegs and cloves.

In 1801, Mr. Hogendorp gives the following returns, from the head of the first commercial houses, of the amount of pepper procurable from the Malay region (Raffles, *History of Java*, vol. i. p. 238): Sumatra, Bencoolen, 1,200 tons per annum. Susu and Acheen, 2,000 tons. Palembang, 700 tons. Lampong, 500 tons. Malay Peninsula, Penang, 100 tons; Tringanu and

Kelantan, 2,000 tons; Borneo, Banjermasin, 12 to 1,500 tons. Java, Bantam, 500 tons; Siam, Chantabun, 1,000 tons.

In 1829 the Malayan cultivation had increased greatly. Milburn (Watt's *Dictionary*, p. 819) gives the following figures: Sumatra, 16,800 piculs; Bintang, Lingga, and other neighbouring islands, 12,000 piculs; Malay Peninsula, 28,000 piculs; Siam, East coast, 10,000 piculs; Borneo, 20,000; India, West coast, 30,000 piculs (16·8 piculs make a ton).

The cultivation of pepper in Singapore and Johore increased to a very large extent after the founding of Singapore in 1822, the cultivation being in the hands of the Chinese, who combined its cultivation with that of gambir till about 1894, when, owing to the fall in price, and to the scarcity of firewood for cooking the gambir, the plantations gradually died out. A good deal still remains in Johore, however, and of late years (1909, 1910) the cultivation has shown signs of returning.

Names of Black Pepper.—Many of the European names for pepper are derived from the Sanskrit, *Pipal*, which seems properly to belong to long pepper.

French, *Poivre*; German, *Pfeffer*; Latin, *Piper*; Greek, πέπερι, *Peperi*; Hindu, *Gulmirch*, *Filfilgura*; Bengal, *Muri Chuong*; Tamil, *Milagu*; Malay, *Lada*; Arab, *Filfiluswad*; Sanskrit, *Maricha*.

CLIMATE

Pepper is strictly a tropical plant, and seems to have been successfully cultivated only between latitudes 20° N. and 20° S. It requires a heavy rainfall, and though a dry season of some duration does not appear to injure it, a very prolonged dry period, or too long exposure to sun, certainly affects it adversely. Long continued droughts, as Marsden[1] remarks, stop the vegetation of the vines and retard the produce. "This," he says, "was particularly experienced in the

[1] *History of Sumatra*, p. 106.

year 1775 in Sumatra, when, for a period of eight months, scarcely a shower of rain fell to moisten the earth. The vines were deprived of their foliage, many gardens perished, and a general destruction was expected. But this apparent calamity was attended with a consequence not foreseen, though analogous to the usual operations of nature in that climate. The vines, as soon as the rains began to descend, threw out blossoms in a profusion unknown before; old gardens which had been unprolific for two or three years began to bear, and accordingly the crop of 1776-1777 considerably surpassed that of many preceding years."

The necessity (as the Chinese have noticed) for protecting the roots in the open fields against excessive sun-heat by covering the ground with cut grass, or the refuse gambir leaves, and the healthier appearance of vines grown under light shade, among fruit trees and the like, also evidence the fact that pepper does not like continuous and excessive heat and dryness. It is a high-rooting plant, and its roots are very liable to be affected by excessive heat and dryness of the soil, which is often shown in neglected, exposed plantations by the sickly yellow colouring of the leaves. The rainfall in the Straits Settlements is heavy and continuous, being evenly spread throughout the year. In the great pepper region of the west coast of India the rainfall is also very heavy, from 70 to 100 in. a year.

SOILS AND SITUATIONS

All writers on pepper seem to agree that flat land is more suitable for pepper cultivation than the slopes of hills. The Chinese in Borneo and the Straits Settlements make a point of selecting flat spaces among the hills, in preference to the steeper declivities. Gentle hill slopes can be used, and even steeper ones if they are terraced. If the hills are too steep, they are apt to suffer from the heavy wash of the tropical rainstorms, and in the dryer seasons are liable to drought from the too rapid draining away of the moisture. Level ground lying along a river bank, not too swampy, and free from flooding, is the best situation for a pepper garden. But even if occasionally flooded, little harm is done if the water does not remain over the ground for more than a day. Good drainage is necessary, especially in very low-lying ground, for excessive moisture, as well as excessive dryness, is to be avoided. Salt marshes or ground containing an excess of salt is to be avoided.

Altitudes.—Far the greatest amount of pepper plantations lie at about sea-level, or only 200 or 300 ft. above it. Pepper can, however, be cultivated at a higher level with success.

Soils.—The richer the soil the more suitable it is for pepper. The plant, like all species of the genus, naturally inhabits dense forests, where it grows on the rich decaying leaf-mould or humus, formed in the woods. The more vegetable soil, therefore, that there is in the ground, the better it is for the vines. The soil in the Straits Settlements and also in Sarawak, where the Chinese have long successfully cultivated the plant, is a stiff yellow clay, very poor in potash and lime. Analyses of similar soils in the Botanic Gardens of Singapore, from spots which were formerly pepper gardens, show the composition of this class of soil to be as follows :—

	A.	B.	C.
Moisture	3·800	3·800	2·400
Organic matter combined with water	11·000	12·000	10·600
Oxide of iron and manganese	6·600	2·000	6·400
Oxide of alumina	4·664	4·439	4·024
Lime	0·140	0·180	0·220
Magnesia	0·057	0·115	0·086
Potash	0·030	0·030	0·015
Phosphoric acid	0·038	0·038	0·012
Soda	0·271	0·398	0·243
Sand and Silicates	74·000	77·000	76·000
	100·000	100·000	100·000

The mechanical composition of these soils is :—

	A.	B.	C.
Fine soil passing 90 mesh . .	44·50	26·00	40·00
Fine soil passing 60 mesh . .	32·00	25·00	33·00
Medium soil passing 30 mesh .	6·50	18·00	8·50
Coarse sand and small stones .	17·00	31·00	18·50
	100·00	100·00	100·00

C. Kelway Bamber (*Agricultural Bulletin of Straits Settlements*, vol. vii. p. 581).

In these stiff clay soils, weak in potash, manuring is absolutely essential, and the Chinese use burnt earth, which has been already described, and which is rich in potash. Poor, however, as this class of soil is, some of the best pepper in the world has been grown on very similar soils. The fine pepper grown at Kamuning Estate, in Perak, was cultivated in a considerably richer soil—old forest humus, rich in lime from the neighbouring limestone rocks. But such soil cannot always be met with.

Where virgin jungle is procurable, the soil is naturally richer and should be used, and in abandoned plantations which have become covered with secondary scrub of from three to ten years' growth, the plantation may be successfully made.

The ground is cleared, the forest felled, and when the brushwood and branches are dry they are set on fire, and when thoroughly burnt, the pepper is planted. Such ground has, in addition to the humus, the potash, carbon, etc., of the burnt forest, and this is very suitable for the pepper. Owing, however, to the heavy rains, much of the soluble constituents of the soil, as well as the finer particles, are soon washed out, and manuring in these soils (as treated of later) becomes absolutely essential.

According to Marsden, in Sumatra pepper throve with nearly equal vigour in all varieties of soil, between the two extremes of sand which prevailed near the coasts, and the stiff yellow clays of the hills. Sand, however, is quite unsuitable for the plant unless mixed at least with a good proportion of humus, and it is, as a rule, advisable to avoid land which can be definitely classed as sandy.

Rocky soil is equally objectionable, though in Ceylon it was said that pepper grew very well over rocks. Under light shade it might do well, provided that the soil between the rocks is rich enough for the plant, but exposed rocks are so strongly heated by the tropical sun that pepper would soon be destroyed by the excessive heat.

CULTIVATION FROM SEED

Black pepper is almost invariably grown from cuttings, but it may be grown from seed. It is stated that pepper vines grown from seed take a very long time to fruit, and indeed it has been said that in some localities they will not fruit at all from seed. In this case they probably revert to the unisexual form, *i.e.* the original wild form; on the other hand, there are many places, at least, where pepper is readily raised from seed and grows well and quickly. It is certainly preferable to grow from cuttings, as it is then possible to be sure that a good heavy fruiting strain can be secured, cuttings generally coming true more frequently than seedlings. There are cases, however, where, for some reason or other, it is necessary to raise pepper from seed. Thus in some parts of the world it has been found expensive or almost impossible to introduce pepper by cuttings, which have to travel in a Wardian case, and seed is the only form in which the plant can be introduced. Seed of pepper is, however, by no means a good traveller, and has often failed in cases of long-distance travelling.

It is said (Simmond's *Tropical Agriculture*) that in Malabar it is often raised from seed, and that experienced men prefer this mode of propagation, because the vine bears for fourteen years, while the cutting-vines bear only for seven years. These, however, crop better, and give bigger berries.

The following account of the method of planting pepper from seed is taken from the *Indian Agriculturist* of September 1878.

> Take ripe pepper and put into water for three days, at the end of which take off the skin, and after you have mixed good red earth with cow-dung and water, put the pepper into it, exposing the same to the sun for three days early in the morning and evening: it is necessary that this mixture be neither too thick nor too thin. After this, plant the same in an earthen pot, every grain at a certain distance, taking care to water them every day with a watering-pot until the stalk has four leaves. Then dig a hole at the foot of a tree 2 ft. deep, and 9 in. long and broad, take cowdung and ashes of all sorts of firewood, put it into the hole and mix the same with the ground dug out of it, taking care to fill it in such a manner that there only remains 4 or 5 in. of elevation. Fifteen days later, plant four pepper plants in every hole, cover them with earth 2 in. deep. During the summer water them every day, morning and evening, and cover during the rains. Likewise take care that no water remains at their feet by covering them with earth. As soon as the rains are over, throw up a circular bank of earth round them to contain the water they are watered with. In this manner they must be nourished for three years. In the fourth year they will begin to give fruit.

Cuttings.—Pepper is, however, nearly always grown from cuttings. These cuttings are made from the tops of a bearing vine, as those from running shoots will not, as a rule, produce flowers; old and nearly worn out vines should not be used, nor should cuttings be made from hardened old stems, but they should be taken from well grown healthy vines of a good strain, and in localities where the vines are apt to run unisexual. Care must be taken not to cut from male vines only. The cuttings should show roots at the joints, but most will develop them quickly when planted if they do not at first show them. There are many different ideas as to the length of the cuttings. Many planters make them 1 ft. long, and in planting bury them 6 in. in the ground. Some urge that the cutting should have not less than seven joints and two branches, or three for preference, all above the upper branch to be cut off. Much shorter cuttings will grow, but are naturally rather slower in making a good bushy plant.] Care is necessary in making the cuttings to detach the roots by which the stem is attached to the stake gently from the wood, and to make the cuts clean and sharp, to avoid bruising the stem or bud. The base of the cutting should be cut smooth just below the swollen node, so that no bit of an internode is left to rot below it when planted and cause an invasion of fungi. The side-branches, except the two youngest, are carefully cut off.

Nurseries.—It is possible in good localities and good weather to plant the cuttings out *in situ*, without developing them in a nursery, but it is better to raise them in a nursery before planting out. The nurseries are made in much the same way as those for vanilla and other such plants. The ground is well dug and drained if too wet, and if not sufficiently rich burnt earth and charcoal with some cow-dung may be dug in. The cuttings are planted in the beds, which should be shaded with palm leaves or pandanus leaves, or any other suitable light shade on sticks or poles at some height, say 5 ft. from the ground. The beds should be watered when necessary, being kept damp and cool, but not sodden.

The cuttings should remain in the beds till they have struck well and begun to make good growth, when they should be removed to their future permanent positions.

A planter suggests, in the *Ceylon Observer*, the following plan for a small clearing of 12 acres. All the undergrowth and small trees should be cut down, so as to admit an abundance of light, at the same time affording a moderate degree of shade. Trees to support from 250 to 300 vines to the acre should be retained. The cuttings should, before becoming too dry, be piled in small heaps and burnt. (It would be better either to pile it in lines and allow it to rot down, or to use it in making burnt earth.) A space of about 1 acre should be cleared and dug deep, cleaned of roots, etc. In this pepper cuttings should be laid down about 1 in. apart, 12 in. buried beneath the soil, and 6 in. exposed. For the 12 acres about 15,000 cuttings would be required. In about a year these should have made roots and shoots, and can be planted out near the trees left for supports. As a rule, the trees left in this manner being irregular in size and position, are not well suited for a good pepper garden.

Preparation of the Ground.—If the ground selected for the plantation is covered with forest, this is completely felled and burnt. The stumps and roots are dug out after the burning, and collected into heaps for making burnt earth. Any hardwood timber may be stored for the stakes. In fields covered with lalang grass (*Imperata cylindrica*), as is often the case in the Malay region, the grass is fired or cut, and the ground dug over so as to expose the rhizomes of the grass to the sun. If possible a plough may be used with advantage. After three weeks most of the lalang will be dead, and the rhizomes that are not are again dug out.

As burnt earth is a necessary manure for pepper in most countries, the planter will utilise as much as he can of the vegetation cut during clearing to have it ready for the planting. There is no need to waste it all by merely burning it on the ground. The failing supply of brushwood for the gambir and pepper plantations, and the scarcity of good stakes for the pepper, contributed much to the disappearance of these cultivations in Singapore some years ago.

The ground cleared, it is lined and sticks are put in to mark the positions of the pepper posts, 6 ft. apart. J. Bosscha, in *Teysmannia* (1900, xi. No. 2), mentions a case of overcrowding at this distance, where from want of proper air-space the vines in a wet year were attacked by a fungus, the mycelium of which covered the leaves and branches, while plants farther apart were unhurt. I have seen a similar attack on coffee plants growing too near the forest edge and similarly shaded, so that after rain the sun could not reach them sufficiently strong, or for a sufficiently long time to dry them. The pepper wants full light and sun on it, and in case of very shaded localities it is advisable to plant wider apart. But, as a rule, 6 ft. apart allows space for sun and air, and gives enough room for the planter to move about among the vines.

The ground is left for three weeks to dry when the drains are made. The ground round the sticks is well dug and broken up to the depth of 1 ft. The soil is well mixed with burnt earth and charcoal, and raised to a mound about 18 in. high, when the stake is inserted in its place.

Planting out.—When the cuttings or seedlings in the nursery are ready for planting out, or when the ground and supports are ready, the plants may be put in place. This is usually done in Borneo and the Straits Settlements in January during the wet monsoon. In Bombay pepper is planted in August, but the date of planting in any given locality depends entirely on the period of the wet season. The cuttings when short are arranged in the soil at an angle of 45 degrees or thereabout, so that the top presses against the support. In the case of a cutting which has two branches the fork is pressed against the support so as to clasp it. The Chinese put the cuttings facing the east. One to four cuttings are planted to each stake.

After watering, the plants have to be shaded from the sun, by fern fronds or bunches of lalang grass, or boughs of trees.

Within a week or so after planting each vine receives an application of burnt earth, a few handfuls at a time, and this application is continued every four months.

Semmler (Tschirch, *Heil- und Nutzpflanzen*) describes a Sumatran method of pepper cultivation as follows. The plants are cultivated in rice fields, which are first sown with rice. When this is done the pepper plants are planted close to strong cuttings of a rough-barked, quick-growing tree. In the first half-year the rice gives the necessary shade, and when it is cut the shade trees are more developed and effective and grow better every day. At the commencement of the second rainy season, after the first planting, the pepper plants are bent down and their tips put in the ground so that only the arch of the stem is visible. The buried tip emits roots, so that the feeding organs of the plant are doubled. From the arch three or four strong shoots spring, which grow so fast that as a rule the plants fruit in the next year.

Supports.—These may be young trees, or stout stakes of timber. They must be ready by the time the cuttings are planted out, so that the plants may be able to climb at once.

Of living trees a considerable variety have been recommended, among which are such plants as the Jack (*Artocarpus integrifolia*) and Mango (*Mangifera indica*). These are planted from seed or seedlings and are said to have proved satisfactory in some localities, but the slow growth of these trees is very much in their disfavour, and they are not to be recommended. The Erythrinas are very much more suitable, as they can be grown from large-sized cuttings, and there is no delay while the supports are growing. The best kinds are *Erythrina lithosperma* and *E. stricta*. The short bushy species, *E. crista-galli*, etc., should be avoided as they do not make straight regular stems. Straight boughs about 2 in. through and from 6 to 12 ft. tall are cut and planted *in situ*, about 6 ft. apart. They commence growing at once, throwing out shoots from the top. Side shoots, when they appear, are cut off so that the stem to which the pepper is to cling is straight and regular, while the foliage at the top gives a certain amount of light shade. These trees are generally used by the Achinese, who are very good pepper-cultivators. Other trees which grow readily and straight from branch cuttings can be used, should they be met with in any locality where Erythrina is not to be found. In Bombay the betel-nut palm, *Areca catechu*, is used, the pepper vines being planted on the trees in a betel-nut grove, and the plantations of betel-nuts which have given up bearing, as they do after a comparatively few years, may very well be put under pepper.

Among other trees which have been utilised or tried as pepper supports, are the Kapok or silk cotton tree, *Eriodendron anfractuosum*, and Munkudu (Mengkudu), *Morinda tinctoria*. The former of these two does not seem to be really suitable, because the bark is too smooth and the pepper cannot get a grip on it, and therefore is apt to slide down. The Mengkudu is used in Trang in Southern Siam by the Chinese, and, according to Mr. Derry (*Bulletin of the Straits Settlements*, vol. viii. p. 243), is the most ideal shade tree for pepper he has seen. The Chinese, indeed, who formerly used Erythrina, were replacing it at Trang by this tree. It is a smaller tree than the Erythrina and it gives a better shade, its root development being smaller, thus not interfering with the growth of the pepper roots.

He thus describes the planting in Trang :—

On the older allotments, dadap (*Erythrina umbrosa*) had been planted for shade, but as a result of continuous pruning had become gnarled and stunted. Except that this tree grows quickly it is not a good shade tree, as a matter of fact it is much too large and the free development of roots is too exhausting on the soil for the successful growth of the vines. On all the younger allotments dadap had been superseded by mengkudu, a much smaller tree and affording better shade at a minimum root expansion. Between alternate rows of mengkudu a row of posts had been run, and in the rows, whether trees or posts, an additional post or posts had been added wherever a good offshoot could be obtained, so that while the shade was efficient the allotment was cropped as closely as feasible. The mengkudu trees were topped above the second whorl of branches, and as a consequence the branches spread in a moderate horizontal direction. At the time of my visit the shade trees were being pruned; where necessary the spreading branches were shortened, and all superfluous growths removed. This was the season of ploughing and padi-planting, or, as will be inferred, the commencement of the rainy season, and as the catkins or flower spikes are borne in the axils of new growths, the vines would not be over-shaded in the growing season.

The Chinese in the south of the peninsula do not use shade trees, but it must be remembered that the dry season in Siam is much longer and more marked than it is in the south of the peninsula. But even here a light shade is certainly good for the pepper, as is shown by the fact that it is necessary to throw waste gambir leaves or cut grass over the pepper roots during a dry spell to protect them from the great heat of the sun.

The mengkudu tree is a comparatively small one, and never attains the bulk of an *Erythrina*. It is a native of the Malay region, occurring commonly round villages in a semi-wild condition. Its roots were formerly used for a red or red-brown dye, obtained from the bark of the larger roots.

In Sir William Hunter's account of pepper cultivation in Penang in 1803, given as an appendix, he says that the Chinese planters say that the pepper on *Erythrina* lasts longer than that on *Morinda* and gives some evidence to show the superiority of the former. *Erythrina* certainly has the advantage of rapid growth, and is easy to handle. It is also obtainable all over the tropics and can be had in quantities. It grows readily from seed, but it is for the purpose of pepper-growing best propagated from cuttings. These cuttings should be stout boughs cut into pieces, 3 ft. or more long, and about 2 in. through. One good-sized *Erythrina* will supply a considerable number, enough for 1 acre or 2 at least. Its main objections seem to me its smoothness of bark which the pepper cannot always grip firmly, and its liability to die from wound fungi.

In *Planting Opinion*, 1899, p. 689, "Producer" writes:—"Till some fifteen years ago pepper was cultivated only on the plains (of Malabar), but it has been proved to do well at 2,500 to 3,000 ft. elevation above the sea and even to 3,500." He recommends *Erythrina* and Jack trees as standards and also *Grevillea robusta*. Almost any hardy tree with *rough* bark will do, as pepper is apt to keep slipping down off smooth bark. An ideal tree is a straight, slender stem with a rough bark and a small head. Trees like Jack trees with big heads must be lopped. For the first three years a certain amount of shade is best, but in the fourth year it must be lopped to admit plenty of light. Without sufficient light the crop will be small, but it is a mistake to remove all shade, as pepper is naturally a shade plant. Besides, excessive lopping may kill the standard. He recommends planting 25 ft. apart, that is a 100 to the acre. (This appears to me to be waste of space.) He suggests planting pepper in abandoned coffee plantations, the old shade trees being utilised as standards. Shade trees for coffee have been practically abandoned, in most places at least, but should such a spot be available and otherwise suitable, the planter might well follow out this idea.

"Producer" gives the cost of planting at 5 to 6 rupees per acre when the standards are established, but when *Erythrina* has to be planted, 20 rupees the first year and 10 rupees for succeeding years. He says also that 1,000 cuttings are required for an acre's planting, as only 33 per cent grow. (This seems a very small percentage, as pepper cuttings are not at all difficult to strike, and I have generally succeeded in getting nearly three times that amount develop into healthy plants.)

Posts and Trellises.—In the Straits Settlements and Borneo the Chinese do not utilise living trees to support the vines, but grow them exclusively on stout wooden posts, about 12 to 14 ft. tall and 7 in. through. Care is taken to select hard and durable timber which will not be destroyed by termites or fungus-decay before the life of the pepper plant is finished. But these are not always procurable and it is not uncommon for the posts to fall when loaded with a well developed vine. The Dutch sometimes cultivate the pepper on trellises, but these are even more liable to decay and require constant renewing in a hot damp country where termites and fungi very quickly destroy any but the hardest woods. On the whole, the stout hardwood stakes of the Chinese planter are, if procurable, the most convenient supports. This system, however, presupposes the existence of an accessible forest with suitable trees, which is not always at hand, and the exhaustion of the suitable timber near the plantations was given by the Chinese as one of the causes of the abandonment of the cultivation in Singapore in 1896. It must also be pointed out that the posts practically give no shade to the roots of the pepper, at least at first. The Chinese obviate this by covering the ground between the posts with cut lalang-grass and refuse, gambir leaves, etc.

Growth.—As the vine ascends the post or tree, it is tied with a soft bast or twine. When it reaches the top it has been the custom to pull it down, and wind it round the base of the support, when it throws out more shoots, which climbing to the top cover it with a dense bushy mass. Some pull down the vines thus more than once. The prostrate portion of the vine round the base of the support is covered with soil to induce growth of the ascending shoots. This method was in vogue among the Achinese, and also formerly among the Chinese, but the latter have abandoned the method in Borneo, according to Mr. Dalton in Mr. Hewitt's paper above referred to. They now allow three shoots to climb up the post, tying them at every internode.

If a single stem only rises to the top of the support, it requires to be cut back or pulled down, so as to cause it to branch heavily, as a good pepper plant should completely cover the post with a dense mass of stems and branches.

After about six months, or even earlier, the flower spikes begin to appear and are removed at once. The pepper gardeners prevent sporadic fruiting, which may occur at any time during the life of the vine, in order to concentrate on the proper annual crop. It is recommended to cut or break off these flower spikes in the early morning or during the rainy season.

When the vines are about a year old, those destined to supply cuttings for an extension of the plantation are pruned so as to have a single main shoot. This is allowed to grow for six months more and is then cut off, being used for propagating.

Manuring.—The chief manure used is burnt earth, which is applied from time to time during the growth of the vine. The method of making burnt earth has already been described. It is dug in or thrown upon the mound on which the pepper vine is growing, but should not be allowed actually to touch the vine itself. The exact action of burnt earth on the plant does not seem very clear, but it is suggested that the half-burnt earth absorbs the product of distillation of the burnt wood, chiefly in the form of ammonia.

Where, as in the Straits Settlements and Sumatra, the cultivation of gambir is carried on with that of the pepper, it is the custom of the Chinese to throw the used leaves of the gambir on the ground between the pepper posts and to spread them about. This shades the soil from the intense heat of the sun, and protects the roots of the pepper from getting burnt, also acting as manure. Where there is no gambir, cultivated lalang-grass is cut and thrown thickly on the ground between the posts.

When procurable, the Chinese also use as manure "prawn-dust." This is the shells of the prawns used in the manufactory of the condiment known to the Malays as "Belachan," a kind of shrimp-paste eaten with curry. Of this ½ catty (about ½ lb.) is applied to the base of the vines the first year in preparation for the first crop, and also later during the life of the vine. Fish manure, that is the waste of the nets, small fish or broken bits and other refuse obtained in the fish-drying industry, is often used as a substitute.

In Bombay the manure is made of leaves and twigs gathered during the wet season and used as litter in the cattle and buffalo byres. This is removed with the dung and urine of the cattle to pits every day or every second day, and after about a year's decay is given to the vines in March or April. The pepper there is usually grown on betel-nut palms, and this manuring benefits both the palm and vine. A basket load is thrown in a circle around the plants, the baskets being 3 ft. round and 15 to 18 ft. deep.

During the first year while the plant is growing, besides manuring, the cultivator occupies his time in weeding the ground, attending to the drains, and spraying to kill caterpillars and other pests. A good deal of judicious pruning is often required to prevent the plant from growing too bushy at the top, and to induce it to branch out below so as to cover the post. By the time it has reached the top of the post it will have been pruned at least three times. All suckers and useless shoots are removed during this time.

The vine will reach the top of the post in from three and a half to four years, and may then be considered to be full grown.

A planter who contributes an article on pepper planting to the *Singapore Free Press*, in 1888, advises that no crop should be taken till it has reached the top of the post, the flower spikes being removed as they appear. The Chinese commence gathering the crop in two or two and a half years, but allow it to bear gradually upwards from the base. At this age from 1 to $1\frac{1}{2}$ catties of white pepper (4 to 6 catties of green pepper) are produced by the vine, and this is doubled when at three and a half years the vine has reached the top of its post and is full grown.

Liquid cattle manure can be used if procurable, and gives very good results. A planter in the *Singapore*

Free Press (May 1888) recommended the burning of bulky manures to prevent them attracting termites and other injurious insects, or mixing them with soil. He mentions that he has seen castor cake applied to the vines, both to the surface and below the soil, and that in both cases the result was the death of the vine. There does not seem to be any record of the use of chemical manures or guano, etc., for pepper.

C. P. K. Nair in the *Tropical Agriculturist*, June 1906, p. 562, points out that heavy manuring may damage the support tree, which is serious, as he says that vines transferred to fresh standards do not last more than three years and their yield is affected. The destruction of the support is certainly serious, for apart from the difficulty of transferring the vine without injury, the new tree will take some time to grow before it can support the mass of pepper vine. The Chinese do, however, frequently find a pepper stake fallen and replace it successfully, and in the case of the death of a tree-support, a stake could be used to replace it. But the danger to the support by over-manuring is one which should not be overlooked.

PESTS AND DISEASES

The pepper is liable to a variety of diseases, both animal and vegetable, as almost every cultivated plant is.

Insect Pests.—Many years ago I found in the stems of pepper, or more accurately the shoots, a burrowing beetle larva, apparently one of the *Rhynchophora*. It was a very small species, boring vertically up the shoot, which blackened and fell off. I failed to rear the insect. In a case of an attack like this, the shoots showing signs of withering should be at once cut off and burned. I have not met with it since.

The roots of the pepper are, in Sarawak at least, subject to the attacks of large larvae of some Lamellicorn beetle, perhaps those of *Oryctes rhinoceros*. They are large, dirty, white, fat grubs, sparsely covered with brown hairs. In burrowing through the ground at the foot of the pepper vine they bite through the roots with their powerful jaws. The application of lime-water in the neighbourhood of the roots is considered effectual in driving them away.

Bosscha mentions another insect of the *Lamellicornia* group which attacks the roots in much the same way, but is apparently a kind of cockchafer. It flies at night in great numbers together, and Mr. Hewitt suggests might be caught by light-traps. The larvae attack the roots underground in some numbers, and the leaves turn yellow and fall off. Traps for this class of insects are made by filling a large pan of metal or earthenware with water, to which a little kerosene has been added. A lamp is placed above this, and the insects flying to the light fall in the water and the kerosene which floats on the top kills them. An improvement is to put a sheet of glass vertically below the lamp over the water, as the insects strike against this in their flight and readily fall into the trap.

Grasshoppers, and the big yellow and green locusts with pink hind wings, *Cyrtanthacris varia*, also attack the shoots of the pepper and devour them or bite them through. The smaller grasshoppers are difficult to catch, but the locusts can easily be destroyed by children chasing them and knocking them down with sticks or wooden bats. Spraying with tobacco water will kill the smaller grasshoppers. Insects of this group usually spend the earlier stages of their life in low herbage or grass, and the cutting down and burning of this in the vicinity of the plantation will cause a great diminution in the numbers of grasshoppers, locusts, and crickets.

Leaf-eating Caterpillars.—Mr. Hewitt mentions the attacks of the caterpillar of a Limacodid moth, which, however, he only met once devouring the leaves. He describes it as an oval green caterpillar, disk-shaped, beset laterally with stinging hairs or processes, and indeed covered with these hairs. A similar insect, if not the same, was sent to me from Port Dickson in Negri Sambilan, Malay Peninsula.[1] This insect ate the bases of the leaves and shoots, and though it did not actually kill the plants, prevented their bearing. The caterpillar was 1 in. long and very thick and slug-shaped. Its back, all but the head, was bluish white, covered with radiating tufts of blue or white spines. Its head and abdomen are dirty yellow, and at its tail above was a yellowish patch with four black velvety spots in a transverse row. The spines on its back are poisonous, and the caterpillar like all of this set can sting rather badly with them. I failed to rear any of the moths from these caterpillars, as they were too much injured in travelling, but I have often seen them attacking soursop trees, and it is certainly a common species. There are a number of these stinging caterpillars in the East, and they are popularly known as nettleworms. They are very troublesome to get rid of, as they are too well defended for hand picking. They can be removed or killed with small pieces of stick or splinters of bamboo. Wounds in caterpillars, even if slight, invariably prove fatal very shortly, and they can be destroyed by merely spearing them with a sharp splinter of bamboo. They do not usually occur in large numbers, but Mr. Green warns planters to look out for and destroy the preliminary broods of nettlegrubs in the tea estates where they do much harm, and suggests the use of arsenate of lead sprayed over the leaves at once to prevent a sudden increase of the pest. Planters must, however, remember that this substance is poisonous and pepper fruit sprayed with it might be dangerous to health. It would perhaps be better to use some form of nicotine or tuba root.

Another caterpillar, or perhaps the same, is recorded as attacking pepper in Assam, and the "Cinchona caterpillar" is mentioned by a writer in the *Singapore Free Press* (1888) as being an enemy to pepper. The great caterpillar of the Atlas moth (*Attacus Atlas*) is

[1] *Bulletin, Straits Agricult.* iii., 1904, p. 101.

occasionally to be found attacking pepper plants, and I have seen vines in Singapore quite denuded by these animals, which are almost omnivorous. The caterpillar is easily distinguished by its great size and its pale sea-green body, powdered with white and armed with thorn-like processes, which, however, are not poisonous. It is a most voracious feeder, very soon eating up every leaf on its food plant, and stripping it quite bare. It pupates in March in a tough, egg-shaped cocoon which is attached to a leaf or twig. The moth is of great size, often over 9 in. across the wings, and of a variegated rufous brown and grey colour, with a small angled transparent "window" in each wing. The caterpillars are best destroyed by hand picking.

The flowers and fruits of the pepper plant do not escape attack by various pests. On a plant cultivated in the Singapore Botanic Gardens I found a number of fair-sized bugs, sitting upon the pepper spikes, and apparently sucking them. The bug was $\frac{1}{2}$ in. long, with slender antennae about as long as the body, black, with the base of the last joint emerald green, head small, green, thorax four-angled, wedge-shaped, back margin broadest, with two short points at the angles, green, entirely punctate, upper wings greenish olive, strongly ribbed scutellum green, punctate, under wings dull red, visible when it flies, abdomen pale-green, legs long and green. There were a number of pepper fruits destroyed, black, dry, and shrivelled on the plants on which this bug was settled, but whether this was due to the attacks of the insect or a fungus, I could not be sure. The bug belonged to the group *Coreidae* and apparently to the genus *Pendulina.*

Mr. Hewitt mentions a number of insect pests which attack the flowers and setting fruit in Borneo. The worst of them are the small plant bugs (*Hemiptera*). When the flower spikes appear there may be seen a number of small black insects, each armed with a long spine on the back and one on each shoulder. They settle on the flower spike and feed on the flowers.

This insect is a species of *Centrotus*, one of the *Membracidae* belonging to the order of *Hemiptera*. I have found in Singapore one of these *Centroti* on the pepper plants and it may be the same as the one described by Mr. Hewitt, but it is rather brown than black. The little animal is $\frac{1}{4}$ in. in length, and of a dark amber brown colour, lighter coloured beneath from the pale pubescence on its underside. Its eyes are large and far apart. Its body is somewhat of an inverted boat shape and stout in proportion to its length. From the angles of its square thorax spring two curved horns, giving it from a front view the appearance of a goat's head. The wings are appressed together and flattened, and from the thorax lying over them for two-thirds of their length is a long horizontal spine. The legs are rather long. This insect attacks the flower spike with its short beak, which it thrusts into the spike to suck the juices. It is a quick, active animal, and can walk, jump, or fly. Indeed, it is rather difficult to catch it.

Another small plant bug, which is equally destructive, is a small, black, flattened creature which creeps along the spike, sucking it with its beak. This is known as *Elasmognathus Hewittii*. Another species of *Elasmognathus*, probably *E. Greenii*, is recorded by P. Konigsberger (*Bulletin agric. Ind. néerlandaises*, xx. 6-8) as attacking pepper at Sontang in Borneo. This species punctures the leaves and makes brown spots on them. It does not, however, seem to seriously injure the plant.

In Sarawak Mr. Hewitt also found a small, flattened, green bug, peculiar from having its sides fringed with tiny spines. It is an immature form, probably of some species of *Centrocnemis*. The insect was a very sluggish animal, but a serious pest.

The best method of dealing with this class of animal is by spraying the vines with a decoction of tuba-root (*Derris elliptica*), or some of the well-known insecticides, such as nicotine.

A destructive *Coccus* has also been seen in Borneo, as well as in the Straits Settlements, attacking the fruit spikes as the fruit commences to set.

The insects are soft-bodied stout creatures covered with the white fluff so characteristic of this group of blight. When they attack the spike it speedily becomes black and withers up, and is often completely destroyed.

The Coccids also frequently attack the leaves on the underside, the stem and other parts of the plant.

The presence of Coccids on a plant in any abundance always must be taken to suggest that the plant is weak and in poor health, though this is not always the case. It is advisable to manure the plants if much affected, but at the same time steps must be taken to get rid of the pest. As a rule the ordinary insecticides fail with these animals, as they are too well protected by the white fluff which is of a waxy nature, and protects the insect from the action of any ordinary liquid. I have had some success in dealing with this class of pests by using a solution of phenyl, mixed with water, so as to have the appearance of rather poor milk. The phenyl dissolves the wax, and then acting on the skin of the insect destroys it. All the carbolic disinfectants must be used in a well diluted state, as they are otherwise apt to injure the plant, but many of them, if weak enough, will prove very effective against the waxy Cocci.

Mr. Hewitt observes in Borneo that the Cocci are commonly attended by a small ant (*Crematogaster Rogenhoferi*), which feeds on the sugary excretions of the blight, and probably conveys the coccus from plant to plant, as ants constantly do in other cases. The presence of ants in quantities running over a plant in cultivation is often a sign to the watchful planter that blight has appeared on the vine.

Mytilaspis. Scale Insects.—Attacks by these are reported by Mr. Barber as injuring the pepper vines in India. They are probably common elsewhere, as scale insects are extremely abundant in the tropics. He describes the attack as follows :—

Vines were met with in various places in which a bare patch occurred at some distance from the ground. The patch had no leaves and was rusty in colour. The parts above and below were normal. An examination of the branches from this place showed that all the leaves had dropped, and that the surface of the twigs was covered with an immense number of scale insects (*Mytilaspis*). The scale was found in several places to be subject to attacks from fungi and parasitic insects.

The weather previously had been dry and trying, and this may have weakened the vine, and assisted the *Mytilaspis*. Rain seems to check the development of these insects. Mr. Barber recommends the use of kerosene emulsion, sprayed on these insects. Soft soap and tobacco water is also a good remedy for scale.

Another insect of this group, but a Coccid, appeared on peppercorns in Singapore as minute white lines almost covering the nearly ripe fruit. The insect itself was a minute, soft, dull red animal, which protected itself by an oblong, grooved, white coat of wax, rather longer than itself. It gave the fruit the appearance of being covered with mould.

Aspidiotus destructor, Sign.—This white Coccid, which attacks all kinds of plants much in the same way as the previously mentioned species, is recorded as attacking pepper by Watt, in his *Pests and Blights of the Tea-plant.*

Besides these scale insects and mealy bugs recorded as definitely attacking pepper, there are many other insects of the same group which attack almost any kind of plant, and no doubt many of them will be found to occur on the pepper. The treatment is the same for all. Strengthen the plant with manure, and disinfect it with soft soap and tobacco, or kerosene emulsion, or if the animal is too well guarded by its waxy coat, with weak solution of phenyl and water.

Eel-worms (*Heterodera radicicola*).—The root eel-worm is a very small, transparent nematode worm which attacks the roots of many plants, often without doing any great amount of harm. Though more or less local in their distribution, they have the power in suitable surroundings to increase in enormous quantities. Mr. Barber in his report (published in *Planting Opinion*, 1903, p. 619) says: "I have never seen such a remarkable series of tumours in plant tissues as those lately met with in the infected plants of the Wynaad." When the tumour decays it is not easy to detect the remains of the eel-worms, but some at least of the cankers have been proved to be due to eel-worms. In one of the plain gardens near Calicut "there had been twenty vines. Five died last year, five are moribund, while the remaining ten are attacked." "It would be wise, when an attack of this sort is met with, to carefully collect all the nodules formed on the roots and underground stems and to burn them. The hole should on no account be planted again for many years." To get rid of the pest in such soil, Mr. Barber suggests the planting of the goat weed or white weed (*Ageratum conyzoides*). This universal weed, generally held in horror by planters, is very attractive to the eel-worm. Planted in the abandoned hole it will attract the eel-worms to its roots, and after a time it can be pulled up and burnt. By repeating this process the eel-worms might be cleared out.

In 1903 Mr. Barber devoted a fortnight to investigating the cause of disease in the pepper plantations of the South Wynaad. After some years of phenomenal success many of the vines were found to be dying out. A number of diseases were met with, but there was no one universally found. The plants were extremely liable to cankerous growths, and in some cases severe attacks of eel-worms were met with. In certain vines a hyphal infestation was found throughout the fibro-vascular bundles, but the presence of the fungus did not appear to have any relation to the relative sickness of the vines.

In his report (*Planting Opinion*, 1903, p. 618) he goes more fully into the three diseases noted, viz. canker, eel-worm, and hyphae in the vessels.

The Canker.—It was found that in the pepper vines the tissues were soft and easily injured. The slightest scratch produced a sore on the plant. This occurred in both wild and cultivated plants, whether healthy or not, but whereas in the wild plant the dead cells were cut off by cork formation, so that the wound was stopped, in cultivated plants masses of corky tissue were formed which again became diseased, so that, from a comparatively inconspicuous cause great cankerous growths were formed. The readiness to form cankers in all its parts appear to indicate a lack of vitality in the cells. As would be expected, cankers are most frequently and injuriously formed at the collar. In one case the whole plant was found to be bursting out with cankerous eruptions. Mites were found in the eruptions and might possibly be the cause.

Hyphae in the Vessels.—This is another serious disease described by Mr. Barber. It consists of fungal hyphae in the fibro-vascular vessels. The hyphae are found in every part of the plant from the youngest root to the smallest shoot, and are confined to the fibro-vascular bundles while the tissue is alive, and probably obtain their food by haustoria or suckers from the neighbouring starch-filled parenchyma. After the death of the tissue they spread in all directions. Plants affected with this should not be used for cuttings. The hyphae can be seen in a shoot with a low power microscope.

Pepperwilt (*Nectria* sp.).— In the Wynaad Mr. Butler found the pepper attacked by a species of fungus, which also did much damage to the pigeon-pea or dall (*Cajanus indicus*), a crop largely grown in India.

This fungus occurred on every dying vine he examined, and there is little doubt that it was the cause of a large proportion of the pepper disease on the Malabar coast. It becomes more intense during breaks in the rains and immediately after the monsoon. Exposed vines die more rapidly than those that are shaded. The roots or part of them rot or become blackened, and the blackening extends to the stem. The fungus spreads rapidly through the tissues, most rapidly through the vessels, causing the appearance of black streaks outlining the affected parts of the vascular system. An abundance of gum or oil is formed, which further obstructs the water circulation. The pepper commences to die from the top, as is usually the case when the water-supply is cut off by root-death. After the fungus has developed luxuriantly in the tissues of the pepper, it begins to form spores. A brick-red efflorescence appears on the bark overlying the blackened streaks of the wood. This is composed of myriads of minute spores which easily separate and fall to the ground, or are blown by the wind far and wide, and thus may infect other plants. This is not the only form of reproduction possessed by this fungus, for there are no less than four ways in which it can reproduce. In one form it appears as small round bodies, bright red in colour, smaller than a pin-head. Within these are slender sacs containing eight spores each. One of these spores sown in water germinates and produces one or two long transparent threads which soon produce a small branched erect plant bearing balls of minute spores (the form known as *Cephalosporium*). Another form consists of spindle-shaped bodies, or appears in the form of cushions on the stem, forming the red patches on the withered vines (*Fusarium* form). In any of these forms the fungus can infect another vine and cause its death.

Mr. E. J. Butler, in the *Agricultural Journal of India*, i. p. 31, gives a further account of the diseases of the pepper in Malabar. He says that the supports for pepper in the Wynaad are mostly jungle trees, that the nature of the standard does not appear to affect the disease, and that the worst destruction took place in the hills, though dead and dying plants were not infrequent in the plains.

He gives the following account of the appearance of the sickness :—

In a healthy full-grown vine the trunk of the standard is entirely hidden by a mass of foliage, which arises from a number of climbing stems which closely embrace the standard and secure themselves to it by numerous tufts of aerial lateral roots. When such a vine becomes diseased, the first symptom noticed is an appearance which was described as a "staring" look of the vine. This is due to the loss of rigidity in the leaves and leaf-stalks resulting in their drooping. With the collapse of the leaves the dense covering of foliage becomes diminished, and the stalks of the vine and patches of the trunk of the standard come into view. The next noticeable thing is that a portion of the climbing stems fall away from the standards as a result of the death of the roots and consequent relaxation of their grip. Soon the leaves begin to turn yellow and numbers of them are shed. Later all the vine withers, and the standard remains lightly festooned with dead relaxed stalks bearing a few dried leaves. While the upper part of the vine makes no attempt at recovery, the lower part often retains enough vitality to form new leaves or even to throw out fresh shoots, but these in their turn succumb, and I have known no case of recovery when once the leaf-dropping has commenced.

A similar disease appeared in Cochin-China and Java about the same time as in India. Professor Zimmermann and Dr. Van Breda de Haan wrote two articles on the disease, attributing it to eel-worms. Dr. De Haan considers that the eel-worms do not directly cause the death of the vines, but attributes that to bacteria, the entrance of which to the plant is caused by the attacks of the eel-worm.

As Dr. De Haan and Mr. Barber point out, the pepper is less able to defend itself from injury by the eel-worm than many other plants, as it is largely a surface-feeder, and the roots tend to collect in the mound on which it is grown. Once the worm has established itself, it meets with ideal conditions for its multiplication. The worms have only a short way to travel to meet with fresh roots.

The diseases which broke out in the Malabar pepper estates are very interesting. They seem to show that the plants were deficient in vitality or power to resist disease. It must be remembered that pepper is nearly always propagated by cuttings, and has been so propagated in this region for at least five hundred years and probably much longer. Propagating from seed has, it is true, been occasionally done, and it is probable that a certain number of stray seeds dispersed by birds, or accidentally fallen on the ground, have come eventually into cultivation, and perhaps strengthened the stock. There is every reason to believe that plants constantly reproduced by cuttings deteriorate seriously after a lapse of time. Some completely die out, others become feeble and readily succumb to the attacks of insects and pests. A few plants, like sugar-cane, pineapples, and pepper, seem to remain healthy under this treatment longer than others. A time, however, will come in which they also break down, and it is probable that this has been the case in the Malabar pepper.

Planters are always in a hurry to reap the results of their labours as soon as possible, and can hardly be expected to delay by raising pepper slowly from seed so as to eventually get a stronger stock which will last longer than plants raised from cuttings continuously, and this is especially the case in native cultivations, of which pepper is mainly one. Still, planters, while continuing their cultivations from cuttings, might at the same time raise seedlings from a good stock in order to replace at a later date the cuttings derived from a sexual reproduction carried on perhaps for many centuries.

Root Fungus.—A very serious disease due to a root fungus is described in the *Kew Bulletin*, 1895, p. 178. The disease broke out in Mysore. It is due to a fungus allied to *Dematophora necatrix*, a fungus which does much damage to vines and orchards in Europe. The planter who describes the attack, Mr. T. S. Middleton, writes as follows :—

It is not the pepper only that is attacked, but even the saplings or undergrowth of the forest trees which spring up very rapidly suffer also. All over the plantations, at various points, this disease attacks these young saplings in patches of from 5 to 10 or 15 yds. square, and I may say, killed them off outright. As regards the pepper vines, most are attacked at the root, though some are attacked a few feet from the ground, and very soon afterwards the vine dries up, having affected most of the other vines in the neighbourhood. I have tried coal tar mixed with water, and paraffin oil, also mixed with water, all to no purpose, but I have found great benefit from the application of fires lighted in large numbers throughout the affected parts, though a great number of vines get scorched and die afterwards.

Of this Mr. Massee writes :—

The material sent shows that the pepper fungus can reproduce itself by two different methods.

1. The most general form, and the only one when the disease spreads from a centre, is by mycelium or spawn, which travels in the soil, spreading from plant to plant and destroying the roots. When such centres of disease are found they should be at once isolated by digging a narrow trench, about 10 in. deep, round the diseased patch, thus preventing the outward spread of the mycelium, which cannot pass the trench. As there is no cure for the plants when the roots are attacked, it would be best to remove and burn all plants within the affected area, otherwise the diseased plants will form a centre of infection by another method.

2. If the stem of a plant that has been diseased at the root for some time is examined, very minute black lumps, just visible to the naked eye, will be seen scattered over the surface, and in addition small velvety black patches are also very frequently present.

These are two distinct fruiting conditions belonging to the fungus, each of which produces myriads of conidia or very minute reproductive bodies which are dispersed by wind and inoculate other plants. By this method the plants become diseased above ground, while the roots remain healthy.

Nothing short of prompt destruction by burning of all plants showing such black lumps or velvety patches can prevent the disease by diffusion of conidia. As conidia are dispersed mostly by very low currents of air, screens of branches might with advantage be erected between the plantation and the affected forest region.

The benefit derived from the fires is explained by the fact that each fire forms a vortex, through which a certain volume of spore-laden air passes and is purified.

Where the root form of the disease has shown itself, it is useless to plant on the same spot before the soil has been thoroughly sterilised. Lime, if available, will affect this. Finally, great care should be taken in the selection of perfectly healthy cuttings. No part of any diseased plant should be used, for though the plant may not at any one spot show the disease, the mycelium is present, and will, at a later stage, grow out and show the disease. In many parallel cases where root disease is the trouble, the disease is really fostered by the planting of diseased cuttings.

The case of such a disease as this calls distinctly for treatment of the soil with Bordeaux mixture. My experience of treating this class of fungus with liberal doses of lime and copper sulphate leaves no doubt in my mind that this will purify the ground of the pest. The planter should lose no time on the first appearance of any underground root fungus on the pepper. Isolate the infected area at once by trenches, as described, and sprinkle them well with lime, cut down every vine within the infected area and burn on the spot, stake and all. Do not try to save a plant within the area that does not by then appear to be infected. It entails risk of greater loss. Dig the ground over thoroughly, throwing the soil into the centre of the plot, and not outside. Pour the Bordeaux mixture thoroughly over the whole plot, and do not replant on the same spot for a full year.

DURATION OF THE LIFE OF A VINE

This depends mainly on the way the plant is cared for, and the amount of manure which it receives. A Chinese planter, if pepper happens to be low in price, will give it no manure further than the first year or two's burnt earth, and the plant becomes worn out in four or five years. If properly treated, however, it should last in good condition for from twelve to fourteen years. In Assam, where it is only considered as beginning to fruit in five years, or at earliest three, the vine continues to yield for at least twenty years. In Madras, where it is said by one writer to commence bearing in seven years, it lasts for twenty-five.

The difference in the length of time it takes to commence bearing in different places is due probably to the method of cultivation. Where the plant is allowed to grow 20 ft. up a betel-nut palm, it naturally takes longer to come into bearing than on the 8 or 10 ft. post of the Chinese.

There are records of a plant bearing well at thirty years of age, but the cultivator may reckon the vine has lasted well if it lasts for twenty years in good bearing condition.

Fruiting.—Pepper will commence to fruit as early as a year after planting, but it is not advisable to allow the flower-spikes to remain on so early. It is usual rather to wait till the vine is fully developed, in the second or third year. When the vine is fully grown it completely covers the stake, and is well provided with spikes covered entirely with closely appressed berries. The berries do not ripen all at once. At first dark green, they become yellow, and then red. When one or two are red on a spike it is plucked by hand. As the stakes are tall, the gatherer requires a step-ladder in order to reach the top of the vines. Ladders resting against the vine cannot be allowed, as they bruise and break the branches.

The crop is collected in September and the following months till January in Sumatra, and in March or April in India. In most parts of the East there are two crops, the larger one in August or September, the smaller one in March and April, but frequently gathering goes on all the year round. Much depends on the season, abundance of rain, and sun. It is not uncommon to see flowers, half ripe and ripe berries on the vine at the same time.

There is a considerable variation in the fullness of the spikes. In an ideal bunch the peppercorns are close pressed together, with no empty space between, and all the fruit full-sized or nearly so, and all approximately of the same developmental stage. The irregular ripening of the fruit prevents their all being actually ripe at the same time, and one never sees a spike with all the fruits red. There are often many flowers unfertilised, indeed it would be impossible for every flower on a spike to produce a fully developed fruit; and there are losses from imperfect fertilisation, attacks of insects, and other such causes. A full spike of ordinary length can carry fifty fruits, but a large proportion of spikes are rarely fully filled.

In an article in the *Koffij Gids*, 1900, p. 966, a writer says that the natives of East Java class the fruit-spikes of pepper as follows:—

1. Meritjoh krentil — a bunch furnished well with large peppercorns.
2. Meritjoh ranti—spikes short, and fruit of unequal size.
3. Meritjoh lawee (lawi)—a long bunch with distant, more scanty fruits, ripening at different times.

The first of these is nearest to the ideal pepper.

COST OF CULTIVATION

Dobree (*Ceylon Observer*, February 1883) gives an estimate of cost of cultivation for the first three years in Ceylon, which, of course, is to a certain extent dependent on variations in cost of land, labour, etc., but which gives a fair idea of the approximate cost.

First Year (per acre)

	Rupees.
Superintendence	10
Felling	8
Nurseries	10
Weeding, 8 months	8
Lining	1·50
Holing	9
Filling in	9
Drains and roads	12
Planting and shading	6
Planting supports	2
Tools, building contingencies	20
	Rs.95·50

SECOND YEAR

	Rupees.
Superintendence	12
Nurseries	2
Weeding	12
Roads and drains	1
Terracing	8
Manuring	5
Pruning and training vines	3
Supplying	1
Buildings and contingencies	10
	Rs.54

THIRD YEAR

	Rupees.
Superintendence	12
Weeding	12
Roads and drains	2
Manuring	10
Pruning and training vines	3
Supplying	1
Building, etc.	10
	Rs.50

The fourth year's crop ought to cover expenses. There is, of course, the additional cost of picking, curing, packing, etc., and the cost of land-rent.

As to returns and profit, calculating the crop at 28 piculs per acre, and estimating the price at 10 dollars a picul, this works out to 28 dollars, or about 600 rupees per acre, which, estimating the whole cost of bringing into bearing at 200 rupees, he shows a profit of 400 rupees per acre. This is too high for an average return, however, as pepper fluctuates in price, and is often lower than his estimate.

Yield.—The yield of a pepper vine varies a good deal, according to circumstances. Of course, ill cared-for vines give but a poor return compared with a good, well-covered vine in the best condition. In reckoning, too, the amount of crop to be expected, the method of growing must be taken into account. The Bombay and old Acheen system of growing the vines on tall betel-nut palms, allowing the plant to climb up 20 ft., naturally gives a larger return than the ordinary Chinese method of growing it on 10 or 12 ft. stakes.

In the Straits Settlements, under Chinese cultivation, it used to be reckoned that in very good soil a vine would yield $\frac{1}{8}$ lb. of dry pepper in the end of the first year, $\frac{1}{4}$ lb. in the second year, 1 lb. in the third, 3 to $3\frac{1}{2}$ lbs. in the fourth, and from 8 to 10 lbs. in the fifth, after which it should give about 10 lbs. till the fifteenth or twentieth year. In Sumatra, a single vine is considered to give $1\frac{1}{2}$ lb. each year. In Borneo, under Chinese cultivation, the first crop at two and a quarter or two and a half years of age gives from 1 to $1\frac{1}{2}$ catty ($1\frac{1}{3}$ to about 2 lbs.) of white pepper, or from $5\frac{1}{3}$ to 8 lbs. of green pepper. At three and a half years of age, when it is supposed to be full grown, it would give 3 catties, or about 4 lbs. of dry pepper. T. S. Dobree, in the *Ceylon Observer*, says that he saw 30 lbs. of green pepper (which is equivalent to about 6 lbs. of dry pepper) taken from a vine said to be thirty years old, in Singapore. Taking the number of vines to the acre as 889, this gives 26·670 lbs. of green pepper for the autumn crop of an acre, and the Chinese owner said the spring crop was as large; that is to say, the plantation gave 53·340 lbs. of green pepper or 10·668 lbs. dry pepper per year. This is probably very exceptional, and such a return could not be expected. In Bombay, where the vines are grown on betel-nut palms to a height of 15 or 20 ft., with two or three vines on each palm, it is reckoned that the vines on a single palm should give 1,000 spikes of fruit, equivalent to 7 seers (49 lbs.) of dry pepper. In Assam, the usual return is 7 lbs. of dry pepper from each vine, in a year, and the largest amount that can be got from a single vine is 21 lbs.

In Madras, according to J. Murray (*Dictionary of Economic Plants of India*), three forms of vines are recognised which are distinguished according to their yield. Of these the form known as "Kari Malisaric" gives the highest return, namely 3 lbs. of pepper a year, "Arsina Murtiga" $1\frac{1}{5}$ lb. per year, and "Sambar" only $\frac{3}{5}$ lb.

In Cambodia, M. Adhemar Leclerc (*Revue des cultures coloniales*, VI. ii. p. 117) states that 400 vines in full bearing give from 8 to 12 piculs a year. A picul is 133 lbs., so that this makes 1,064 to 1,596 lbs. a year for 400 plants, or $2\frac{1}{2}$ to nearly 4 lbs. a vine. In the *Bulletin économique de l'Indo-Chine*, 1907, p. 371, M. Le Ray states the average production of a pepper plantation from five to twenty-two years old is very variable, not only from year to year, but also in different spots, according to the amount of care taken in cultivation, and also as to the planter, whether European or Chinese. He gives the following estimates by planters and officials in Cambodia:—M. Bouillod declares that more than 3 lbs. a vine cannot be expected, M. Blanc $3\frac{1}{3}$ lbs., and M. Malescot about $3\frac{1}{2}$ lbs.; a planter, M. Blanc, says that the average of the vines in good plantations give a little less than 3 lbs. M. Apavou gives the following table as the scale of production of 100 plants of from five to twenty-two years of age:—

	Kilos per plant.		Kilos.
Exceptionally good	3·000	1 plant	3·000
Very good	2·400	20 plants	48·000
Fine	2·100	30 "	63·000
Fairly good	1·600	30 "	48·000
Passable	1·000	20 "	24·700
Total for 100 plants			186·700
			or $311\frac{1}{6}$ lbs.

CURING

The pepper is gathered into small baskets, and treated differently according to whether black or white pepper is to be made.

Black Pepper.—The spikes are gathered when only a few of the fruits are ripe and red, and spread by women and children on mats to dry in the sun. It is improved, however, by being plunged in boiling water before spreading out to dry, as it hastens the eventual drying. It is usual among the Chinese to put the spikes into a wire skillet and plunge it for a few minutes in boiling water. This renders the skin tougher and gives the pepper a better colour. As the pepper dries it becomes quite black, and is then rubbed by hand to separate the stalks, which are removed by winnowing.

A planter writing in the *Indische Mercuur*, No. 40, 1903, states that if pepper is dried in ordinary drying-rooms there is a risk of getting the fruit spoiled by damp, or the seeds wrinkled and reddish. To avoid this he recommends a Huyser drier, beneath the perforated plates of which fires are lit as is done in drying tobacco. The pepper is thus fumigated as well as dried, and the results are said to be astonishing. A simpler method is generally used in Java. A smoke-room is made square, with walls 5 or 6 ft. high, and about 1 ft. from the top is made a platform of split stems of the Nibong palm (*Oncosperma filamentosa*). This palm has a stem 4 to 6 in. through, and is split into slats about 1½ or 2 in. wide. The slats are laid together in the form of a floor, close enough to prevent the pepper from falling through, but allowing the smoke to pass. At one end of the smoke-house is a fireplace, where damp wood is burnt in order to produce a heavy smoke, which is conducted by a pipe beneath the floor or shelf on which the pepper lies. An iron pan, known locally as a "Kwali," is so arranged beneath the shelf that the smoke striking against it rises and is spread over the smoke-room.

Other modifications of the smoke-room can be used according to convenience, the object being to treat the pepper with hot, but not excessively hot, thick smoke. In dealing with pepper in large quantities, especially in wet weather, it is essential to dry it with fire heat. Pepper is very liable to injury from mould, and can never be turned out in first-class condition unless it is thoroughly and rapidly dried. The use of boiling water, as described, increases the rapidity of drying, for the younger, green fruits do not commence to wither for some time after they are gathered, being indeed still alive for a day or two. Plunging into boiling water kills them immediately, after which they quickly commence to blacken.

During the process of drying, in whatever way, the pepper must be constantly turned over, and care taken that no mildew appears.

White Pepper.—As this is merely the ripened seeds of the pepper deprived of skin and pulp, in order to obtain a good quality the gathering of the spikes is delayed till nearly all on the spikes are showing a red colour, if possible. The fruits, however, on the same spike ripen so irregularly that this cannot always be done.

The ordinary method adopted by the Chinese for making white pepper is, first, to detach the fruits from the branches by pressing them underfoot. The berries are then put into large bags and allowed to soak for a week or ten days in water. Where possible, a running stream in full sun is used, but open water-holes are more commonly made for this work. The heat and moving water, however, accelerate the decomposition of the skin and pulp, and so streams are preferred. When the skins are sufficiently loose and soft the pepper is put into tubs, where it is stamped underfoot in a little water, and washed till all the skins, pulp, and stalks are detached. The peppercorns are then taken out of the tub and put to dry in the sun on mats. J. Bosscha (in *Teysmannia*, 1900, No. 2) suggests that it is better to make troughs of brickwork or hard wood, through which the stream can be allowed to run slowly, and to carry off the waste pulp, stalks, etc., which are lighter than the seeds.

White pepper is also made from dried black pepper in England by milling it in a special machine made for the purpose. The machine consists of a rotating stone enclosed in a wire-covered circular box. The pepper is thrown against the wire netting by the stone, and rebounds. By this method the skin is gradually rubbed off, and the friction gives a fine polished appearance to the pepper, which is much admired.

The finest grades of white pepper are made from Singapore and Penang black pepper in Europe in this way, or by soaking it previously and using decorticators. The same process is used in America, but apparently as late as 1899 there were only one or two white pepper factories, most of the white pepper coming direct from the East. An attempt was made by a merchant in Penang some years ago to hull dry pepper with the aid of chemicals and to bleach it afterwards, but the process proved too expensive.

In Penang the white pepper is made from Sumatran dried black pepper. The fruits are soaked in milk of lime for some weeks, till the outer coats soften and can be rubbed off with the hand or by trampling with the feet. After this it is slightly coated with lime.

When freshly dried the pepper comes out white after hulling, but after being kept some time before hulling, it is apt to be greyish in colour. This grey seed is sometimes polished and rubbed with lime to make it look white (*Planting Opinion*, 1899, p. 263). Liming pepper to whiten it is not at all uncommon, and limed pepper is often found in commerce, as its whiter appearance is popular and allows of its being passed as of a higher grade. The fraud seems to be most generally perpetrated in the country in which pepper is grown. The seed is normal in appearance, but presents a rougher surface than usual, and is generally of a more dead-white colour. It is an objectionable treatment, and limed pepper is disqualified from exhibitions of agricultural produce in the East. The best white pepper should be large, even, clean, and of good light colour, with no stains or grey tint.

The hulls rubbed off in decorticating are ground up and sold as pepper dust, or as ground black pepper. This substance is liable to heavy adulterations with dirt of all kinds, and even ground olive stones.

REGIONS OF PEPPER CULTIVATION

India.—The pepper plant being indigenous to the Malabar coast, was first cultivated and exported thence, and that in very early times. From this region it gradually spread over other parts of Asia, but at what dates is not clear. From the earliest recorded times till the fifteenth century at least, the greater part of the spice in the markets of the world was derived from the west coast of India. The whole of this region, from Cape Comorin to Kanara, was the pepper-country for many centuries, producing not only the greatest amount, but also the spice of the highest reputation. Nearly all the pepper was shipped at Madras, being conveyed there by the coasting trade from the various centres of cultivation.

The development of the industry in Sumatra, the Straits Settlements, and Cambodia, however, broke through the monopoly of the trade possessed by India, and the exports diminished materially. In 1829, Milburn reports (quoted in the *Dictionary of Economic Products of India*) that while the produce of Sumatra was estimated at 168,000 piculs, that of the islands south of Sumatra 12,000 piculs, of the Malay Peninsula 28,000, the Gulf of Siam 60,000 piculs, and Borneo 20,000 piculs, that of India was only 30,000 piculs; and in 1872, out of 27,576,710 lbs. imported into England, 25,000,000 lbs. came from the Straits Settlements, and only 256,000 lbs. from India; and in 1889, the total imports into England from the whole of the British East Indies being 28,555,304 lbs., 28,041,096 lbs. came from the Straits Settlements. The Indian trade, however, increased largely in recent years, as the following tables show, taken in quinquennial periods :—

1875-1876 to 1879-1880 . . .	5,420,963 lbs.
1880-1881 to 1884-1885 . . .	5,061,098 ,,
1885-1886 to 1889-1890 . . .	7,652,334 ,,

A considerable quantity of pepper was imported into India from the Straits Settlements, Java, etc., in

1875-1876 to 1879-1880 as much as 7,322,176 lbs. This import trade decreased, in 1883 to 1889, to less than half, but rose the next year to 5,707,147 lbs. Nearly all of this was derived from the Straits Settlements.

Of late years the cultivation has been much disturbed by the several diseases which became very serious (see Pests and Diseases). Steps, however, have been taken to remedy these evils, which seem to have been largely due to constant propagating from cuttings.

In Ceylon.—Pepper is said to have been one of the earliest exports from Ceylon. When this island came under the rule of the Dutch, some attention was paid to its cultivation, and in 1739 it is recorded that they exported 465,000 lbs., the greater part of which was derived from the Kandyan provinces. After the island passed into English hands, the pepper cultivation declined, and though a little was grown for local consumption, nothing further was done till about 1879, when it again attracted the attention of planters, and several restarted the cultivation. The plant seems to have grown well, even to an altitude of 2,000 ft., and the produce was considered to be of very good quality, but perhaps from a fall in price the cultivation seems soon after to have lapsed again, and little more has been heard of it for some years.

Malay Peninsula.—Linschoten mentions much pepper as being grown around Malacca in 1583, but at that time there was little trade in it there to Portugal, for he says that it was "two years between each shippe which sailed thence," and though each ship took some pepper, it was chiefly loaded up with cloves and nutmegs, and other merchandise of China. Most of the local-grown pepper went to Pegu, Syon (probably Siam), and China.

Garcia da Orta (1593) says that pepper, in his time, grew in Malacca by the sea, but was inferior in quality *et magna ex parte inane*, by which I presume he means flavourless.

As time went on, Malacca became a great emporium for produce of the eastern islands, notably for pepper, chiefly from Sumatra and Java, and was thence shipped to Europe. Very little, however, seems to have been actually cultivated at Malacca itself.

In 1802, pepper was the staple production of Penang, probably introduced from Sumatra shortly after the foundation of the settlement by Captain Light. An account of its cultivation in that year was published by Sir William Hunter in the *Asiatic Researches*, vol. ix., 1809. The average quantity produced annually was 4,000,000 lbs., but before 1810 it had decreased to 2,500,000 lbs. The price fell at length to 3 and 3½ dollars a picul, with occasional rises, and the cultivation was gradually abandoned. The total produce in 1836 did not exceed 2,000 piculs. In 1818 there remained on the island 1,480,265 vines in bearing, and the average annual value of exports from Penang, cultivated there, and exported from the surrounding countries, was 106,870 Singapore dollars.

The cultivation does not seem ever to have again assumed large proportions, and the extensive development of pepper planting in Singapore, soon after its founding, probably restrained that of Penang.

As in the rest of the peninsula, the cultivation was almost entirely in the hands of the Chinese, though, especially in Province Wellesley, there was a good deal of cultivation by immigrant Achinese.

Europeans have seldom attempted the cultivation, but about 1830, J. J. Thomson records an extensive area under pepper by a European gentleman in Malacca (*Logan's Journal*, iv., 1837). This, however, proved a failure. Pepper of a very high-class quality was long produced at Kamuning estate in Perak, but not abundantly.

In Singapore pepper cultivation seems to have been first started by an energetic Chinaman in 1825, who, as has usually been done, combined this cultivation with that of gambir. Pepper was then selling at $1·50 a picul. Unlike most pioneers in planting, he ended by making a fortune by his plantations. The cultivation soon increased, and continued a prominent feature of the country till about 1896, when, partly from the low price, and partly from the exhaustion of firewood for cooking the gambir, and making burnt earth for the pepper, and also of suitable timber for pepper posts, both the gambir and pepper plantations dwindled away, and in 1906 hardly one was left. During this period, the area under pepper and gambir was very large, and almost the whole of the original forest of the island was destroyed to make way for the two plants. After the abandonment of the ground, it became covered with lalang grass, and eventually with secondary scrub, and was valueless for many years. The cultivation was carried on exclusively by Chinese, and the pepper was grown more as an adjunct to gambir than as an independent crop.

Singapore has for many years been the great emporium for pepper. In 1872, 25,000,000 lbs. was imported into England from Singapore and Penang, while British India sent only 256,000 lbs.; and in 1877, 26,500,000 lbs. was exported. Most of the white pepper in trade comes from Rhio and the Straits Settlements.

The following are the trade figures given to me by Mr. W. C. Kün, the Registrar of Imports and Exports of Singapore, since 1875, for each fifth year :—

IMPORTS

	White Pepper.	Value.	Black Pepper.	Value.
1875	...	(kind not specified)	391,735	4,074,455
1880	...	”	206,174	2,368,200
1885	29,644	810,260	323,428	5,774,472
1890	18,447	450,277	511,440	6,902,648
1895	32,257	581,661	415,452	3,889,577
1900	41,961	1,812,972	221,398	6,342,914
1905	80,259	2,948,859	283,119	7,268,227

EXPORTS

		Piculs.	Value.
1875	Pepper, white and black	426,491	4,712,089
1880	,, ,,	272,625	3,076,377

	White Pepper.	Value.	Black Pepper.	Value.
1885	43,944	1,277,278	291,198	5,481,444
1890	97,756	2,207,062	406,813	6,122,301
1895	100,914	1,648,148	263,245	3,591,134
1900	80,285	3,513,888	204,567	5,950,723
1905	83,880	3,126,257	253,838	6,702,266

Borneo.—Pepper is extensively cultivated in Sarawak. Indeed it is the most important crop in that country. The cultivation is entirely in the hands of the Chinese, and the area of the cultivation very large. We have, however, no actual figures.

In British North Borneo, it is now only grown for local consumption, the low price (1910) having killed the export trade. One Chinaman has some hundreds of acres under pepper, but the poor markets have caused him to neglect the cultivation.

In 1908, 385·58 piculs of the value of 4,584 dollars, and in 1909, 417·55 piculs valued at 4,742 dollars were exported.

Siam.—Pepper, next to rice and teak, is the principal product of export from Siam. In 1893, 1,175 tons were exported, a little less than that exported in the previous year. The price that year fell, ranging from 22 ticals a picul (30s. 10d. a ton) for white, and 16 to 10 ticals (22s. 3d. to 13s. 7d. per ton) for black.

In 1888 it sold for 88 dollars a ton. The profits were made by Chinese middlemen who bought the standing crops. The pepper sold at Bangkok comes from Chantabun. It is gathered in March, and sold at Bangkok in April. When the fruit is picked, it is sorted into three compartments by a winnowing machine; the heaviest is used for white pepper, the next heaviest is made into black pepper, and the third, after the best fruits are picked out, goes as refuse pepper. Two-thirds of the crop form white pepper, and the remaining third black. The white pepper goes to London, and the black to China. The freight from Chantabun to Bangkok is 13s. 9d. per ton, and there is an inland duty of £1 : 7 : 6.[1]

Sumatra.—Pepper was cultivated in Sumatra in very early days, as early as 1509, chiefly by the Achinese, who are still among the best cultivators. Marco Polo does not mention it as being cultivated in Sumatra, and it was perhaps introduced later. It is recorded by Linschoten in 1598, as being a product of Sumatra. In 1783 Marsden writes that of the commercial articles of produce pepper is the most important and abundant. The trade in this spice was then the object of the East India Company's trade with Sumatra, and the only product that they kept exclusively in their hands, their servants and the merchants under their protection being free to deal in any other commodity but this. Many of the local chiefs had invited the English to form settlements in their respective districts, and factories were established, and a permanency and regularity given to the trade, previously very uncertain, while it depended on the success of occasional voyages to the coast. Failure of adequate quantities for cargoes, and the caprices and cheating of the rajas, made the trade very uncertain. The Company's agents, however, residing on the spot could inspect the plantation, secure the collection of the produce, and estimate the tonnage required. Contracts were made with the chiefs, who were obliged to compel their dependents to cultivate pepper, and to secure for the Company the exclusive right of purchase, in return for which they enjoyed English protection, and received an allowance on the produce. The price paid by the Company was 10 dollars (15s.) per bahar (5 cwt.). It was later raised to

[1] Foreign Office Consular Report, 1893, *Kew Bulletin*, 22, 1893.

a higher figure (15 dollars). The chiefs were paid about $1\frac{1}{2}$ dollar on each bahar purchased by way of an allowance. The Company looked well after the cultivation, making annual surveys of the plantations. Their servants resident in the different districts reported annually on the number of vines, their condition, and returns of crop, and gave rewards or punishments where necessary. The inhabitants of the districts were obliged to plant a certain number of vines, each family 1,000, and each young unmarried man 500, and as the gardens attained their prime, young gardens were prepared to keep up the cultivation continuously. The Directors seem not always to have been satisfied with the output of pepper, which was often less than they estimated. This was due to various reasons—accidents, such as the death of the owner, floods, raids of elephants, unfavourable seasons, and want of sufficiently careful calculation by the Directors of the Company. To obtain the medium proportion of produce to acreage, a Mr. John Crisp prepared in 1777 a general comparative review of the Manna Residency, in which he showed that the proportion of bearing vines to the whole number in the Residency was 5·1 to 11, and that the produce of 1,000 vines in bearing was, on the average, 453 lbs. Further calculations, taken collectively through the country for twelve years, gave as a mean annual production of 1,000 vines in actual bearing, but of all ages, 404 lbs. The average annual produce of the Company's settlements on the West coast of Sumatra were estimated at 1,200 tons, and this was what was actually received. The return given above for 1,000 vines seems to be rather small, but it must be remembered that a considerable number of the vines included were obviously only commencing to bear, and it does not appear that any manure was used.

The system of compelling the natives to cultivate pepper for the Company to buy was the method commonly in use in Dutch colonies until comparatively recent times. It had certainly some great advantages.

In a country such as Sumatra was then, where the difficulties the native had to contend with in getting a regular sale for his produce were great, having to depend on the irregular and scanty visits of ships to take it, the absence of roads to the interior naturally deterred them from extending the cultivation. It is perhaps due, too, to the system of enforced cultivation as practised in Java that the Javanese has developed into a higher class cultivator than the Malay, who, not compelled to cultivate anything, will never settle down to steady work.

At the same time the system was obviously open to abuse. A native compelled to cultivate a crop and to supply the produce to a European at a price fixed by the latter, whether the planter lost by his garden or not, is in the position of a slave to the European. As long as the influence of the chiefs continued, the stipulated quantity of pepper was cultivated and delivered to the Company, but the price given for the pepper was less than the value of labour employed, and the cultivators held back their labour. The chiefs were unable to enforce their orders. The Company in 1801 reduced their establishment, and a system of contracts introduced, by which the residencies were farmed out to Europeans in return for a certain quantity of pepper, and the Resident received a commission of one dollar for every cwt. of pepper he delivered to the government. Money was also advanced to the Malays to cultivate pepper, and as most of the advance was never paid back, according to local law the children of those who had died or emigrated, or the whole village, became liable for the debt, and so became slave-debtors. Sir Stamford Raffles, however, in 1813, abolished this slavery and declared pepper cultivators free, and allowed the people to cultivate it or not, as they pleased. Bencoolen, which supplied much pepper as well as other spices, was given up to the Dutch, and it was stipulated in the treaty that the British inhabitants were to enjoy until the 8th of June 1820 the unfettered liberty of disposing of themselves and their property. As soon, however, as this period expired, the Dutch levied a tax of 36 per cent on the exportation of all spices unless sold to the Dutch Government, in which case they were exempted from duty altogether.

Most of the spice plantations belonged to British planters, and by 1836 ten of the best plantations had gone to ruin and only two remained which paid any profit to the proprietors. With the failure of the spice plantations, Bencoolen soon ceased to be of any importance, and this district, which flourished so well under Sir Stamford Raffles, is now practically deserted.

The cultivation of pepper, however, still continues in Sumatra, chiefly in the Achinese district.

Though the Honourable East India Company must be credited with the first breaking down of the Dutch monopoly of spices, by introducing and extending the cultivation of pepper, nutmegs, and cloves, the Directors of the Company seem to have been remarkably ignorant of the nature of the spices they dealt in. It is recorded that on one occasion they sent out orders to cultivate only white pepper and not black pepper plants; on another occasion they ordered a ship at Bencoolen to be loaded with pepper only, refusing to allow some sugar to be taken as ballast, being apparently quite ignorant of the fact that the extreme lightness of the cargo would cause the ship to float so high in the water that her passage round the Cape of Good Hope would entail the greatest possible risk of being overturned.

However, similar blunders have been made even in later days by directors of companies and merchants who had every opportunity of knowing better.

Java and other Dutch Islands.—A considerable quantity of pepper is grown in the islands of the Rhio-Lingga group by the Chinese, together with gambir. Tschirch (*Heil- und Nutzpflanzen*) says 100,000 piculs (16,633,333 lbs.), more or less, per year. Most of this comes into the Singapore port and is shipped thence. He gives the export from Batavia as :—

1884	7,129 piculs.	1886	17,006 piculs.
1885	11,924 „	1887	39,482 „
1888	17,267 piculs.		

Cambodia.—The cultivation of pepper in Cambodia forms the subject of an extensive paper by M. A. Leclerc in the *Revue des cultures coloniales*, 1900, pp. 87 and 116, and another by M. Le Ray, *Bulletin économique de l'Indo-Chine*, 1907, p. 361.

The first record of pepper-planting in this country is found in the *Voyage lointain au Cambodge* by a Dutchman, Wusthof, in 1644, who mentions pepper as furnished by the province of Thbaung Khmoun on the Chileang River. The cultivation seems to have discontinued later, and to have been re-started about 1840 in the Kampot province, and about twenty-five years later in Peam and fifteen years later in Treang. M. Leclerc mentions the only pepper producing districts as Peam, Kampot, Treang, and Banteay-mear. These districts are arranged thus in order of importance of the cultivation. In 1884 the amount of pepper exported from Kampot and Peam was 5,000 piculs, but the unsettled state of the country in 1885 and 1886 seriously injured the cultivations. Young plantations were abandoned and many plants in older plantations were destroyed by the bandits, or died from neglect, and the planters ceased to open up fresh ground or plant. The production fell to 2,000 piculs in Peam and to 1,800 in the Kampot province. When the country was at peace the cultivators set to work again, and in 1889 the production had risen to its former amount, the four provinces producing 6,000 piculs.

In 1902 the cultivation rapidly increased owing to the exhaustion of the soil in Hatien (Cochin-China) and the superiority of the Cambodian soil, which required no manuring, and which allowed of a first crop in the fourth or even the third year; to the higher taxation of Asiatic aliens in Cochin-China than in Cambodia, and to the objection of the Chinese to certain anthropometrical examinations which entailed their spending much time at the headquarters of the Colony, added to which was the reduction of the tax on pepper from the French colonies in France. Chinese from Cochin-China settled in Cambodia, and even Cambodians commenced planting. At the time of the writing of this report, M. Leclerc says that in four pepper-producing provinces there were thirty-seven villages engaged in this planting, 3,357 planters, and 1,773,561 plants of different ages on the estates. The greater number of the planters were Chinese, but there were nearly as many Cambodians and a few Malays and Annamites.

The author of this report says that France and its colonies use at most 3,000,000 kilograms of pepper. Cambodia and Cochin-China in very good years can produce about 2,325,000 kilos, 1,800,000 in ordinary years, and 1,500,000 kilos in bad years, so that these colonies could produce a large portion of the pepper required by France. The Cambodian pepper, however, cannot compete with that of Singapore, Tellicherry, and Cochin, which are cheaper and better known on the European markets. He gives the following estimate of cost and returns: one hectare of 2,500 to 2,800 vines in good soil and well manured gives 70 to 100 piculs prepared pepper (20 to 30 vines giving a picul at most). Taking the lowest figure, 70 piculs, and the pepper down to 25 dollars, the return is 1,750 dollars a hectare. The expenses are never more than 1,100 dollars for a Chinaman who does not work himself, or 900 for a working Chinaman, so that the planter gets a very fair return for his labour.

By 1906 the pepper plantations had so much increased in Cochin-China and Cambodia, according to Mr. Le Roy, that the supply had exceeded the demand in France, and more than half had to be re-exported to other markets, where it had to compete with pepper from other countries often superior in quality and actually cheaper.

Africa.—Little is done now with pepper, though it could easily be grown successfully. Formerly it was extensively cultivated in Zanzibar, and in one of the consular reports (undated), quoted in the book *All about Spices*, we read that in one year 315,000 lbs. were grown, valued at 36,000 dollars. Later falls in price seem to have caused the abandonment of its cultivation, for Mr. Lyne, in July 1909, writes me, "Pepper is here, but not cultivated."

West Indies and South America.—Though no doubt pepper could be grown well and productively in the New World, very little has ever been done in its cultivation there.

Mr. Hart writes (*Kew Bulletin*, 1894, 79) that the pepper in Trinidad gave a good crop, and a crop of 200 lbs. was harvested from some vines giving 2 lbs. each. Messrs. W. and D. Harvest report on the sample that it was clean and bold, and resembled the better qualities of Tellicherry black pepper, except that it had rather more husk. The value at the date at which it was prepared was $2\frac{3}{8}$d. to $2\frac{1}{2}$d. per lb.; but the markets were then depreciated and an immense stock had been received from the Straits Settlements. A short time previously the Trinidad sample would have fetched 5d. to $5\frac{1}{2}$d. per lb.

In Jamaica, pepper plants fruited in 1897 for the first time, but only two plants (*Jamaica Bulletin*, December 1897).

There seems to have been some difficulty about the plant in Jamaica. Plants and seeds of good strains were sent from the Singapore Botanic Gardens on several occasions, but they never appear to have done well.

USES OF PEPPER

The use of pepper as a spice or condiment for flavouring dates from very early times. Its strong pungency and stimulative action on the digestive organs made it very much in demand for cookery. Black pepper is more pungent, and contains more of the alkaloid, but the consumers seem usually to prefer the white pepper. This is perhaps due to the colour and also probably because white pepper is less liable to adulteration than black. Whole pepper seems practically never to be adulterated, whether black or white, though it is said that in India it is occasionally adulterated with the dried fruits of *Embelia Ribes*, a common climber in India and Malaya. Ground pepper, and what is known as pepper dust, refuse, and waste fragments of black pepper is, however, easily and often adulterated with all kinds of rubbish, such as ground-up olive stones.

Pepper as a spice is not only extensively used in the kitchen, but largely also in the preserving business, sausage-making, etc.

Medicine.—Its virtues as a drug are mentioned by many early writers. Linschoten says, "Pepper is used in the kitchen and in apothecaries' shops, although in both places not as a meate or food, but for physic"; and proceeds to mention it for indigestion, for mistiness of the eyes, and other complaints. Sanskrit authors describe it as acrid, pungent, hot, dry, carminative, and useful in intermittent fever, haemorrhoids, and dyspepsia. Externally it is used as a rubefacient in alopecia and skin diseases in India. Dymock states that Mohammedan writers describe it as a deobstruent, resolvent, and an alexipharmic, as a nervine tonic and a digestive, and believes it to be diuretic, an emmenagogue and a stimulant in cases of snake-bite. Externally it is used by the Mohammedans of India in paralytic affections and in toothache as a mouth wash. It is also recommended by many natives as a remedy for cholera, as an aromatic stimulant, and many of the Indian doctors of the present day value it in epidemics of cholera in the form of a very strong infusion. During an outbreak of cholera some years ago in Singapore there was a great demand for "pepper-oil," a distillate of black pepper, which was prepared in a distillery in Singapore.

Externally pepper is also used as an application to inflamed parts, or for boils or pimples, and mixed with ghee for urticaria.

In European medicines the use of pepper has almost completely been abandoned, except as a stimulant or flavouring for other medicines.

Pepper Oil, the distillate of pepper, appears to have been prepared in the Middle Ages. It is first mentioned in 1574. The method of obtaining it was first described by Winther in 1750.

Perfumery.—Piperonal or *Artificial Heliotrope*, is obtained from *Piperine* by distillation. It possesses a scent resembling that of Heliotrope, and is therefore used in perfumery.

Ground white pepper, preferably that of Singapore, which contains 9·15 per cent of the alkaloid, is mixed with twice its volume of slaked lime and sufficient water, and evaporated on a water bath. The powder is then exhausted with commercial ether, when the piperine can be obtained nearly pure in straw-yellow crystals. From this, by the use of caustic potash, *Potassium piperate* is formed and treated with permanganate of potash, when the piperonal crystallises out.

Heliotropine is destroyed by sunlight and injured by heat. It requires to be kept in yellow glass bottles and preserved in a cool dark cellar till required for use.

OTHER PEPPERS

African pepper, *Piper clusii*, Dc., also known as Ashantee pepper, or West African pepper.

This is a wild pepper widely distributed in tropical Africa, most abundant in the Mam-main country. It differs in appearance from black pepper, being one of the Cubeba section, characterised by the fruit being borne on a short stalk, whence the old Portuguese name of *Pimienta da rabo*, *i.e.* tailed pepper. The plant is very handsome with its splendid red branches of fruit. The dried fruit is ashy grey, and possesses the taste and odour of pepper containing piperine.

It was known as early as 1364, being imported from Liberia to France, but the King of Portugal prevented its importation into Europe, for fear of depreciating the value of Indian pepper (1485). It is used in West Africa locally as a spice, but though it could be had in abundance, should it prove as good as black pepper, it seems to find its way into European markets but seldom. It is not cultivated.

Cubebs (*Piper cubeba*, L.), though used as a spice up to 1480, have long been used only as a drug. For this purpose they were very largely cultivated in Java till about 1890 when their use was much diminished, and the cultivation almost died out. As they are now only used as a drug, they are not described in this work.

Appendix to Chapter

The following accounts of early pepper cultivation in the Straits Settlements are of interest, especially as they are published in works not usually accessible.

The first is taken from a manuscript account of the plants of Prince of Wales Island (Penang) by Sir William Hunter, written about 1803, and published in the journal of the *Straits Branch of the Royal Asiatic Society*, vol. 53, 1909. It is interesting as giving an account of the cultivation practised by the Chinese at that date, with an estimate of the cost of opening up a plantation and the profit.

The second is a letter by Mr. De Mornay to Major M'Nair, detailing the system practised in Province Wellesley in 1883. It was published in the *Government Gazette of the Straits Settlements* in August 1884.

I. Pepper cultivation in Penang, 1803, by Sir W. Hunter.

1. *P. nigrum*, black pepper.

This plant has been so fully described that I have nothing to add on that head. But as it is the most important article of produce on Prince of Wales Island, the manner of cultivation pursued there merits a particular detail.

It is propagated by cuttings or suckers. These are generally planted at a distance of about $7\frac{1}{2}$ ft.; that is 1,000 plants in an Oorlong, which is a measure of 80 yards square, nearly equal to $1\frac{1}{3}$ acre. But some experienced cultivators think that the distance should be greater, perhaps 9 ft., as the roots would be better nourished and the produce more abundant.

When a plantation is to be commenced, the large timber is cut down by Malays at the rate of 5 dollars per Oorlong. The remaining labour is performed by Chinese, who dig out the roots, burn them and the trunks, pulverise and level the soil, plant the pepper vines and the trees which are to support them. It is usual to contract with them for making the plantation in this manner, and taking care of it for three years, at the end of which time it is in bearing at a rate of 225 dollars for 1,000 plants. The sum is liquidated by instalments, as the contractor requires it, to pay his workmen. Something more than one-third is paid in the first year, because the labour is the greater; but about one-fourth of the whole is generally reserved till the contract is completed and the plantation delivered over. This does not include the price of the plants, or cuttings, which are found by the proprietor of the plantation.

The vine is first made to climb on a pole. At the end of ten or twelve months it is detached from the pole to undergo the process called laying down. A circular hole, about 18 in. in diameter, is dug at one side of a plant. At the bottom of this the plant is carried round in a circle, and the end of it is brought to the tree which is in future to form its support. The depth of the hole in which the vines are laid down varies according to the situation and nature of the soil; and much judgment, to be acquired by practice, is requisite to adapt it to these circumstances. In high and dry situations the depth must be considerably greater than in those which are low and moist. Too little depth in the former would expose the roots to be parched in dry seasons; and too much in the latter would occasion them to rot from excess of moisture.

The trees used for supporting the pepper vines on Prince of Wales Island are the *Morinda citrifolia* (Munkoodu) and the *Erythrina corallodendron* (Dudup). The Chinese planters allege that the pepper supported by the Erythrina thrives better and lasts longer than that supported by the Morinda. One instance I heard quoted in proof of this assertion was a plantation which had long been neglected and overgrown with weeds. When it came to be examined the vines which had grown on the *Morinda* were all dead, while those on the *Erythrina* were still strong and productive. The reason assigned by the planters for the difference is that the roots of the *Erythrina* do not spread so much or penetrate so deep as those of the *Morinda*; whence they interfere less with the pepper, and do not draw so much nourishment from the earth.

The *Morinda* was formerly made to grow with one stem, but this was not found to afford sufficient spread for the vines. Therefore, when that tree is used, the practice now is to break off the principal stem, at a height of about 2 ft. from the ground. This obliges the trees to put out lateral branches at that height. When these have attained a length of about 1 ft. or 15 in., they are cut off. From their end arise erect shoots, each of which forms a stem, so that the vine has 4 or 5 stems to climb on instead of one.

The vines, at three years of age, begin to produce, and they are reckoned to be in full bearing at five or six. They continue nearly in the same state for eight years more, or till they are fourteen years old. From that period they are reckoned on the decline; but the planters on Prince of Wales Island cannot yet judge from experience at what rate or in how long a time they decay. Some Chinese who have cultivated the plant on the Malay coast say the vines have not arrived at their point of greatest produce till they are fourteen years old; that from this, gradually declining, they continue bearing till nearly thirty.

The first year of bearing, or at three years old, the vines do not yield more than half a catty each. But plants kept in good order, when in their prime, will produce three catties. A plantation of 3,000 vines at Soongey Clooan, now in its eleventh year, has been let for three years at 70 piculs yearly, or at the rate of $2\frac{1}{3}$ catties each plant. It must, therefore, produce as much more as will pay the tenant for his labour and risk. They are generally let for the first five years of bearing, or from three to eight years old, at 160 piculs per lacsha (10,000), or at 160 catties for 100 vines.

The vines yield two crops yearly. The first gathering commences in December, after the heavy rains are over; and at the same time the vines have to put out new flowers. This first collection may be finished in February. The flowers which spread in December have ripened their seeds in April or May. The second collection then begins, and ends in July. During this time blossoms have expanded which are to furnish the crops of next December. But with the most careful cultivators, who gather only the bunches which are fully ripe, these two harvests run so nearly into one another that the collection is, in a manner, continued without interruption from December till August; so that there is only an interval of four months in the year, which is the season of the heavy rains.

The bunches are plucked off entire, taking care to pull only those that are ripe. They are thrown into baskets, and allowed to remain for a day. Then they are spread on mats, and trodden with the feet, to separate the fruit from the stalk. The grain is then winnowed, to clear it from the stalks and the lighter grains; and then the good heavy grains are spread on mats in the sun to dry for three days. It is calculated that 100 catties of green pepper, with the stalks, yield 35 catties of clean and dry pepper. The collection of one day from 46,000 plants of three years old was 500 catties of green or 175 of dry pepper.

It is usual, as was before noticed, when the plantation is delivered over to the proprietors at the end of three years to let it to a Chinese farmer for five years more; as the proprietor is thereby less liable to imposition, the only precaution necessary being to see that the tenant is careful of the vines during the last year, and leaves them in good condition at the expiration of the lease. This is the only way in which an extensive plantation, or one whereon the proprietor cannot bestow his whole attention, can be managed to advantage. But, if the proprietor has time and is careful and acute, he may render it something more productive by keeping it in his own hands. The labour of cleaning the vines, throwing up earth about the roots, and collecting the produce of the plantation above mentioned of 46,000 plants was performed by sixteen Chinese workmen.

In an Appendix to a letter from the Superintendent of Prince of Wales Island, dated 12th November 1796, is an estimate, whereby it would appear that a plantation of 100,000 vines should yield, at the end of twelve years, a clear profit to the proprietor of 153,000 Spanish dollars. But the value of the pepper is stated too high at 14 dollars per picul; and the interest of money, on both sides of the account, is neglected. Yet if we value the pepper only at 10 dollars, for which it is presumed it may always be sold on the field, and compute the interest, the result will give an advantage exceeding the Superintendent's calculation by 31,000 dollars. See Appendix A.

The whole quantity of pepper produced last year on the Island was estimated at something between 16,000 and 20,000 piculs. Taking the medium quantity at 12 dollars, which was the selling price, this article must have amounted to 216,000 dollars. The pepper is more esteemed than that which comes from the Malay continent and Sumatra, and it sells for about 1 dollar more per picul. The difference is occasioned by the haste of the Malays to gather fruit before it is sufficiently ripe.

APPENDIX A

ESTIMATED EXPENSE AND PRODUCE, IN TWELVE YEARS, OF 100 OORLONGS PLANTED WITH PEPPER

	Dr.	Cr.	Balance.
	Sp. Drs. Pa.	Sp. Drs. P.	Sp. Drs. P.
1st Year—Clearing of heavy timber by Malays at 5 Drs. Oorlong .	500		
To the Chinese contractor, in the course of 3 years, when he engages to deliver the Plantation in full bearing, at \$22·50 per 1000 plants . . \$22,500·00			
Of this in the 1st year . . . . 8,437·50	8,437·50	...	8,937·50 Dr.
2nd Year—Further payment to contractor . 4,218·75	4,218·75		
Interest of 1st year at 12 per cent	1,072·50	...	14,278·75 Dr.
3rd Year—In full to contractor . . . 9,843·75	9,843·75		
\$22,500·00			
Interest in the 3rd year . .	1,707·45	...	25,779·95 Dr.
4th Year—Interest	3,093·59		
Supposing the Plantation to be let during the first 5 years of bearing at 160 Piculs per Lacsha, this will be 1600 Piculs, which may be sold on the ground at 10 Drs.	...	16,000	12,873·54 Dr.
5th Year—Interest	1,544·82		
5th Year's crop	...	16,000	1,581·64 Cr.
6th Year—Interest	...	189·80	
6th Year's crop	...	16,000	17,771·44 Cr.

ESTIMATED EXPENSE AND PRODUCE—*continued.*

	Dr.	Cr.	Balance.
	Sp. Drs. Pa.	Sp. Drs. P.	Sp. Drs. P.
7th Year—Interest	...	2,132·57	
7th Year's crop	...	16,000	35,904·01 Cr.
8th Year—Interest	...	4,308·48	
8th Year's crop	...	16,000	56,212·49 Cr.
9th Year—Interest	...	6,745·50	
The plants, being now in full vigour, may be let for 4 years more at 2 Catties each plant, or 2000 Piculs, which is . .	...	20,000	82,957·99 Cr.
10th Year—Interest	...	9,954·96	
10th Year's crop	...	20,000	112,912·95 Cr.
11th Year—Interest	...	13,549·55	
11th Year's crop	...	20,000	146,462·50 Cr.
12th Year—Interest	...	17,575·50	
12th Year's crop	...	20,000	184,038·00 Cr.

MALAKOFF ESTATE,
PROVINCE WELLESLEY, 19*th November* 1883.

II. MY DEAR MAJOR M'NAIR,

At my request one of the head pepper planters of Arra Kudah came here this morning to answer my inquiries regarding their mode of cultivation, etc. He says that pepper should always be planted on land sufficiently high to be easily drained, but may be flat. Rich light soil is preferred, although it succeeds well on stiff soil, where the vine produces fruit for a longer period than on light soils, but is, of course, more expensive to cultivate.

On rich soil, they plant at the same distance apart as Mr. Dobree recommends, viz. 7 ft. by 7 ft., otherwise they plant closer, as the vines do not grow so large on inferior soils, requiring less room. At Arra Kudah they plant 6 ft. apart each way.

At Arra Kudah they first plant a nursery with cuttings, each slip having a hardwood stick about 2 or 3 ft. long near it to cling to. At the same time, they plant out in the field the supporting trees, called in Malay dedup, at intervals of 6 ft. each way, which are allowed to grow one year before transplanting the pepper plants from the nursery near them, which plants are, of course, then also one year old. In that time the dedup tree grows from 12 to 15 ft. high. Then holes are made 1 ft. square, and the same depth, prepared as Mr. Dobree describes, near each tree, in which they plant the cuttings taken from the nursery. Only one plant is put in each hole. They do not make a small mound round each vine, as Mr. Dobree says the Chinese do at Singapore. No manure at all is used.

The vines of three years' growth in the field yield their first small crop. Two years after, they are in full bearing, yielding an average of $3\frac{1}{2}$ catties per vine of dry black pepper. An acre contains one thousand two hundred (1,200) vines, yielding at this rate forty-two (42) pikuls. This greatly exceeds Mr. Dobree's account of the returns at Singapore, although manure is used there and not at Arra Kudah.

The pepper is gathered about the middle of the year, and is dried by being spread out on the ground exposed to the sun and wind, fire not being used.

He did not know the difference of weight between green and dry pepper, but thinks it is not nearly so great as described by Mr. Dobree.

To make white pepper, they bury thoroughly ripe black pepper in damp ground for five days, when they take it up. By that time the skin is rotted, which is washed off and the corns then dried in the sun.

I did not inquire the cost of cultivation, to compare with Mr. Dobree's estimate, as nothing reliable could be learnt on this point, and would be most likely misleading rather than otherwise. No doubt it is much less costly to the Achinese here than to the Chinese in Singapore.

The above is all the information I could obtain without visiting Arra Kudah, which I hope will be sufficient for your purpose.—Yours sincerely,

H. De Mornay.

(*Straits Settlements Government Gazette*, 15th August 1884.)

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CHAPTER IX

LONG PEPPER

There are two distinct kinds of pepper known as long pepper, and as such sold in the native markets of the East. These are the dried fruit spikes of *Piper longum*, L., a native of India, and *P. officinarum*, L., a native of Java. The former may be called Indian long pepper, the latter Javanese long pepper. Very little has ever been published or recorded as to the history or cultivation of these plants; although there has been an extensive trade in the spice for many centuries, and it is the Indian name for the long pepper from which the word pepper is derived, that is to say the Hindustani "pipat."

Long pepper was known almost certainly to Theophrastus, in the fourth century B.C. It is mentioned with a rough woodcut by Clusius (*Historia aromatum*), but he does not seem to have been well acquainted with it.

Piper longum, L., Indian Long Pepper

This plant is a native of Bengal, Nepal, Assam, and Khasiya and southward to Travancore, and is cultivated chiefly in the northern parts of India. It has been occasionally met with in native gardens in Ceylon, but appears to be quite absent from the Malay peninsula and archipelago, where it is replaced by the Javanese long pepper. The climate indeed appears to be too damp for it.

According to Roxburgh, it is not a climbing plant, but possesses a perennial root stalk from which are produced many creeping rounded stems, which, as in all peppers, are jointed with swollen joints. The young shoots are downy. The creeping stems bear large, broadly cordate leaves, somewhat polished and showing the nerves, the tip acuminate, the base with a broad and deep indentation. The erect fruiting branches have rather smaller oblong cordate leaves, with fine nerves, the upper ones of which have no petioles, but are stem clasping. Miquel, who figures it under the name of *Chavica Roxburghiana*, shows the upper leaves quite like those of the lower part of the plant, and like those which I have in cultivation. The plant, however, climbs readily like the black pepper, and is cultivated in exactly the same way in Assam and Mysore.

The male spikes are slender, and from 1 to 3 in. long; the female spikes shorter, sessile, or nearly so, opposite to the leaf, cylindrical, with a rounded base and blunt at the tips, $\frac{2}{3}$ to $1\frac{1}{2}$ in. long and erect, red when ripe. The flowers are very numerous and close packed as in the black pepper, but the bracts are orbicular, and the fruit is not a red fleshy drupe as in black pepper, but a minute drupe embedded in the fleshy spike. The whole spike of fruits forms a cylindric mass, broadest at the base, and when dry is of a grey colour and very pungent, but less so than Javanese long pepper.

It is known as *pipul* in India, and cultivated from mature branches or suckers. N. Mukerji (*Handbook of Indian Agriculture*, p. 43) states that the branches, shoots, or suckers are layered, *i.e.* bent down into the ground, and when they take root they are severed from the parent vine and planted out in shade, and trailed on to trees. This is done at the beginning of the rainy season. The base of every vine is kept scrupulously clean and well manured by cow-dung cake, which acts also as a mulch. Three or four years after planting the vines begin to bear in the cold weather. The spikes of the long pepper are dried in the sun. Mr. Basu, Assistant Director of Agriculture, estimates the average yield of each vine at 1 seer, valued at 8 annas. It is said to flower in August and September, and fruit is ripe in January.

The plant seems to be cultivated exclusively by natives in India, and I can find no record of Europeans ever having attempted to grow it. The only other accounts of its cultivation are those of Dr. Roxburgh in the *Flora Indica*, and Major Bruce in the *Agri-Horticultural Society of India Transactions*, iii. 60, who say that the plant is propagated by suckers, and requires a rich, high, and dry soil. The suckers are transplanted soon after the setting in of the periodical rains, at a distance of 5 ft. apart. A little manure is applied to the soil, and during the hot weather the roots are shaded by covering the ground between the plants with straw. No water is applied. The natives usually plant radishes, brinjals, or barley between the plants as a catch crop. The spikes are gathered in the month of January, when it is still green and unripe, as it is most pungent before it is fully ripe. When quite ripe the spikes are red in colour. The spikes are merely dried in the sun, and take on a grey colour. The plant produces 250 to 500 lbs. of dry pepper to the acre in the first year, 1,000 lbs. in the second, and 1,500 lbs. in the third year. After this time it becomes less productive, and is then dug up, and the roots and thick parts of the stem are dried and sold as a drug, under the name of *Pippul mula.* The field is then replanted with a fresh stock of roots or shoots.

Regions.—Bengal is still the chief source of the long pepper of India. The dried fruit fetches 9 rupees a maund of 41 lbs. The root, of which the most valued form is derived from Mirzapore and Malwar, fetches 50 rupees per maund from the latter locality, against 10 to 40 rupees from Bengal. A certain quantity is exported from Calcutta to Europe, but the chief long pepper of commerce is the Javanese species.

Bengal long pepper is shorter and more slender than Javanese, and also darker in colour. It is less pungent.

Uses.—Long pepper contains the same principles as black pepper, a volatile oil, resin and piperin, and it is used ground up as a spice in the same way as ground pepper, chiefly by natives.

As a drug, both the spikes and the dried root and shoots are used by natives. Like black pepper, it has practically gone out of the European Pharmacopoeia, except an occasional use as a stimulant in compound medicines. In native medicines it is especially valued in coughs and catarrhs, and usually mixed with honey for these complaints. It is valued also in indigestion and colic, possessing stimulant and carminative properties similar to those of black pepper, but more powerful, and also by Indians in paralysis, tetanus, and apoplexy, as a liniment for snake-bite, and in the form of a snuff for coma and drowsiness. The roots are used for the same purposes, but are considered weak in action.

Piper officinarum, L., Javanese Long Pepper, Chabei (Malay)

This long pepper differs from the Indian long pepper in its leaves not being cordate or deeply incised at the base. The lower leaves are lanceolate acuminate at the tip, with a rounded but entire base; they are smooth, dark green above and pale beneath, 3 in. long, $1\frac{1}{4}$ in. wide, with a petiole $\frac{1}{2}$ in. long. The upper leaves are much larger ovate, 6 in. across and a little longer, the base rounded, broad, the tip acute. The stem is about $\frac{1}{2}$ in. thick, and grey in colour. The inflorescence is much like that of the Indian long pepper, but the spike is less broad at the base and the tip less blunt. When ripe it is red, and when dry it is of the same grey colour as the Indian one, but more pungent. Otherwise it is almost exactly like it.

It is grown from cuttings, and, if allowed, would climb very high. The Javanese train it to a stake, and prune it back to about 5 ft. from the ground. Unless this is done they say it would never flower. When adult it flowers and fruits all the year round, and 30 or 40 spikes can be taken from one plant every few days. They are merely dried in the sun.

The plant is figured, and some account of it is given by Rumphius in the *Herbarium Amboinense*, vol. v. p. 333, under the name of *Piper longum*. He states that it was abundant in his time in Java, Bali, and Uliasser, but only cultivated in a few gardens in Amboyna, and gives the well-known Malay name, Chabei, and also Lada padang, as used by Malays. The Amboinese word is Maritsja ammo or Marisa ammu. He states that it was cultivated on the stems of the tree *Moringa* (the Ben-nut), or on coco-nut trunks, but not on stakes as black pepper is. Natives of Java say, however, that they cultivate it on posts just as black pepper is grown. Miquel, *Illustrationes Piperacearum* (Ill. xxxix.), gives a good figure of it.

The Javanese use it in curry and in native medicine. It is chiefly grown in Java, Bali, Rhio, and other islands. I cannot find that it has ever been cultivated in the Straits Settlements, though it is mentioned by Hunter in his *Plants of Prince of Wales Island* (Penang), as "cultivated and used as long pepper, but a very distinct species from the Malabar or Bengal long pepper," in 1802.

Uses, etc.—The spikes are gathered when they begin to turn red or yellowish, and quickly dried in the sun, or over a fire, as they are very liable to rot if not speedily dried, and especially if gathered when red.

The dried spikes are cylindrical and somewhat tapering to the tip, and marked with superficial spiral furrows. They are 1 in. or $1\frac{1}{2}$ in. in length, and $\frac{1}{4}$ in. through; of a brownish or greyish white colour (said to be caused by rubbing them with lime), and when washed they have a deep brownish red colour.

The pepper is very much more pungent than black pepper, and has a pleasant aromatic taste.

As a spice it is chiefly used in pickling, and also as ground pepper for preserves, and in Malay curries. It is used also in veterinary medicines, but has practically gone out of European pharmacopoeias.

In Malay regions it is used for indigestion, colic, and flatulency, and as an unguent in paralysis, in much the same way as black pepper is in other parts of the world. The bark of the stem is also used in native medicines for similar purposes, but is less strong.

This appears to be the commonest of the two long peppers exported to Europe, and is chiefly shipped from Singapore and Penang. It is imported here mainly from Java and Bali, and is exported again principally to British India, England, Turkey in Asia, China, and a little to the United States, Germany, etc. Out of 3,366 cwt. imported into Singapore in 1871, only 477 cwt. went to England; most of the rest went to India. The export from Penang was about 2,000 or 3,000 piculs annually, probably derived from Sumatra.

The following imports and exports into and from the Straits Settlements for every five years from 1885 give some idea of the trade. Previous to that date it was registered with black pepper, so that figures of earlier date cannot be given.

IMPORTS

1885 . . .	5,903	piculs	value	97,774	dollars
1890 . . .	10,410	,,	,,	44,561	,,
1895 . . .	5,254	,,	,,	20,806	,,
1900 . . .	5,356	,,	,,	113,209	,,
1905 . . .	2,951	,,	,,	130,277	,,

EXPORTS

1885 . . .	5,862	piculs	value	102,395	dollars
1890 . . .	10,778	,,	,,	61,320	,,
1895 . . .	5,069	,,	,,	20,345	,,
1900 . . .	5,844	,,	,,	131,684	,,
1905 . . .	3,144	,,	,,	147,594	,,

It sells at about 20 dollars a picul.

Piper Chaba, Hunter, BAKEK

This is a stout climbing pepper, with thick jointed stems, rooting at the nodes as in *Piper nigrum*.

The branches, however, are stiffer and longer, light brown with green streaks; the internodes, drum-stick shaped, are about 4 in. long, round and smooth. The leaves are ovate acute, the base rounded and cordate, the two lobes slightly unequal. They are light green, thinner than those of black pepper, 6 in. long by 4 in. wide, two pairs of nerves rising from the notch at the base; between them rises the midrib, which soon breaks into three slender nerves; the leaf-stalk is 1 in. long, grooved above. The leaves are alternate, and from the nodes opposing the leaves are produced the flower spikes, hanging down on stout pedicels 1 in. long. The flower spikes are 6 in. long and $\frac{1}{4}$ in. thick, cylindric and blunt. They are of a pale glaucous green, marked with the spirally arranged stigmas. The greyish colour of the spike is caused by a fine white down which covers the spike. Unlike black pepper, the flowers are so closely compacted that it is very difficult to separate them. The ovaries are sunk deeply in the fleshy rachis, and are narrowed to a slender point, which reaches to the surface and bears a starlike stigma, with 3 to 5 lobes; with each ovary there is on the surface of the spike a round, green, shield-shaped bract, quite smooth.

Bakek is cultivated in much the same way as pepper, that is to say, from cuttings put alongside a stake, up which they eventually climb, and are tied on by strips of bark or rattan. They commence bearing in about six months, and usually last for about four or five years. They are seldom manured except with a little burnt earth, as the price of the spice is low, and it does not seem to be considered worth while; but they are cultivated in damper and better soil than pepper, and under the shade of fruit trees. With a proper supply of manure they would doubtless last longer. The spikes when ripe are gathered and dried in the sun, and then turn black. They have a hot pungent taste, and are about as hot as long pepper, but with it there is also a bitter and rather unpleasant flavour.

Bakek is chiefly used by natives as a medicine, and also to chew with gambir, and is especially used as a substitute for betel leaves when travelling in places where the fresh leaves are not procurable. It sells at a price of from 6 to 15 or 18 cents per catty.

Piper arnottianum, C. DC., Kadok

This pepper was described by me in the *Bulletin of the Straits Settlements*, old series, p. 123, under the name of *Piper longum*, which it somewhat resembles. It is a low-growing, non-climbing plant, emitting long runners, which creep along the ground; the flowering stems are erect and about 6 in. tall. The leaves are ovate cordate, polished dark green, 7-nerved, acute, about 4 or 5 in. long, and $3\frac{1}{2}$ to 4 in. wide. The spikes are cylindrical and at first white, brownish grey when ripe, not broader at the base than at the tip, and only $\frac{1}{6}$ in. through. It is less pungent than long pepper, and has a peculiar and rather unpleasant bug-like flavour. It is seldom if ever cultivated, as it grows on shady banks everywhere in the Malay peninsula, and is very readily propagated by cuttings. Its spikes are used more as a medicine by the natives than as a spice.

Grains of Paradise, or Melegueta

Grains of Paradise, or Melegueta, are the aromatic pungent seeds of one or more species of the genus *Amomum*, of the order *Scitamineae*. Both of these plants are natives of West Africa, where they are more or less cultivated, and also found in a wild state. The seeds of both species appear to be used and sold commercially, under the name Grains of Paradise.

Amomum Melegueta, Roscoe, is a herbaceous plant with a stout rhizome, sending up leafy stems from 3 to 5 ft. tall. The leaves are linear, or linear oblong acuminate. The flowers are borne on a short stem about 2 in. long, hardly rising 1 in. above the ground, and terminated by a spike of reddish bracts, from which spring the large and delicate flowers. In these the corolla has one erect lanceolate lobe, and two narrow linear ones, white or pale violet, and a large, spreading, fan-shaped lip, white tinted with rose, with a red and yellow blotch at the base. The fruit is pear-shaped, 3 or 4 in. long, red or orange, and containing a large number of very small seeds. The seeds are $\frac{1}{10}$ in. through, hard, roundish, oval, bluntly angular, golden brown in colour, aromatic and pungent.

A good figure of this handsome plant is given in Roscoe's *Scitamineae Pl.* and also in Trimen's *Medical Botany* and in Johnson's *Liberia.*

The plant appears to vary considerably and two varieties are described, one the var. *minor* with smaller, pale lavender flowers and narrower leaves (*Botanical Magazine*, T. 5987), and the var. *violascens*, red, with bright violet flowers.

The plant is widely distributed in Sierra Leone and Lower Guinea, as far as Angola. I cannot find that it has ever been cultivated in any quantity anywhere even in West Africa. The plant was cultivated in Demerara some years ago and throve there, producing fruit 5 in. long, but I find no record of the plant being there now, in referring to the Garden reports of British Guiana, Surinam, etc.

History.—This spice was, it appears, earliest known under the name *Melegetae*, a word derived from Melle (Meli or Mely), a name for an empire in the upper Niger country, formerly inhabited by the Mandingos. The word is also commonly spelt Melegueta, Mellegette, Mallaguetta, Manigeta, and Maniguetta, and the country whence it was obtained was called by the Portuguese Terra de Malaguet, or Costa di Maniguetta, and also was known as the Grain Coast, or Pepper Coast, from this spice.

It does not appear that the spice was known to the ancients, and the earliest record of it is in an account of a festival held at Treviso in 1214, in which an imitation fortress, held by twelve ladies and their attendants, was besieged by assailants armed with flowers, fruits, sweetmeats and spices, among which Melegetae are mentioned.

After this period there are many records of the use of Meleguetta, showing that it was of common occurrence in commerce. Nicolas Myrepsius, physician at the Court of Emperor John III. at Nicea in the thirteenth century, prescribes Menegetai. Grana Paradisi was enumerated among spices sold at Lyons in 1245, and by the Welsh physicians of Myddvai, under the name of Grawn Paris.

In the early days the spice was conveyed overland from the Mandigo country through the desert to Tripoli and shipped by the Italians from the port of Monti di Barca on the Mediterranean coast, and as they did not know whence it came they called it Grains of Paradise.

Towards the middle of the fourteenth century there began to be commercial intercourse, direct by sea, with Western Africa, and ships were sent there from Dieppe (1364), and, loaded with ivory and Malaguette, sailed from the mouth of the river Cestos (Sestros).

In the sixteenth century English voyagers traded to the Gold Coast for gold, ivory, pepper (doubtless that of *Piper Clusii*), and Grains of Paradise.

Trade.—Grains of Paradise are chiefly shipped from the settlements on the Gold Coast, the most important being Cape Coast Castle and Accra.

The official Blue book for the Colony of the Gold Coast in 1871 gives the exports as 191,011 lbs. (1,705 cwt.), of which Great Britain received 85,502 lbs., the United States 35,630 lbs., Germany 28,501 lbs., France 27,125 lbs., Holland 14,250 lbs. In 1872, 620,191 lbs. were shipped, valued at £10,303: in 1875 the export fell to 151,783 lbs., valued at £912.

Uses.—Grains of Paradise seem chiefly to have been used in the early days as a substitute for pepper, and according to Pomet (*Livre des drogues*) as an adulterant by pepper dealers. It was an ingredient in the spiced wine known as hippocras, and in more recent times used to give an artificial strength to wines, beer, spirits, and vinegar. Though it is by no means an injurious drug, an Act was passed in the reign of George III. that no brewer or beer-dealer should have any Grains of Paradise in their possession, or use it in making beer, under a penalty of a fine of £200, and any druggist selling it to a brewer was fined £500.

The use of it is not, however, so great nowadays as it was in medieval times, when it was one of the main exports from Western Africa.

It is probable that then the shorter distance which it had to be conveyed, as compared with that of the black pepper of the Indian region, caused its trade to be so extensive, especially as from the same region Guinea pepper (*Piper Clusii*, DC.), was exported in some quantity, though it has long ago disappeared from our markets.

Melegueta has, however, always held its own as an independent spice, and Queen Elizabeth is said to have been very partial to it.

Cultivation.—I have no record of its cultivation commercially anywhere, but it could doubtless be easily cultivated in the same way as cardamoms, were there a sufficient demand for it. The wild plants, however, seem sufficient to supply all that is needed for the trade.

CHAPTER X

CARDAMOMS

THERE are several plants of the order *Scitamineae* which produce spices known as cardamoms, and as such are, occasionally at least, known in trade. By far the most important, however, is the plant known as *Elettaria Cardamomum*, the Malabar and Ceylon cardamoms, and this plant will here be discussed first, as it supplies the greatest part of the cardamoms of commerce and is apparently the only one ever cultivated.

Elettaria Cardamomum, Maton.

The Malabar or lesser cardamom is a herbaceous plant belonging to the order of gingers (*Scitamineae*). It has a tolerably thick, rather woody rhizome, from which arises a number of leafy stems about 7 to 9 ft. tall, forming often a thick clump. The leaves are lanceolate acuminate, dark green, glabrous, or more or less pubescent above and puberulous beneath, 1 to 3 ft. long, and 3 to 6 in. across, sheathing at the base, and villous at the top of the sheath. The flowering stems rise from the root-stock or rhizome, and are 2 or 3 ft. long, slender with rather large green bracts, and numerous flowers in short 2 to 3-flowered racemes. They open singly or two or more at a time, and are rather attractive. The calyx tube is green and 1½ in. long, and the corolla lobes, narrow and spreading, are pale green, ½ in. long; the lip is ⅔ in. long, obovate, spathulate, clawed with waved margins, pure white with violet-purple streaks radiating from the centre. The fruit is globose, ovoid, or oblong, more or less three-sided and slightly ribbed, pale buff when ripe. It splits into three valves of a thin papery texture, each cell of the fruit containing 5 to 7 dark brown aromatic seeds. The seeds are about 2 lines long, irregularly angular, and transversely wrinkled. There is a good deal of variation in the size and form of the fruit, and they are sorted in commerce according to their forms.

There are two distinct forms or varieties of the plant, viz. var. *minus*, the Malabar cardamom, a taller plant with narrower and less firm leaves and globose fruits from $\frac{1}{5}$ to $\frac{9}{10}$ in. long, greyish yellow or buff in colour. This is confined to Southern India. Var. *majus* with shorter stems, broader leaves and oblong fruit, from 1 to 2 in. long, and rather narrower than the Malabar fruit, distinctly three-sided, often arched and dark greyish brown when dry, the seeds larger and more numerous, and less aromatic. This is the Ceylon cardamom, and is peculiar to that country. (This variety of cardamom must not be confused with the *Cardamomum majus* of Arabia, a name applied by some old writers to *Amomum Korarima*, a native of Africa and a very different plant.)

Mr. T. C. Owen, in his *Notes on Cardamom Cultivation in Ceylon*, mentions three varieties which he calls the indigenous Ceylon, the Malabar, and the Mysore. He says that the easiest method of distinguishing the first two is by the colour of the stem, which in the Malabar plant is green or whitish at the base, while that of the Ceylon form is distinguished by a pink tinge deeply marked at the base, and more or less traceable up the leaf-stalk for the whole way (presumably he means the leafy stem). This character forms an excellent one for selecting seedlings.

The Mysore form is known by its robust habit, larger and coarser leaves of a darker green, hard and smooth on the under surface, and not soft and velvety.

Its most remarkable feature is that the racemes instead of spreading over the surface of the ground are borne perpendicularly from the bulbs, and the fruit grows in clusters of five and seven. This form is best suited for growth at higher elevation than the Malabar, and stands exposure and wind better. The value of the produce is not less than that of Malabar.

The best figure I have seen of the plant is the original one in White's *Malabar Cardamom*; there is also a tolerably good coloured figure in Trimen's *Medical Botany*, but the figure in Schumann's *Zingiberaceae* published in the "Pflanzenreich" is hardly recognisable. Schumann distinguishes the forms above described, viz. the varieties *majus* and *minus*, as species, which I think can hardly be maintained. There is also a photograph of the plant in the *Journal of the Horticultural Society*, vol. xxxviii. fig. 137.

HISTORY

There was a spice known to the Greeks and Romans as *cardamomum* and *amomum*, but it appears to be certain that these spice plants, whatever they were, were not the cardamoms of the present day, although the name of this spice, as we know it, is evidently taken from these words.

The spice was known to Indian and Arabic writers in very early times. The Indian writer Susruta (about the eighth century) mentions it under the Sanskrit name Eta, which with variants is the prevailing name over India and Arabia, and it is mentioned in the list of spices liable to duty at Alexandria in A.D. 176-180. It was mentioned by Edrisi as a production of Ceylon about A.D. 1154, and was probably a trade spice in Europe long before that, though there is no definite record of it. Marco Polo does not mention it in his travels. Barbosa, the Portuguese traveller, mentions it as a product of Malabar coast in 1514. Linschoten mentions both the lesser and greater cardamom as used in Southern India. Of the former he writes: "It most groweth in Calicut and Cananor" (places on the coast of Malabar). The greater cardamom he refers to is doubtless the Nepal cardamom.

Garcia da Orta writes of the two true cardamoms, and says that the long cardamom comes from Ceylon.

The spice, as imported, was for very many years obtained from wild plants, both in Malabar and Ceylon. The custom was to fell the trees and cut down the brushwood, only a few big trees being left as shade, and the seedlings of the cardamoms were left to spring up. When ripe the fruit was gathered. The ground was cleared of brushwood every year till the plants were exhausted, and then the spot was abandoned and a new clearing made. This system was in use as the only method till 1803 at least, as mentioned by White in his paper on Malabar cardamoms.

The demand, however, of later years being too large for this method sufficing for the supply, cultivation on a large scale became the rule, and it has since been an important industry in Ceylon and India.

see Laufer: Sino-Iranica p.

NAMES

Most of the Indian names of the spice are derived from the Sanskrit *Eta*, such as Elachi (Hindu and Bengali), Yelaki (Kanarese), Eletari (whence the name of the genus *Elettaria*), Malabar Pala, Bhala (Burmese), Hila (Arabic). The name in Ceylon is Ensal or Enasal. The European languages use variants of the Greek Cardamomon, which as previously stated was originally applied to some totally different plant.

The Malays use the word Kapulaga.

CULTIVATION

Soil.—The plant being naturally an inhabitant of the forests, requires a soil rich in humus. White describes its locality in Malabar thus: "Lofty hills whose summits are ever clothed with clouds, a moist atmosphere, or copious rains for three-fourths of the year, and an exposure admitting but a limited proportion of sunbeams are the circumstances which the natives tell us, and experience proves, are most favourable to its growth, and are the sole requisite for an abundant crop."

Owen says of the Ceylon cultivation: "Fine, rich, loamy soil is absolutely essential for the successful growth of cardamoms, and this is usually found in the situations most favourable to their growth—sheltered moist hollows. The plants will grow on ridges and in inferior soil, but their fruiting powers are but small and their growth stunted. It is, therefore, unadvisable to plant large blocks with them, as a considerable proportion of the land cannot fail to be unsuitable. The most successful method is to devote the banks of streams and damp hollows alone to cardamom cultivation, planting the ridges and all exposed or poor land with some hardier product." Very damp spots, waterlogged or periodically flooded, will not suit the plant. Stiff clayey soil is equally unsatisfactory. In such places, though they may grow luxuriantly, they will give but little fruit.

Climate and Altitude.—The plant is strictly a tropical one, but seems never to have been very successful south of Latitude 7° nor north of Latitude 25°. It requires a hot, rainy region, with a rainfall of 100 to 121 in. a year, and a mean temperature of 72° Fahr. The Indian varieties are found indigenous at an altitude of between 2,500 ft. and 5,000 ft. The Ceylon variety occurs chiefly in the low country. It has not been successful in the low country of the Malay peninsula, which is farther south, and has a truly equatorial climate, with heavy and continuous rains, and a somewhat higher mean temperature.

At the higher elevations the plants take longer to come into bearing and seem very backward for a year or two, but when they come into bearing fruit freely, says Owen. The robust Mysore variety grows and fruits at a higher elevation than the Malabar one. The general idea seems to be that cardamoms are typical hill plants, and that a certain altitude must be selected for their cultivation. That altitude, apart from the accidental circumstances of difference in temperature and possible rainfall, has a distinct influence on plant life in the tropics seems clear, but the cause of this is at present obscure.

Wild Cultivation.—In the early days of cardamom cultivation, if cultivation it can be called, the system in Malabar, and also in Ceylon, was merely a system of helping the wild cardamoms of the forest to increase in numbers, and to produce large crops by clearing away the forest round them. This system seems to be still adopted in Coorg.

It is described by White in the paper previously quoted thus :—

> The months of February and March are, on account of the prevailing dry weather (in Malabar), selected as the most proper for commencing their labours; the first part of which consists in cutting down the large and small trees, promiscuously leaving of the former, standing at nearly equal distances, certain tall and stately individuals, adapted to that degree of perpendicular shade which experience teaches them to be the most favourable for the future crops. They affirm, and with some reason, that no little exactness is required in hitting this prolific medium, for as too much sun burns up, so does excessive shade alike disappoint the hope of harvest. The grass and weeds are then cleared away, and the ground disencumbered from the roots of brushwood; the large trees lie where they fall. The shrubs, roots, and grass are piled up in different small heaps, and their spontaneous and gradual decomposition fertilises the space they cover.

He notes here that Pennant's statement that the ground is manured by the ashes of the rubbish when burnt is an error. It is obvious, indeed, that if the cardamom seed and rhizomes were already in the ground there would be a great risk of destroying them if fire were used, unless with great care in definite spots. The decomposition of the weeds and shrubs *in situ*, though slow, is certainly less wasteful than burning them. In some forests there would be too much of this undergrowth to be left on the ground even in piles, and some would have to be removed in some way. The system of leaving the weedings, branches, etc., just pulled into heaps or lines if abundant, or left where it falls if scanty, is the plan adopted in the cultivation of gutta-percha, a shade-lover in the Malay peninsula, and I have cultivated nutmegs, cloves, camphor, and ramie in the same way. The ordinary planter, however, has a horror of seeing rubbish left on the ground, and prefers an extensive and thorough conflagration, which is, of course, impracticable where shade trees are to be left.

The Malabarese, according to White, recommend it as an infallible sign of fertility if the large trees on falling cause a trembling of the soil, and this he accounts for by the fact that where the soil is of great depth with a spongy mass of roots or fibres the shock of a big tree falling will be felt, while where there are strata of rocky or gravelly nature it would be less readily noticed, and thus the trembling of the earth shows that the soil is rich and deep. Ludlow, in talking of the tradition among the Coorgs, says that in olden times the people noticed that it only grew in places where the ground had been shaken by the fall of some large tree or of a large branch thrown down by the force of the wind, especially when this had happened a short time previous to the falling of the annual showers in March and April.

In imitation of this during the months of February and March they selected in their jungles the largest trees and felled them, previously cutting down all the smaller surrounding trees and brushwood, which would otherwise have lessened the shock given to the ground. The mere clearing of the ground and letting in the light would account for the springing up of the plants, if their rhizomes and seeds were in the ground. Scitamineous plants frequently appear in abundance on the felling of the jungle, and letting the sun and breezes into patches of forest where the plants previously appeared scanty and weak. In this way I have seen considerable areas in the Malay peninsula, which had been felled, covered soon after with a dense forest of wild bananas to the exclusion of almost everything else.

The Coorgs, says Ludlow, have many signs by which they are more or less influenced when selecting sites for new gardens. Many know the good jungles by tradition from their ancestors. In a doubtful jungle they will fell a few trees here and there, and judge the following year of its capabilities as a cardamom jungle by the presence or absence of young cardamom plants near the felled trees.

In Travancore, the author of the *Madras Manual* states that the cardamoms grow spontaneously in the deep shade of the forest, and the owners of the gardens come from the low country east of the Ghauts to cut the brushwood and burn the creepers and otherwise clear the soil for the growth of the plants, early in the season, so as to be ready by the advent of the rains. They return to gather the crop in October and November, and a writer in the *Madras Mail* says that the plants will only grow in certain places, and the presence of a few wild plants safely indicates that the soil will suit the cultivation. The ground is cleared of all undergrowth and the seeds are sown before the monsoon. In October, when the young cardamoms spring up, it is necessary to thin them out where they are too crowded, and to sow the ground with seed where they are too sparse (Watt's *Dictionary*).

For the next two years, according to the writer in the *Malay Mail*, and for four years, according to White, nothing more is done except to put a fence around the clearing, though in some places the cultivator weeds over the ground in the following year.

The plants commence flowering about two years after the ground is cleared, and ripen some fruit about five months later, but a full crop is not got till at least a year later, so that it is about three and a half to four years before a full crop is obtained. The process of weeding is continued annually as long as the plants bear, or as long as they require weeding. As in the first instance, according to White, the weeds are piled up in heaps to rot and are not burnt.

Owen in his notes on Cardamom cultivation says that

> Weeding of a cardamom clearing except the first clearing is a matter of small moment. When the plants are young, the ground should be gone over whether the ground is naturally weedy or not, every two or three months. In most cases, intervals of two months are not too long, a few weedy corners being cleaned oftener. In about two years' time, when the plants cover the ground, no weeding at all is necessary or advisable, for the fewer coolies that are allowed among the fruiting plants the better for the proprietor. It is unadvisable to give the weeding of a cardamom clearing out in contract at any time; a few coolies sent when other works do not press are sufficient. The important part is the weeding of ravines; these should be drained and planted if possible, but in any case must be kept thoroughly clean. If planted with grass, or allowed to remain full of jungle stuff, they harbour vermin, which are most destructive to the crop.

Mixed weedy herbage on the edge or in corners of an estate of any kind is most objectionable. Such places in the tropics are the breeding-grounds of grasshoppers, crickets, beetles, and slugs, which from such points attack the crops by day and night. It is better to plant waste spots where the cardamoms will not for some reason grow with fruit trees, bananas, betel-nut palms or some such plants. The amount of vermin that these neglected weed patches will harbour is often astonishing.

When the plants begin to flower it is advisable to clear off all dead and dying stems. In this class of Zingiberaceous plants, the leafy stems soon attain their maximum growth, and after a period often of some months the leaves begin to turn yellow, the stalks brown, and finally the whole stem dies and becomes dry, disjointing itself at last where it joins the rhizome. Its work is finished when the leaves become yellow and droop, and it may then be cut off to avoid encumbering the young shoots and interfering with their growth.

Mr. D. T. Evers writes an interesting article on the subject of cardamom cultivation in the number of the *Indian Forester* for 1908, which is quoted in the *Agricultural Journal of India*, vol. iv., 1909, p. 103. The plant is said to grow well in moist places in the Forest Ghauts of the Mansarabad and Belar Taluka of the Hessan district, but does not thrive on the Southern and Western exposures. It comes up spontaneously in the ghaut forests when light is admitted by the felling of some large trees. It is a general belief that the seed which induces such growth is disseminated by monkeys and rats. The cultivation by some planters is considerable; nearly all coffee estates have fair-sized areas under this crop on partially cleared forest land.

There are two methods of cultivation: (*a*) the Brook-Mockett and Middleton system, recommended by these two planters, and (*b*) the Coorg system. In the former the forest is thinned out to admit sufficient light, and nursery-raised seedlings used to plant out the cleared area. The crop begins to yield in the third or fourth years and is in full bearing in the fifth or sixth. Irrigation if available is useful at some seasons and weeding is required.

The Coorg system has been already mentioned, but I repeat Mr. Evers' remarks, as there are some slight differences and additional ideas:—"Small detached areas in which the plant has come up naturally are carefully selected. In February to March small trees 2 or 3 ft. in girth and brushwood are cleared away. The leafy canopy should not be too dense, and it may be necessary to fell one or two large trees across each plot. The seedlings make their appearance at the first burst of the monsoon, and by its close are 3 or 4 in. high. At the beginning of the following monsoon they are thinned out where overcrowded and vacant spaces are stocked. The plant yields in the fourth and fifth year according to the richness of the soil. They continue to produce good crops till the fourteenth year, when they begin to decline and die. Then the soil has to be renovated by felling one or two large trees across each small plot."

Garden Cultivation is recommended in places where the forests have been so effectually destroyed that the method of cultivation described above as wild cultivation cannot be adopted. Cardamoms can be grown as a crop in shaded gardens and orchards, and this system is in use in Kanara. Here it thrives under the same conditions of soil, etc., as do the betel palms and pepper grown in that region, but by preference in cool, very shady gardens with soil kept continually moist. The essential conditions are a soil of clayey-loamy consistence kept by favourable position moist, but not wet, at all seasons, and that the garden should by its natural position be shaded by trees and protected from strong winds.[1] It appears that the plant is never cultivated alone in the North Kanara hill gardens, but in mixed gardens of betel-nuts, pepper-vines, and bananas. In a fully stocked betel-nut garden there can be grown 300 to 400 plants per acre.

Propagation.—Cardamoms are cultivated both by root cuttings and by seed. It is said that it is usual in Kanara to use cuttings in old gardens, seedlings in new ones. In India, on the whole, it seems more usual to raise the plants from seeds, in Ceylon from cuttings.

Rhizome-Cuttings.—The rhizome-cuttings called "bulbs" in Ceylon are usually purchased, says Owen, from natives at prices varying from 10 to 25 rupees per thousand. The natives are very careless about taking them up, and many of the bulbs are mutilated and should be rejected. When taking them from an estate it pays well to exercise some amount of care in cutting or breaking the bulbs off. A stool is selected which is not fruiting, and a hole is dug a few inches from it about 1 ft. deep; the earth is then cleared away by hand from underneath as much of the plant as is required, and this part of the rhizome is bent over till it breaks off naturally. In many cases the use of a knife is not required, but

[1] Mollison, *Agric. Ledger*, 1900, 31, 107.

sometimes one or two cuts are necessary; the separated portion is then broken up into bulbs by hand. The objection to this system is that the wounded side of the plant takes a long time to recover, and frequently such plants continue to bear on one side only.

A better system is to select and mark out a portion of the clearing, and uproot the whole of it. The clumps are then broken up into sets, some of which can be used for replanting.

In buying "bulbs" from natives, Owen cautions the planter to take care to see that inferior plants are not mixed with the true Malabar cardamoms, as this may cause much loss and disappointment. The velvety feeling on the under surface of the leaf and leaf sheath and the pure white or greenish colour (not tinted with pink) of the bulb distinguishes the right Malabar. "Double bulbs" alone should be bought. These consist of two stems connected together, and should have a shoot or two springing from the leaves. Such bulbs consisting of a single stem and a bulbous base, even if offered cheap, are worthless and sure to fail. A single bulb, however, with a well-developed shoot springing from it, if not denuded of all its roots, will probably succeed. The bulbs should also be fresh, for although the rhizomes retain their vitality for a long time under adverse circumstances, yet the fresher they are the better. The dealers in bulbs buy them in small lots at one rupee a hundred, and in the case of large orders, have to get them from numerous localities at once, so that it frequently happens that a portion of the bulbs deteriorate greatly before the full complement of the order is obtained.

Rhizomes can be purchased through the Botanic Gardens at Peradeniya and through European dealers in plants in Ceylon and India, by which means the best bulbs fit for planting may be obtained. It does not pay in the cultivation of cardamoms or anything else to take inferior stock because it is cheap; it usually eventually turns out much dearer.

Owen said that the most successful planting he had was from shoots of growing plants with a few roots attached, which came on without a failure. It would be difficult to get a large quantity of these at the right stage, but the younger the bulbs the better. He suggests the following plan if time is no object and can be afforded. Plant the bulbs in a nursery uncovered, and water them when necessary. If left in long enough they will throw out shoots which can be broken off with a few roots attached and will succeed admirably.

In India the plant is more commonly grown from seed, but an account in Rice's *Gazetteer* (quoted in Watt's *Dictionary*) says, referring to Mysore, that they are propagated entirely by cuttings. A cluster of from three to five stems with the roots attached is separated from a clump in the month following the autumnal equinox, and planted in the same row, one between every two areca-nut palms in the spot from which a banana plant has been moved.

The ground around the plant is manured with leaves of the *Phyllanthus emblica* tree. The plants fruit in the third year in the autumnal equinox, and after fruiting the plants are dug up, separated, and planted in fresh places, all superfluous stems and roots having been previously removed. The stems all die and new ones spring again. The plant does not fruit the year following its transplantation, but the year after that, after which it is again taken up and transplanted as before.

Raising from Seed.—The seeds of cardamom are contained in capsules, and it is necessary when raising a plant from seed to select only perfectly ripe fruits. When ripe the capsules are of a yellowish colour and readily split into three valves. By squeezing the ripe capsules the seed is discharged, but it adheres together by a glutinous substance, composed mainly of the arils. To free them from this mass and cause them to separate readily it is necessary to expose them to the sun or a current of air. The former is the most effectual and they soon become dry. The seeds are then readily separated, and after being steeped in water for a short time can be sown in the nursery beds.

Some persons recommend mixing them with ashes before sowing, as they are so small, and this enables them to be more evenly distributed over the seed beds.

Nursery Beds.—The beds for the seed require careful preparation. The soil must be well tilled until it is loose and friable, and should be well manured. The manure should be old and well decayed, so that it can be readily crumbled into a fine powder. Mollison recommends leaf manure as the best, and it is indeed the most natural manure for a plant whose habitat is the leaf-soil of the forest, but cow-dung, if finely mixed with the soil, is also a very suitable manure. The nursery beds are about 8 ft. long by 4 ft. wide, and about 2 tolas of seed are required for a bed of this size. The seed is sprinkled loosely over the bed and a small quantity of soil thrown over them.

The beds then require protection from sun and rain. Fronds of ferns stuck in the ground may be used to shade them, and have been found to form an effective shade in Ceylon, but it is better to shelter them by a water-tight roof about 3 or 4 ft. high, composed of thatch or Kadjangs or attaps, a roofing made locally of the leaves of screw pines (*Pandani*) or palms. In Kanara a platform is made over the beds and covered with branches, or the branches are simply laid over the nursery beds, and this is the only protection given if the seed bed is otherwise well protected from rain and wind. This, however, I would not recommend, as it often occurs in cases where the branches are laid directly on the bed that they form hiding-places for snails and other vermin. It is better to raise them on the platform.

In Kanara, Mollison says that the branches of the tree *Phyllanthus emblica* are considered the best for laying over the beds. The cultivators allege that the leaves and branches of this and certain other trees prevent insect attack. The trees preferred are all rich in tannic acid, and Mollison suggests that this may be poisonous or deterrent to insects.

Several writers have recommended an artificial germination of the seed in a closed tin case, the lid of which is kept close to exclude light and air as much as possible. The seeds are placed on a piece of flannel or cloth, and kept moist by a layer of saturated soil below. The seeds, when they have germinated, should be shaken off the cloth on to the surface of the nursery bed, and covered with fine soil (Watt's *Dictionary*).

Seed if sown on a nursery bed take a month to germinate according to Moller, but the Director of Land Records for Bombay states that they take in Kanara three months. Owen, in dealing with them in Ceylon, says that the time depends on the temperature, that is the elevation, entirely. In the low country the seed will be above ground in three weeks, whereas at an elevation of 4,000 ft. it takes as many months or even longer. It is therefore, says he, advisable to make the nursery at as low an elevation as possible if for Malabar seed, indeed a successful nursery at high elevation is very improbable, the plant being very slow of growth and damping off in a very disheartening way. Mysore cardamoms are on the contrary comparatively easily grown from seed. The seeds are sown in Madura and Kanara from July to October, apparently usually in the latter month, which is the usual time for ripening.

The seedlings are very delicate, and very liable to damp off when young, and as, furthermore, a large proportion of the seeds do not germinate, a considerable excess of seeds is required for the nursery beds.

Owen gives the following calculations:—1 lb. of fresh fruit will be found to contain on an average 776 capsules, each containing on an average 16 to 17 seeds. Thus 1 lb. of fresh fruit contains 12,804 seeds. 10 lbs. of fresh fruit produces $2\frac{1}{2}$ lbs. of seed, and 1 lb. of seed contains about 50,000 seeds, of which, however, only a small proportion germinates.

Shading.—There seems to be a consensus of opinion that cardamoms require a certain amount of shade. Plants grown in full sun seem to deteriorate soon, and even if some plants thus grown do develop rapidly the racemes do not grow to any size, only extending to a few inches in length, in fact only as far as the shade of the foliage extends. If the method of growing in clearings in forests is adopted, a certain number of trees are left standing to make a light shade, and it is advisable to have this light shade too dense at first to allow for death of trees or loss by wind. The loss of trees after clearing brushwood and small timber away, and letting the light into the forest, is always greater than might appear likely, and a large proportion of the trees left standing will be certain to die after thinning out. It is easy to thin out the trees if the shade is too dense at a later period. In many parts of India, *e.g.* in Kanara and Mysore, the plant is grown between betel-nut palms or bananas, or in gardens of mixed cultivation where the other cultivated plants give it the requisite shade.

In such a cultivation as this, it is undoubtedly best to select a piece of ground upon which there are a number of trees already. Secondary growth of small trees is suitable, if procurable. Failing this, it will be requisite to plant rapidly growing shade trees, such as the rain-tree, *Inga Saman*, Saga, *Adenanthera pavonina*, *Albizzia moluccana*, or the like. As trees to give shade are naturally slower in growth than the cardamoms, they should be planted as early as possible. In selecting the best trees for rapid growth, the planter will have to use his judgment to a considerable extent, for a tree which is of rapid growth in one country or at one altitude is not necessarily suited for another region or height. It may grow in one place more slowly or not at all, while in another it grows with great rapidity and is in every way suitable.

Draining.—The extent and depth to which drains should be dug depends on the nature and slope of the soil. In flat wet land they will require to be 2 ft. deep at least. In some grounds, with a good and not too abrupt a slope, drainage is hardly necessary, except for a few surface drains to run off the rain as it falls, and to dry the roads through the estate.

Planting Out.—Seedlings must not be transplanted too young, as they are very delicate and do not bear transplanting well. It is therefore advisable to sow the nursery beds thinly, so that the plants may be allowed to become of a good size, about 1 ft. tall, before shifting. If planted too close they interfere with each other's growth, and it is difficult to move them without injury to the roots. Should the seedlings be found to be coming up too closely, it is advisable to prick them out into baskets ready for planting out when they are big enough. This is better than shifting them into other beds, and transplanting later. In all plants, especially those of a herbaceous character, the less you interfere with the roots by shifting the better, and this is most important in the case of young seedlings.

In any case, even if crowded, they should not be moved at all till they are at least 4 in. tall, and have developed the second and third leaves.

In Kanara, the system, according to Mollison, is to thin out the seedlings if they come up too close, leaving the remainder for four or five months in the seed-bed, which is kept moist. They are then transplanted to a second nursery.

Rice-beds in the neighbourhood of the gardens are commonly used, where there is a plentiful supply of water.

A series of narrow channels is cut in the rice-bed parallel to each other, and 2 to 2½ ft. apart. The soil from the furrows is put on the ridges between, so that a series of ridges and furrows is formed over the whole space. On the ridges the little cardamom plants are planted in two rows, and 9 to 12 in. apart. A shade of bamboo covered with palm leaves tied on gives enough shadow and protection from the wind and rain. The irrigation water is allowed to run through the channels continuously, keeping the ridges moist, not wet, during the drier season, but during the monsoon steps must be taken to run the drainage and irrigation water away from the fields. The plants are kept in this field for from fifteen to eighteen months, by which time they are 4 ft. high, and ready for planting in a permanent position.

The planting usually takes place in two seasons in Kanara, viz. from March to June, and from September to October, but in places where there is no dry spell of weather they can be planted at almost any time.

Where the plants are cultivated between betel-nut palms as in Kanara, they are usually planted between each pair of palms, at an equal distance from each, so as to alternate with them. The number of plants to the acre varies according to the closeness of the shade trees, whether betel-nuts or orchard trees. In Bombay, according to Watt's *Dictionary*, the number of seedlings required for an acre differs much in different parts. "In Sirsi, about 1,000 seedlings go to an acre, while in Yellapur the number required is 650." Mollison says "in a fully stocked betel-nut garden there can be 300 to 400 cardamom plants per acre." Owen, in his estimates for planting in Ceylon, puts down 37,500 good double bulbs as requisite for 25 acres, *i.e.* 1,500 an acre, but this is allowing 50 per cent for supplies. He remarks on this that 50 per cent supplies may seem large, but it is very likely to be required where the bulbs have to be carried far. This in these circumstances works out 750 an acre, but in Ceylon the plants are to be grown under shade trees, and not interplanted with betel-nut palms in a close grove where much of the area is taken up by the palms. Watt gives their distance apart as from 6 to 12 ft. according to the soil.

In planting, the holes or pits for the reception of the plants should be 18 to 24 in. across each way and 12 to 18 in. deep. The soil mixed with leaf mould and finely broken up is returned to the hole, the seedlings planted, and the soil filled in round it almost to the top of the hole. Care must be taken not to plant the rhizomes too deep, and to allow for the earth settling and sinking some inches.

It is advisable to support the leaf stalks with stakes to which they are attached with plantain bast, or some such fibre, in order to prevent their being beaten down by wind or rain, especially if the position is much exposed. In well sheltered spots this is less necessary.

Weeding and Manuring.—There used to be, it appears, a popular idea that weeds did not grow under the shade of cardamoms, but, at least for the first year, some weeding is necessary. After the cardamom fields are well and densely grown, weeding becomes unnecessary, as the plants crowd out the weeds. Some amount of clearing up, removing dead stems, and weeding is usually required about the end of the second or third year. A single rhizome will produce as many as twenty stems or more, and these stems die after a few years, and are replaced by new ones.

Manure does not seem to be often used anywhere, but in Bombay it is usual to give leaf-manure in March and April of each year, if the supply is abundant, but if not it is supplied every second year.

There is little else to do besides keeping a look-out for pests and blights till the plants commence to fruit, which takes place in the first year after planting out, or about three years from seed.

CROPPING

The first crop is usually a small one, the second one a partial crop, and the third, that is five years after planting, a full crop.

The smallness of the first crop is accounted for by several causes. The plants have not, by the third year, fully developed, and have only a few leafy stems. The supplies are not yet in bearing, and those that are fully developed for their age are more liable to the attacks of insects and other enemies. Probably, also, a large proportion of the flowers are unfertilised. The flowers of this plant are fertilised by insects, and it frequently happens with plants in the tropics that the first flowers produced by a plant, especially if new to its locality, fail to set fruit, as the insects which can and do fertilise it appear not to have found the flowers.

There does not seem to be any record from Ceylon or India as to what insects fertilise the flowers, but it is probably effected by some species of bee or possibly a fly.

In the Singapore Botanic Gardens I found a *Dipteron* visiting the flowers, from which it was sucking honey, licking with its long tongue the purple streaks on the lip and the base of the stamen. The fly was $\frac{1}{4}$ in. long, mostly dull ochre yellow, the eyes, centre of thorax, and six longitudinal lines down the abdomen black. It is one of the fruit flies (*Dacidae*). I did not see it actually fertilise the flowers.

The importance of the attendance of the fertilising insect at the right time must be very great, and its absence probably accounts for the smallness of the crops on some occasions.

The plants flower somewhat irregularly in Kanara in April and May; in Ceylon almost all the year round, but chiefly from January to May. Those grown in the Singapore Gardens flowered in the early part of the year, but continued rather irregularly till much later.

The fruits form in June and July, and ripen in August, or the beginning of September, lasting till April in Ceylon, from September to December being the heaviest cropping time. In Bombay they chiefly ripen in September and October.

They are said to require light showery weather during the season of flowering; absence of this causes a failure to crop, and Mollison recommends protecting the growing fruit by a light covering of leaves and brushwood when the rains are heavy during ripening.

As the flowers on the scape do not appear simultaneously, but in ones or twos at a time, the fruits on a scape are not all ripe at a time. There will be blossoms and immature fruit with the ripe fruit on the same scape.

The scapes, in fact, go on producing fruit for at least a second season.

GATHERING

It is common among Indians, and indeed also among European cultivators, to pull off the whole racemes, thereby wasting all the fruit which is unripe, and therefore valueless at that time. This is extravagant and wasteful, and only the capsules absolutely ripe should be gathered, the rest left to ripen for a second picking.

The capsules, when ripe, are known to be so by their turning from green to yellow, and should be full and firm at that time.

It has been found that cardamoms when plucked are apt to split in drying, and even the pressure of the fingers may crack them. When fully ripe they split of themselves, and as the least touch then causes them to fall, it is necessary to gather before they have turned to the deep yellow of full ripeness.

The seeds, however, turn black and develop their full aroma before the fruit is absolutely ripe, but has begun to turn yellow. Considerable practice is necessary before the coolies can tell what is ready for collecting and what is not yet ripe. To obviate the splitting during drying, the fruit should be cut off with a small portion of stalk attached. In Ceylon this is effected by the use of a specially made pair of scissors. The ones recommended by Mr. Owen have very short cutting blades 1 in. long, with handles 4 in. long.

The work of collecting with these scissors is long and tedious, and the coolies dislike it, and are apt to get careless in their work. The method is to hold the raceme in the left hand while the ripe fruits are clipped off. The fruit should not be held in the hand, as it might split if it was fully ripe.

The fruits out of reach of the scissors among the shoots and stems must be pulled off, but this does not amount to a very large percentage.

It would of course be much easier to cut the racemes off, and clip the ripe fruits off afterwards, but by this means a great deal is wasted, as the unripe fruit on the raceme has to be thrown away.

A good coolie accustomed to the work can pick from 12 to 15 lbs. of fruit a day, but 8 to 10 lbs. is the average picking.

PESTS

The Cardamom Butterfly (*Lampides elpis*, Godart).—A complete account of this the worst pest of the cardamom plant is given in *Indian Museum Notes*, vol. i. p. 11, from observations made by Mr. T. C. Owen in the notes on cardamom cultivation, and from letters by Mr. E. Green.

Mr. Owen writes :—

> Of the enemies which attack cardamoms the most serious is an insect which bores a circular hole in the capsules, and clears out the inside. Young plantations seem more liable to this pest than older ones. In the former case as much as 80 to 90 per cent will sometimes be attacked and destroyed in this way: proximity to patana seems also the cause of increased liability to these attacks. Applications of lime, wood ash, or anything of a like nature are said to be beneficial.

Mr. Owen was unable to discover what the insect was that caused the damage, but Mr. Green succeeded in finding an adult larva in one capsule, and bred it out into the beautiful little blue butterfly, *Lampides elpis*, a very common insect over the Indo-Malayan region, occurring in India, Ceylon, Burma, the Malay Peninsula and Islands.

The male butterfly is about $1\frac{1}{2}$ in. across the wings, of a pale metallic azure blue on the upper side, with a narrow black border to both wings; the hind wings have sometimes a series of black marginal spots, and there is always a short, black tail with a white tip near the anal extremity.

The female is dull (not metallic) bluish white on the upper side, the outer black borders much broader, and the black spots on the lower wings considerably more prominent. The under side in both sexes is pale brownish, crossed by numerous more or less broken prominent white lines. It is very abundant in the cardamom fields, and at low elevations flies all the year round, and there is probably a constant succession of broods.

The female probably lays its eggs on the flower buds of the cardamoms (as an allied fruit-eating blue butterfly does), and after a few days the larvae commence to burrow into the young fruit and to devour the centre.

The full-grown caterpillar is described by Mr. Green as ·55 in. long, dull pale green, tinged with red on the dorsal area, with three reddish dorsal stripes, minute black spiracles and a small brown head retracted beneath the second segment. The chrysalis is smooth, pale, dull yellowish brown, marbled and spotted with darker brown, the spots coalescing into three irregular dorsal stripes.

The caterpillar before pupating leaves the fruit, cutting a large round hole in the side. Otherwise, it does not leave the fruit it commenced on unless it somehow becomes unsuitable, when it would seek a fresh one and bore into that.

The caterpillar probably pupates among the leaves and dead stalks. The allied butterflies, however, pass the pupa stage in the fruits. Mr. Green estimates the destruction to be ordinarily from 5 to 10 per cent of the capsules. Mr. Owen, as mentioned above, says that sometimes 80 to 90 per cent of the capsules are destroyed.

There is considerable difficulty in dealing with a pest of this nature. Mr. De Niceville, in the *Indian Museum Notes*, suggests that small boys should be employed with butterfly nets to catch the insects, and should be able to secure the greater part of them in a plantation. The destruction of the gravid females would check the injury very largely.

Boarmia Bhurmitra, Wik.—A brown twig-like caterpillar of this species of Geometer moth was found by Mr. E. Green to have destroyed the foliage of a large number of cardamom plants in Ceylon. The insect really attacked the *Grevillea robusta* trees used as shade for tea plants and the cardamoms, and having devoured all the leaves of the grevillas attacked the next plant they could eat, which happened to be the cardamoms. This is a common occurrence when caterpillars of any kind become so abundant that they too soon eat all their proper food-stuff, and have to supplement the failure by something else. The moth is about $1\frac{1}{2}$ in. across, brown with transverse streaks and dots of darker colour. The case is recorded in Watt's *Pests of the Tea Plant*.

Coccidae.—There is a small but common Coccid which I have found attacking the under side of the leaf of cardamoms. The insects, which are very small, not $\frac{1}{20}$ in. long, are when adult of a reddish brown colour, tortoise-shaped, and bearing all round their bodies a fringe of oblong white powdery wax processes. The adults remain stationary on the leaf, crowded closely together. The young ones move about on the leaf in a more active way. They are more yellowish, with longer legs and less wax on their edges.

In very wet seasons serious losses are sustained by the rotting off of fruit and racemes before maturity. It is probable that this is due to a fungus, but no investigations appear to have been made on the subject.

A so-called disease in the Kanara gardens is described by Mollison. The affected plants become unthrifty; the leaves in part become yellow, and these parts wither and the plants have no vigour of growth. The unhealthy appearance was at first local, but later the disease spread and extended over large areas. This, Mollison thinks, is due to degeneration from continuous planting without change of seed, rotation of other crops, or fallowing. This is very probable, as many of the plants of the ginger family degenerate in a few years if grown continuously on the same soil.

In Kanara borers and grubs are found to cause much damage. They cut through the bases of the leafy stems and bite through the rhizome. "Some of the grubs are identical with the large fat ones commonly found in farmyard manure." These are evidently large lamellicorn beetle-grubs, but no further account of them is given.

It is said that leaf mould made of astringent tree-leaves keeps off these insects.

Rats and wild pigs are in Ceylon and elsewhere very destructive to the cardamoms, and it is said that many cases of snake-bite are due to the hiding of poisonous snakes in the clumps of cardamoms, where they are lying in wait for rats. In the Singapore Gardens squirrels, also, took a part in the destruction of fruits, and also frequently ate the flowers.

For these smaller animals poisoning is perhaps the best treatment. The pigs, which not only eat the fruit but gnaw the rhizomes as well, must be hunted and shot. Thieves in Ceylon are most troublesome, taking bulbs or fruit, according to which is in demand. There is great difficulty in detecting and bringing the persons to justice, even with the aid of night watchmen, who are absolutely necessary in some parts of the country. This form of larceny is common in many plantations, and most legislatures have utterly failed to deal with it at all.

YIELD

The first crop is a small one, but it is said that the individual capsules are larger, and also that the capsules picked earliest in the year are larger than those obtained later in the season.

The yield under favourable conditions is very large. In Ceylon, Owen gives 150 lbs. per acre in the fourth year, and 300 lbs. per acre in the fifth and succeeding years, as the amount which may be looked for.

Mollison says a well-grown, healthy plant may yield up to $\frac{1}{2}$ lb. of dry cardamoms, and at 300 or 400 plants per acre, as grown among betel palms in Kanara, this gives 150 to 200 lbs. dry cardamoms per acre.

In Travancore the yield, according to the *Madras Manual*, only comes up to 20 or 25 lbs. per acre. This is, however, in a form of wild cultivation, where the owners of gardens in forests merely clear away the creepers and brushwood around the plants once a year.

CURING

The object to be aimed at in curing the cardamoms so as to be of the highest commercial quality, is to produce a light straw-coloured fruit with no black or brown spots on it and as little split as possible.

A certain proportion of split cardamoms, composed chiefly of over-ripe fruit, is unavoidable, but our endeavour should be to reduce this to a minimum. The curing of cardamoms is a very simple matter in dry weather, sun-drying being the most effective and cheapest method. Long exposure to the sun during hot weather, the attempt in fact to dry the fruit quickly, is a mistake, for the seed inside gets heated, swells, and bursts its covering. Three hours' exposure in the morning and two hours in the afternoon is as much as it is safe to give. In showery or unsettled weather, of course, full advantage must be taken of whatever sunshine there is. The slower the drying process, the smaller is the proportion of split fruit, and hence too long protracted exposure to the sun or to artificial heat should be avoided. (Owen's *Notes on Cardamom Cultivation.*)

In Southern India as described by Ludlow, the cardamoms are dried by exposure to the sun on large bamboo or date mats. Those nearly dry are not allowed to get mixed with the green ones, and four days in the sun is sufficient if the sun is strong. A shed is required close to the drying-ground in case of rain, so that the capsules can be quickly taken there out of risk of wetting.

Ferguson, in *All about Cardamoms*, says that he hung up a few racemes, with branches and capsules, in a room with a good draught of wind. The cardamoms took longer to dry than if they had been exposed to the sun, but there was no perceptible difference between them and the sun-dried ones.

However, the sunlight would no doubt be of advantage to partly bleach the cardamoms and make them of an attractive colour.

In case of sudden showers Owen suggests putting the drying trays on wooden rails 3 ft. above the ground and to have a tarpaulin covering which can be readily spread over them on the approach of rain. Formerly coffee planters used to have a somewhat similar apparatus for drying the coffee, which, however, was quicker and more convenient; the roofing was fastened to a frame which ran on wheels, and a simple push sent the roof quickly along so as to cover a whole row of trays at once.

The Curing-house.—This is required in damp or dull weather. It is a simply constructed building of wood, roofed by the ordinary local thatch. Owen recommends that the walls be open, of louvre-boarding, or open trellis round the room, with plain shutters to close when the weather is rainy. Thus you get a free current of air when it is dry, and a protection from damp in the rain. It should have as many glazed windows as possible to admit the light. During wet weather one or two stoves, according to the size of the house and amount of the crop to be dried, are requisite. Owen suggests the connecting of the two stoves by a pipe traversing the room with one smoke pipe for the outlet of the smoke for the two stoves. This, of course, will economise the heat.

He recommends trays of wire gauze, 24 meshes to the inch, but this is expensive. More usual are the ordinary trays of split bamboo, which, he suggests, should be partly covered with gunny bags, so as to prevent the seed falling through. This, however, I should say, would hardly be wanted, as it is easy in any Oriental village to get bamboo trays which are not perforated, and which are used by the natives for all kinds of spices, rice, etc., which they dry in such trays.

Owen gives another system of curing when there is no house, or stove, or appliances for doing the thing well. A day's gathering should be thrown into a large tub or box at 4 P.M., and thoroughly washed in cold water. After washing the fruit can be taken out of the water and put into a box or sack over night. Next morning wash the fruit again and spread them out on Hessian cloth or mats in the sun. About 9 A.M. they begin to get dry; they should be sprinkled with water from a watering-can, and given a shake-up so that all the fruit will get wet. Expose them to the sun again to get dry, and when they look dry, say about eleven o'clock, water them again as before. Water them three or four times a day for the first two days, after which you can begin to dry them gradually (without watering). This is done by exposing them daily in the sun, say from 6 to 11 A.M., and from 1 to 4 P.M.; from 11 to 1 o'clock, if the sun is very hot, draw a thin cloth or mat over the fruit while on the barbecue (a cement floor for drying produce) in the sun. This process must be carried on daily for a fortnight, or perhaps more, until the fruit is thoroughly dried. During the night spread them out thinly over your store floor, away from any chance of their getting damp, as damp or mildew is bad for them. After clipping and sorting out husks and light fruit, and separating the split fruit from the good, the fruits are sorted by passing them into three sizes or grades.

After the sorting is finished the fruit is sulphured in a box prepared for the purpose. The box is made to hold a number of trays or tats, say $1\frac{1}{2}$ in. square frame. On this nail cane or bamboo tats, or open jute Hessian cloths. From the bottom of the box to the first tray there should be at least 1 ft. clear space for placing the sulphur, which is put in tin saucers. It is well to have the saucer resting on a stone while the sulphur is burning in the box.

In Coorg the cardamoms are either merely exposed to the sun on mats or trays, or dried over a slow fire. The oven is a long brick and mud structure, the roof of which is either flat and formed of zinc sheeting, or a hollow trough. The fruit is spread out over the oven to dry, after which the stalks are cut off and the fruit is ready for sale. The Hindus pickle the green fruit and use it in confectionery dried. (Evers in *Agricultural Journal of India*, iv., 1909, p. 104.)

BLEACHING

The light bright colour of good cardamoms is obtained by some process of bleaching. This is not a very elaborate process in Ceylon. The capsules are there treated by sprinkling them with water, or dipping them and exposing them immediately to the full sun. This increases the amount of split fruit considerably, and Owen affirms that in good sunny weather a very good colour is obtained without any bleaching process.

A correspondent of the *Observer* recommends steeping the fruit in boiling water for a minute before drying, but this bleaches the fruit excessively, more than would be appreciated by the London brokers.

In India the natives have an elaborate process of bleaching which is described by E. Cozanne (Mollison, "Lesser Cardamom in the Bombay Presidency"). A large earthenware jar is filled with water, into which is put 2 lbs. of pounded soap-nuts, *Sapindus saponaria*, and $\frac{1}{4}$ lb. of the pods of *Acacia concinna*, to 5 gallons of water. This soap mixture is sufficient for 130 lbs. of cardamoms. Another jar contains a strong solution of common soap in water. Two women seated place an earthenware pan before them, into which they put 8 quarts of water and 3 quarts of the soap-nut mixture. Then 10 lbs. of cardamoms are put into the tub, and the women stir it vigorously with the hand for one minute, rest for a minute, and stir it again. The cardamoms are now baled out and put into a basket to drain. They are then transferred to two other women, who wash them in like manner in another tub containing 7 quarts of pure water, 1 quart of the soap-nut mixture, and 1 quart of the soap mixture. After again being put into a basket to drain they are thrown upon a mat, and sprinkled at intervals of half an hour all through the night with well water. Next day when the sun has risen the cardamoms are borne to the roof of the house and spread on mats to dry for four or five hours.

STARCHING

This is done by sprinkling the cardamoms with a solution of starch while the capsules are being rubbed by hand. The starch is prepared by pounding together rice, wheat, and country soap with buttermilk, and dissolving the paste in water. This gives them a white colour, which is popular at least among local consumers.

Neither of these processes is apparently in use in Ceylon, or the greater part of the Indian cardamom region, the light colour obtained by simple sun drying being deemed sufficient.

CLIPPING

When the fruit is dried before packing, it is necessary to clip off the stalk and the little dried calyx at the top of the fruit. In some parts of India the fruit is merely rubbed against the bottom of a basket, after which the women separate the bits, empty capsules, and the loose seeds, preserving the latter.

This is said to be very trying, as the dust produced by rubbing the capsules against the basket is very pungent, and produces illness among the coolies, who have to wear a veil over their faces, and this operation cannot be performed in wet weather, as the capsules would absorb moisture and be spoilt.

In most places, however, the stalk and calyx are removed by clipping them off with a pair of English scissors. The women in India squat on the floor, and, resting the right elbow on the ground, feed the scissors with the left hand. The stalk is very small, and requires some care and practice not to cut the fruit itself. These women work very fast, and Mr. Ozanne, who describes it, saw an old woman clip 90 cardamoms a minute. These women are paid at the rate of $\frac{1}{2}$ anna for the clipping of 1 padi (10 padis are 26 lbs.). Some can even earn $2\frac{1}{2}$ annas a day, and therefore must clip 13 lbs. a day.

In Ceylon the coolies cannot clip more than 3 lbs. a day, but this includes picking out broken and brown capsules as well.

SORTING

The crop is sorted, when dry, into split and entire capsules, and the entire capsules are sorted according to colour; the perfectly cured ones, of a straw colour; those which are discoloured with a brownish tinge or stained on one side; and those which are nearly black, due usually to gathering and curing in unfavourable weather.

Cardamoms are valued not only according to their colour, but according to their plumpness and heaviness, and the sound and mature conditions of their seeds. Good samples afford about three-fourths of their weight of seeds. Thus 200 lbs. shelled at various times during ten years afforded $154\frac{1}{2}$ lbs. of seed. (Messrs. Allen and Hanbury, in *All about Cardamoms*, by A. M. and J. Ferguson.)

There are several forms of the capsule known in commerce; of the Indian forms there are two classes, according to size, the ovoid or nearly globular, $\frac{2}{5}$ to $\frac{3}{5}$ in. long, termed *shorts*, and those of a more elongated form $\frac{7}{10}$ to $\frac{9}{10}$ in. long, called *short longs*.

They are also distinguished by the names of localities, Malabar, etc.; the most valued occur as *shorts* and *short longs*. They are most highly valued, and are shipped from Bombay to Europe.

Madras are chiefly long forms (*short longs*), and are paler; they are shipped from Madras and Pondicherry. *Aleppy* are usually shorts, plump, beaked, and of a peculiar greenish tint, shipped from Calicut.

Ceylon cardamoms, as has been said, are derived from a second type of plant. They are 1 to 2 in. long, and $\frac{3}{10}$ to $\frac{4}{10}$ in. through, three-sided, often curved, and always dark greyish brown. The seeds are larger and more numerous, and somewhat different in taste (Ferguson, *l.c.*). Owen, however, says that perfect Ceylon cardamoms are of a light straw colour. He says that the distinction into shorts and short longs has no value and may be ignored, the capsules only being sorted according to colour.

PACKING

The capsules are packed in wooden cases holding 65 lbs. each, and measuring $22\frac{1}{2}$ in. by 15 in. by 12 in. They should not be lined with lead or zinc, but with light gunny cloth. In packing great care should be taken that the capsules are quite dry.

CULTIVATION AREAS

Practically the whole of the cardamoms of commerce are produced in India and Ceylon. The plant has been introduced into most other tropical countries, but no cultivation of any extent has resulted there.

In India the exact amount of cardamoms produced is difficult to arrive at, as much is consumed in the country. Shipments, in 1872-1873, from Bombay amounted to 184,800 lbs., of which 118,160 lbs. went to England.

In Ceylon the export is very large, as will be seen from the tables below; of this product more than half is sent to India, the rest to Europe.

In Ceylon cardamoms have been one of the most important crops for many years. The output is given by Owen and others for the last few years as follows:—

	lbs.	Value in Rupees.
1872	9,273	...
1873	9,000	...
1874	9,000	...
1875	14,337	15,521
1876	4,965	8,202
1877	11,108	19,226
1878	15,975	35,398
1879	17,732	15,127
1880	17,392	...
1881	17,769	...
1882	23,127	...
1883	21,655	...
1884	66,319	...
1885	152,405	...
1886	236,056	...
1887	321,500	...
1888	310,685	...
1889	350,000	...

The Portuguese were the first to pay attention to the cardamom as an article of trade in Ceylon in the sixteenth century, and the Dutch Government fostered the industry in every way during their occupation of the island. But it was after the failure of coffee in Ceylon in 1878, that the industry developed to its greatest. So successful was this cultivation that it is recorded that an acre of cardamoms produced as much as £300 worth. The price, however, owing to increased production, fell, but even at 2s. per lb. cardamoms give a handsome profit. The present price is about 4s. per lb.

USES

Cardamoms are used in curry-powder, and for flavouring cakes, especially in Russia, Sweden, Norway, and parts of Germany. They are also used in the manufacture of liqueurs, Ceylon cardamoms being almost exclusively used for this purpose.

In European medicine they are chiefly used in tincture of cardamoms, as a stomachic, and in combination with other drugs as an aromatic.

OTHER CARDAMOMS

Nepal Cardamom (*Amomum subulatum*).—This plant is pretty extensively cultivated by the inhabitants of Eastern Nepal. It is essentially a swamp plant, and comes in usefully as a crop for irregular patches of ground by the sides of streams which are unsuitable for rice, than which it is more profitable (Dr. King, *Journal Linnean Society*, xvii.).

The plants are cultivated in much the same way as the true cardamoms. According to N. G. Mukerji (*Handbook of Indian Agriculture*), it is grown in the lower valleys of Bhotan and Sikkim, where the beds are made alongside mountain streams, whence water is taken along narrow channels, alongside of which the cardamoms are grown on ridges. This arrangement secures constant moisture and freedom from water-logging. The plant is known as Bara-dachi, or the greater cardamom, or Kala-dachi, the black cardamom.

The plant attains a height of 3 to 6 ft., and the flowers are produced in a dense short spike close to the ground. In fruit this spike is ovoid, 3 to 4 in. long, densely crowded with bracts. The fruit is about 1 in. in length, ovoid, three-cornered, and marked with thin jagged ridges, and coarsely striped. The fruit splits readily into three valves, and encloses a mass of about 60 to 80 seeds embedded in a pulp. The seeds are highly aromatic, and used by natives chiefly.

There is practically, it appears, no European commerce in these cardamoms, but they are in some demand in India.

Round Cardamoms (*Amomum Cardamomum*, L.) is a native of Cambodia and Siam. It has stems about 4 ft. tall, with a short cluster of pink and white flowers at the base. The fruit is produced in small compact bunches, and is globular (whence the name round cardamoms); $\frac{5}{10}$ to $\frac{7}{10}$ in. through, longitudinally furrowed; the capsule is thin, fragile, buff-coloured when dry, and somewhat hairy. The seeds resemble those of the Malabar cardamom, and have a strong aromatic taste.

It was known as early as 1605, and Clusius affirms it was the true amomum of the ancients. It was valued as a rare drug, but gradually got scarcer till it practically disappeared from trade by the end of the eighteenth century; but in 1853, when Siam was opened up to commerce, large quantities were thrown on the market, but were not appreciated, and soon ceased to come.

In 1857, 47 bags, imported from Bangkok, were offered for sale, and bought at 1s. 6d. per lb.

The shipments from Bangkok in 1871 amounted to 4,678 piculs (623,733 lbs.), all of which went to Singapore and China. In 1875, 267 piculs were valued at 45,140 dollars, about $1·25 per lb.

It was in cultivation in the Botanic Gardens, Singapore, some years ago, and flowered, but did not fruit. There seems to be little demand now, even among natives, for this spice.

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ESTIMATES

By T. C. Owen

Estimate of expenditure and returns on 25 acres of cardamoms, managed from an adjoining estate :—

	R.	R.
1st year—		
Value of land at R.100 per acre	2,500	
Clearing undergrowth, and first weeding at R.15	375	
Lining, holing, planting, and supplying at R.20	500	
Superintendence	500	
Cost of 37,500 good double bulbs, allowing 50 per cent for supplies, at R.30 per 1,000	1,125	
Tools, etc.	100	
Roads and weeding	200	
Cost at end of 1st year (plants one year old)		5,300
2nd year—		
Supplying and cost of bulbs	200	
Weeding	125	
Superintendence	500	
Contingencies	100	
		925
Cost at end of 2nd year (plants two years old)		6,225
3rd year—		
Expenditure 3rd year as before	...	925
Cost at end of 3rd year (plants three years old)		7,150
4th year—		
Superintendence and contingencies	600	
Erection of curing-house, including cost of scissors, etc.	1,500	
Picking, curing, clipping, packing, and transporting 3,750 lbs. dry fruit at 40 cents per lb.	1,500	3,100
Cost at end of 4th year (plants four years old)		10,250
Receipts — 3,250 lbs. at R.2 = R.6,500; 500 lbs. split at R.0·75 =	...	6,875
5th year—		3,375
Superintendence and contingencies	600	
Pruning and clearing tools	100	
Picking, etc., as before, 6,250 lbs. at 40 cents per lb.	2,500	
		3,200
Cost at end of 5th year (plants five years old)		6,575
Receipts—5,400 lbs. at R.2 = R.10,800; 850 split at R.0·75 = R.637	...	11,437
	Profit	4,862

CHAPTER XI

CAPSICUMS

The capsicums or chilies used as a spice, either dried, pickled, or in the form of cayenne or red pepper, are the fruits of one or more species of the genus *Capsicum*, belonging to the order *Solanaceae*, and are originally natives of Central and South America, but now spread all over the warmer parts of the world. A considerable number of species, about fifty, have been described and named, but only three or four are of importance as spices or condiments, and the separation of these into species is not easy, as they are very closely allied and the forms appear to hybridise readily. It is possible that the three or four forms commonly recognised as separate species may be only cultivated forms of one original wild plant.

The three important species are: (1) *Capsicum minimum*, Roxb., bird pepper or bird's-eye pepper; (2) *C. frutescens*, L., chilies or capsicums; (3) *C. grossum*, wild bell pepper or bull-nose pepper; and of these there are a considerable number of forms, differing in shape and colour, of the pods cultivated in gardens in Europe as well as in various parts of the tropics.

1. *Capsicum minimum*, Roxb. Bird pepper, bird's-eye pepper, bird's-beak pepper, mad pepper, Guinea pepper. Syn. *C. fastigiatum*, Bl.

A small, much-branched shrub, 2 or 3 ft. tall, branches spreading, dichotomous, slender, flexuous, four-angled, minutely puberulous. Leaves alternate, one from each bifurcation, thin, lanceolate, long-petioled, the lowest the biggest. Flowers, two or three together in the bifurcations, erect on slender stiff pedicels, $\frac{1}{2}$ in. or 1 in. long, the tip decurved, calyx cup-shaped, truncate, with five very small teeth, green. Corolla $\frac{1}{4}$ in. across, rotate, with a short tube; the lobes, five, cut half-way down, acute, white. Stamens five, inserted on the tube, short, erect, anthers purplish blue, ovary conic, style slender. Fruit ovoid, oblong, cylindric, bluntly pointed, orange scarlet, glistening, smooth, $\frac{1}{2}$ in. to $\frac{3}{4}$ in. long. Seeds flat, oval, or reniform, nearly smooth, bright yellow, $\frac{1}{8}$ in. across.

This plant is extensively cultivated in the East Indies, Zanzibar, Japan, and elsewhere, and according to Roxburgh, Sir John Kirk, and most other writers, is the source of most of the cayenne pepper of commerce. It forms an important article of diet among the Malays and Indians, who seem to require it to eat with the dried fish and rice which forms their everyday food, as they carry it about with them wherever they travel. It constantly occurs in a half-wild state about villages, and especially in limestone rock districts. The seeds are dispersed by birds, and plants in such localities are often to be seen in great abundance on the rocks at the base of the hills and on the precipitous rock faces. The form that occurs in this practically wild state is very small fruited, the fruits being only $\frac{1}{2}$ in. long.

A fairly good figure of the plant is given by Trimen in the *Medical Botany*, iii. p. 189, but the fruits are larger than in the wild form. Duthie, in *Field and Garden Crops*, vol. iii., figures a very different looking plant, with much larger pods. He suggests, however, that this may be a hybrid between *C. minimum* and *C. frutescens*, which appears likely. The most distinctive points in *C. minimum* are the small size of the fruit, which is erect and not pendulous as in most of the other forms, and the correspondingly smaller flower with narrower and more acute lobes, and the smaller leaves. The fruit is also much more pungent than that of the larger species *C. frutescens*, and indeed the most pungent of any, except the small round-fruited *C. baccatum*, L.

2. *C. annuum*, L., is a larger plant, with larger leaves, and flowers over $\frac{1}{4}$ in. across the corolla, lobes shorter and broader, and the pod conoid, oblong-inflated, narrowed to the point or blunt, very much larger, and about 3 in. long. The seeds also are larger.

This is the plant to which the name capsicum or pod pepper is usually applied.

There is a very considerable number of cultivated varieties of it, some of which have received scientific as well as popular names.

C. longum, Dec., and *C. frutescens*, L. (in part, the *C. frutescens*, L., of the *Species plantarum* is said to be *C. minimum*) do not seem to be specifically distinct.

Other cultivated forms are *long red capsicum*, with fruit of an elongate conical shape, 4 or 5 in. long, about 1 in. through at the base, bright red, and rather hot; *Long cayenne*, pods more slender, curved at the tip, more cylindric, about 3 in. long, red, pendent; *Long yellow*, pods conical, cylindric, very hot, yellow.

Purple Capsicum.—Stems, leaves, and flowers tinted with purple, pods very variable, erect or pendent, 2 or 3 in. long, blackish violet, or nearly black. Doubtless the *Capsicum purpureum*, Roxb., described by Roxburgh as received at Calcutta from the Moluccas. The fruit is very hot.

Erect Chili, with slender erect pods 2 in. long, and hardly $\frac{2}{5}$ in. through, bright scarlet, and very numerous. A dwarf plant much grown in Europe.

3. *C. grossum.*—The bull-nose capsicum or bell pepper. A short thick plant with large flowers, and large thick blunt pods, usually red, and hardly or not at all hot to the taste, with few seeds. Some forms are 3 in. through, and 6 in. long. They are variable in shape—sometimes almost globose, some forms oblong, blunt, and truncate. This is cultivated largely in Spain and southern France, and chiefly used as a vegetable. There are a number of garden forms, large bell, cherry

pepper (a spherical fruit, extremely hot), bull-nose, sweet mountain, monstrous Spanish, mammoth, red tomato, all not or hardly at all pungent, and consequently seldom if ever used as a spice. I have, however, seen a cold cayenne pepper made from this form, which had a very pleasant flavour, and might find a market as a condiment.

It is probable that *C. grossum* is only a highly cultivated form of *annuum*. It is, however, given in many books as a distinct species, as is the hot flavoured cherry capsicum, under the name of *C. cerasiocarpum*, which is generally now considered a variety of *C. grossum.*

HISTORY

There is no doubt that all the species of capsicum were originally natives of Central and South America and the West Indies, although the plants are now spread widely over the whole world except the colder regions.

The earliest mention of this spice is found in a letter written by Chanca, physician to the fleet of Columbus, in his second voyage, to the Chapter of Seville in 1494. He says that the natives of Hispaniola (Mexico) live on a root called "Age" (yam), which they season with a spice named "Agi," also eaten with fish and meat. This "Agi" signifies capsicums, and is still the common name in Spanish. It was later described by Fernandez (*Historia de las Indias*, i. p. 275) in 1514.

A plant so easy of transport by seed was not long in reaching the East Indies, and thence was carried to Europe. Fuchs, in the *Historia stirpium*, fol. 733 (1542), describes and figures it as Siliquastrum, or Calicut pepper, brought from India into Germany a few years before. Clusius states that the plant was brought from Pernambuco by the Portuguese, and cultivated in Castile and Moravia abundantly in 1585. Garcia da Orta, 1593, writes: "This capsicum or Indian pepper (rather American pepper) is diligently cultivated all over Castile by gardeners, as also by women in hanging gardens in their houses." He mentions it also everywhere in the Moluccas and in Calicut.

Both *Capsicum minimum*, the bird's-eye pepper, and *C. annuum*, are figured by Garcia, who mentions a yellowish-coloured variety cultivated at Lisbon.

C. annuum was cultivated in England by Gerarde in 1597, and it was at that time sold in the shops at Billingsgate under the name of ginnie pepper.

By this time it appears to have been well distributed all over the warmer parts of the world, and a considerable number of varieties have since been established, varying in size and form of fruit, and in colour, black, purple, red, yellow, or white.

NAMES

The name capsicum (καψικόν) was first used by Actuarius, a Greek writer of the eleventh century, but it is obvious that it could not have signified the plant now known by this name, as it was not then discovered. Fuchs, in 1542, called it Siliquastrum, or Calicut pepper. Clusius seems to have first called it capsicum, and it was also called, in the sixteenth century, Indian pepper and Guinea pepper. The French call it still Poivre d'Inde or Poivre de Guinée, but more commonly Piment or Piment de Cayenne; the Germans, Spanischer Pfeffer. In English, it is known as Pod Pepper, Red Pepper, Chilies, or Capsicum. The only original native names for the spice are "Agí," in Spanish America, and "Quija" or "Quiya" in Brazil (Piso and Marcgraf).

In Eastern Asia there are no original native names, all being compounds of the local word for pepper, with some qualifying word signifying some locality from which it was derived, or its colour, such as Gawai mirchi (Goa pepper) in Bombay, Lada merah (Red pepper) or Lada China (Chinese pepper) in Malay, showing clearly that it was only known to the Asiatics as an introduction.

CULTIVATION

The capsicums are grown from seed, and are plants easy of cultivation. The soil required is light and friable, and should be worked up to a depth of from 4 to 6 in., and brought to a fine tilth. If the soil is poor, it should be manured with cattle dung during the preparation of the soil, and this should be well mixed with the earth till it is decayed, and combined with the soil.

In some countries the natives sow the seed broadcast, and so leave it. This is not, however, at all advisable, and the proper system is to raise the plants in nurseries, and when sufficiently tall to plant the seedlings in rows, on ridges, banked up.

The seeds, when sprinkled broadcast over the land, produce about 15,000 plants to the acre; planted out from nurseries 6,000 go to an acre (Drieberg). In Ceylon, the plants are planted out in April, and the crop commences in June, and continues on and off for six months.

During the growth of the plant, the ground may be improved with a dressing of ashes, and the soil banked up around the plants. In India, when the plant begins to flag from continuous picking, a top-dressing of castor-cake, 600 to 1,000 lbs. to the acre, is given to prolong the cropping season. In Ceylon, the favourite manure consists of the leaves of *Croton lacciferum*.

Cow-dung, given at this stage, is too strong, and causes the plant to develop leaf at the expense of fruit, the leaves becoming large and unhealthy.

In Europe, the soil recommended is a light rich soil composed of tufty loam, rotted leaf mould, and cow manure in equal parts with a little silver sand.

It must be remembered that in the tropics strong manure like fresh cow-dung and horse-dung (a valuable manure in a cold country) cannot be used in the same way as they can in a temperate climate. It seems probable that in a hot climate the decomposition of manures of an animal origin is very much more rapid, and produces an excess of ammonia. Horse-dung cannot be safely used for manuring plants in the tropics till it has been rotted for several years, and even then well mixed with the soil in small quantities.

Both the long capsicum, *C. frutescens*, and the bird's-eye chili, *C. minimum*, will grow well in light open soils as described above, but the bird's-eye chili has an undoubted predilection for limestone rocks. In the Malay peninsula it has thoroughly established itself on the limestone cliffs and talus, wherever the natives have brought the fruits; it spreads all over these places often in great abundance, the seeds being dispersed by birds.

In the *Kew Bulletin* (1892, p. 88; 1898, p. 171), Sir John Kirk, writing on the agricultural resources of Zanzibar, says: "The small red peppers or chilies are largely grown in the more dry and rocky part of the island, where the upheaved coral presents a honey-combed surface that favours the accumulation of rich soil in crevices."

It has also established itself on the coral rocks of Christmas Island.

The plants are usually grown as annuals and re-planted each year, but they can be grown continuously for two or three years, as a Ceylon planter in Central Africa wrote to the *Tropical Agriculturist*:—

I have 100 odd acres planted between the lines of coffee as a catch crop. They are now three years old, and lots are beginning to die off after continuous cropping for two years. After the first crop I cut them down and dug them in as manure to the coffee. They grew up again quickly, and I have now nearly finished a second crop. I intend to uproot them and dig them altogether in the course of a few months more, as the coffee has now closed in upon them, and they have served me well, having more than paid for the coffee clearing. I could not pick half the crop for want of labour, but I should say that each tree gave me more than 1 lb. of dry chilies, and the price I got was from 37s. 6d. to 56s. 6d. per cwt.

The variety I planted was the common kind, the bird's-eye chili used by the Ceylon coolie. This kind of good quality, bright and clean, always meets with a ready sale. I have tried other varieties, but there is a very small demand and uncertain market for any kind except bird's-eye.

In the Malay peninsula the Chinese vegetable gardeners usually cultivate capsicums for the market with their other vegetables. The soil on which they grow the plants is usually stiff clay well dug over. The seeds are first planted in a tub of soil, and planted out three weeks later when they are about 6 in. tall. The beds are made as low ridges, 3 ft. across. In these the little plants are put in a double row, each pair being 10 to 12 in. or more apart, sometimes as much as 2 ft apart, and during their growth they are mulched with a liquid manure, composed of one part of urine and three parts of rice water (water in which rice has been boiled). Burnt earth is also used, both before and during the cultivation. The plants take three months before they commence fruiting, and continue to bear for seven months. The crop suffers much from rain, when the fall is excessive or more than usual through the year.

The rain is said to spoil the flowers and fruits; the fungus which attacks the leaves and fruits being more abundant and destructive in wet weather is probably the cause of this theory.

The large-sized *Capsicum annuum* is the chief one cultivated by the Chinese, as it is best in demand. The bird's-eye chili is more rarely cultivated on a large scale, as there are plants in all village gardens and compounds enough to supply the demand.

The following directions for planting capsicums were given me by a Chinese planter some years ago, as the method in use in Singapore:—Get some fresh chilies, cut them open and take out the seeds. Put the seeds in a bowl of salt-fish water (*i.e.* water in which salt fish has been soaked), and allow them to soak for at least six or seven days. The ground selected is low-lying and always slightly damp. It must be turned over and well broken up, and then sprinkled over with burnt earth (the method of making this has already been given), and when this is done the bed is ready to receive the seeds.

Drain off the water from the seeds and dry them well, and put in some burnt earth or soft earth and mix the mixture well, so that the seeds may be separated and not cling together in a mass. Then scatter the seeds and earth carefully over the prepared ground, being careful not to strew them over one corner only, as the seeds will become spindly and drawn up. The object of this is to separate the seeds as much as possible, not always an easy matter in the case of small seeds, which are apt to adhere together by their sticky pulp.

During their growth, liquid manure, urine, etc., will do them much good if it is given once a week.

After fifty days the chili seedlings can be transplanted to the permanent beds. These beds are made 50 ft. long and 3 ft. in width, and 1 ft. apart, so that the planter can get between the rows without injuring the plants, and between each block runs a 5 ft. path.

The soil of the beds is well worked over and raised or banked up a little. Two holes are made in each row on the outer sides, opposite to each other, about 1½ to 2 ft. apart. Thus you get 50 to 60 plants in each 50 ft. bed. After making the holes, put in first some cow-dung, and then the plants in the centre, covering up the bases with soil from the bed. The chilies are fertilised with liquid manure once every week or oftener. If urine is used, it should be mixed with water in the proportion of three parts of water to two parts of urine while the plants are young, and three parts of urine to two parts of water when they are about a month old. Pig-dung is also used, but water is not added to this. The Chinaman wastes nothing in the way of manure : all excreta of man or beast are valued and utilised. The pigs are kept in long sties with a flooring of sticks, beneath which is a cement tank which receives the excreta of the pigs, waste bits of food, water, etc., through the spaces between the sticks. This forms a valuable liquid manure, which is freely used on the vegetables and other garden produce.

Manure must only be given in the afternoon at four or five o'clock. To the habit of giving manure at mid-day when it is hottest, or to giving manure too strong and unmixed with water, he attributes the rotting of the chili fruits before they are ripe.

This rotting of the fruits, I presume, is really the destruction of the fruits by *Gloeosporium*, or other fungus diseases. It is always an understood thing that liquid manure, and indeed pure water, should not be given to a plant in full sun during the hot part of the day in the tropics. All applications of liquids or watering should be given to the plant either in the early morning or, by preference, in the evening not long before sundown. Possibly, in the case of liquid manure, the absorption during the day is too rapid, and the diluted manure has the same effect as undiluted administered later in the day.

Of course, the administration of too strong manure does not actually directly produce the fungus, but it probably so far weakens the plant that it is readily affected by it. Over-manured plants of any kind are apt to show the results in the pale yellow colouring of the leaves, quite similar to that caused by starvation or disease of the roots.

In Singapore the price fluctuates from 15 cents to 90 cents a catty. The latter price is very high, and is said to be caused by a scarcity due to the heavy and continuous rains.

When the crop is very abundant and the capsicums are cheap, the fruit that is unsold is dried on mats in the sun, but no regular drying system is in vogue, nor is there any attempt to make cayenne pepper. The capsicums are very extensively used fresh with the rice and dried fish which forms the ordinary native food. Dried capsicums, however, are imported very extensively from India. Natives say that the locally dried capsicum has not the flavour of the dried Indian fruit. It is quite possible that this is due to the bad drying of the local fruit, which has often a bad colour, being rather yellow than red when dry, probably due to damp, for I have seen excellent clean-coloured dried capsicums prepared with artificial heat by a European from the plants ordinarily cultivated here. The natives attribute the inferiority of locally dried capsicums to the want of sufficient sun-heat, and say that they do not like artificially dried ones.

India.—Chilies are grown in India extensively as a field crop, being grown in rotation with pulse seeds, oil seeds, or after potatoes. N. G. Mukerji gives an account of their cultivation in his *Handbook of Indian Agriculture.* He says that sandy loam and newly formed alluvium on the banks of rivers do well for this crop, but dry rock soils containing plenty of lime produce the best crop.

The seedlings are raised in nursery beds in a cool and shady spot. The soil is well pulverised, and rotted manure and lime and ashes applied. The seed is sown in May, and when the seedlings are 6 or 7 in. high, they are transplanted after a good shower of rain at a distance of 27 by 18 in. apart. This is done in July and August.

The land for planting out is prepared very early in the season; in December or January this is effected with the hoe, or by the local plough and grubber. The ground should be worked over by the grubber once a month till the planting season. The cultivation of field-crops in India is far more common and better understood than anywhere else in the tropics. The whole system is very different from anything in Ceylon and the Straits Settlements. It is done on a much larger scale, and as it has been pursued probably far longer than in any other part of the tropical East, the ground is in a more cultivated condition than elsewhere. The flat open plains ploughed over continuously for unknown generations can be more easily worked, and a larger series of agricultural implements can be used than in the untilled soils of Malaya and most of the East.

Mukerji continues to say that when the plants have established themselves in raised beds well protected from stagnant water their roots should be partially exposed to light and air by removing the earth from their bottom. A month after this mustard cake at the rate of 6 maunds per acre is put at the bottom of each plant, and the plant earthed up at the same time. The field should be kept clean of weeds, two hand-weedings and two wheel-hoeings being recommended. One or two irrigations may be required after November, and a hoeing after each irrigation.

December to February is the proper harvest season for ripe chilies, though chilies are plucked green in October and November, and sent fresh to market. Plucking should be done about four times, five men being required for an acre each time.

The ripe chilies are spread out in the sun for a fortnight. Night dew does them no harm and they may be left out day and night for a fortnight, but if rain is feared they must be brought indoors.

He gives the cost per acre as follows:—

	R.	A.	P.
Ploughing and making of beds	12	0	0
Transplanting	2	8	0
Two earthings	6	0	0
Two hand-hoeings	6	0	0
Two wheel-hoeings	1	8	0
One irrigation	2	8	0
One hoeing with spades after irrigation	3	8	0
Plucking and drying	5	0	0
Rent	3	0	0
Total	42	0	0

In Ceylon, Drieberg says that the chilies are usually grown in mixed cultivations, being grown with betel pepper or other crops.

Tropical Africa.—We have few details of cultivation in Africa except in Zanzibar and Temba. It is recorded, however, that in 1906 chilies to the value of £19,000 were exported, but the next export in 1908 was of the value of £485 only.

Sierra Leone pepper resembles that of Zanzibar in its pungency, but is yellowish red when dried, that of Zanzibar being dull dark red. Natal red pepper imported into Europe in the form of dried pods (a variety of *Capsicum annuum*) is dark red and very pungent, and till recently supplied all the bright red cayenne pepper in commerce (Holmes' *Pharmaceutical Journal*).

There are no accessible records as to the amount of chilies or capsicums exported from Sierra Leone or Natal, but it is recorded (*Blue Book of Sierra Leone*, 1871, Flückiger and Hanbury) that in 1871, 7,258 lbs. were exported from Sierra Leone, and from Natal (*Blue Book* for 1871) 9,072 lbs.

Turkey.—An article from the *Journal de la Chambre de Commerce de Constantinople*, quoted in *All about Spices*, says that the cultivation of red pepper occupied a very important place among the several branches of cultivation practised in Turkey in the Vilayet of Salonica. The plant there prefers a humid sandy soil, where it grows sometimes almost in water. It produces 340·80 lbs. to 1,136 lbs. per dennum (of 40 square paces), and gives a profit of 300 to 350 piastres per dennum. The greater part is exported to Europe, about one-fourth being used in Turkey.

Japan supplies a large number of chilies, chiefly those of *Capsicum minimum*, of a peculiar bright colour, which has of late years commanded a higher price than any other variety, but is less pungent than that of Zanzibar. When powdered it is indistinguishable from Natal cayenne pepper, obtained from *Capsicum annuum* (Holmes, *Pharmaceutical Journal*, 1897, December 11, p. 519).

CULTIVATION IN CALIFORNIA

Mr. J. B. Neff gives in the "California Cultivator" (*Planting Opinion*, August 26, 1900, p. 602) an account of cultivation of capsicums in California, thus:—

1. *How Plants are Grown.*—A hot-bed is made by excavating about 16 in. deep, fill in to within 4 in. of the top with stable manure, tramping down very solidly. Spread about 4 in. of sandy loam over the manure. The seed is sown quite thickly over the loam, and then about $\frac{1}{2}$ in. of loose sandy soil placed evenly over it, and all kept damp. When the plants have two or three leaves, thin to $1\frac{1}{2}$ in. each way. The plants must be watered while in the hot-bed by sprinkling.

Soil and Preparation.—Rich sandy soil is the best for the chili pepper. It should be ploughed deeply, and be put in a state of thorough cultivation. Ridges should be made 3 ft. apart, and the plants set $2\frac{1}{2}$ ft. apart on the ridges. All plants should be on a water-line, and to get this the ridges should be made high enough to let the water run down the furrows and the plants placed about 2 in. above the water-mark. This ensures every plant receiving water when irrigated. Plant as soon as danger from frost is past.

Cultivation.—Frequent cultivation is necessary until the plants get too large to allow of a cultivator and horse passing between the furrows. All weeds should be pulled out. When the plants are set as above noted all the ridge will be on one side. This must be worked down with a cultivator, and then a plough used to throw earth on either side of the furrow, so that the plants will be midway on the ridge.

Irrigation.—While the plants are small, water will be needed about once in twenty days, but as they get larger it will be required as often as once a week, though always in small quantities. The plants seem to have no deep roots, consequently the surface soil must be kept damp.

Picking.—The field should be gone over about once a week after the peppers begin to ripen, all that are fully ripe being taken off. Great care must be taken to pick all the stalks with the pepper. They should be allowed to lie in the sun for one day after being picked, in order to toughen the stems and prevent them breaking during the process of curing.

Stringing.—A common method is to cut strings of strong smooth twine 8½ ft. long. Draw this through a needle about 10 in. long, which is often made of a bicycle spoke.

Peppers having any break or blemish must be thrown away, as they would decay before drying properly. Of course, where there is an evaporator in use these can be saved. After the strings are full and tied they are hung on nails driven into a rough pole or other framework, standing about 6 ft. from the ground, and left until dry, or, if shelter is available, they may be moved before becoming fully dry and hung closely together under the shelter, but where there is a free current of air.

Evaporating.—Many growers prefer evaporating instead of drying. The evaporators should be large enough, when the peppers are dried on strings, to hold not less than 500 strings. The usual plan is to have a furnace with several turns of 8 to 10 in. pipe in the basement, the peppers being placed in a second story over a very open floor, and with good ventilation. The temperature can be kept at 110° Fahr., and in this way the house can be refilled every four days.

Yield and Price.—Both of these vary of course with the season, soil, and water-supply. Two hundred and fifty strings of 5 lbs. each is called a good paying crop, but with all things favourable, including a late warm season, as high as 400 strings or even 2,400 lbs. of dried pepper per acre may be grown.

Prices range from 35 to 75 cents (American dollar) per string if sun-dried, and 7½ to 12½ cents per lb. if evaporated.

IN AUSTRALIA

A writer in the *Queensland Agricultural Journal* for April 1902 states that the ease with which chilies and capsicums can be grown in Queensland is amply demonstrated in all the northern districts where chilies of various kinds have become a weed, and may be seen growing on the roadside for miles loaded with red chilies. The plant thrives admirably all about the south coast districts, and even grows in parts of the southern table-land where heavy frosts occur, but no commercial use is made of the chilies.

An officer of the department of agriculture made inquiries of two Brisbane firms relative to the market for chilies; one of the firms (pickle makers) are large buyers of fresh chilies, and give 3d. per lb. for good plump berries $1\frac{1}{2}$ in. long. The other firm import in connection with their business as pepper manufacturers bird's-eye chilies, and a few capsicums from the West Indies in a dried condition, and pay $6\frac{1}{2}$d. per lb. for them, or about £60 : 13 : 4 per ton. It strikes us as a most extraordinary thing that we hear of people struggling to make both ends meet in some parts of the north who are, at the same time, in the midst of a crop which requires no cultivation, and only demands picking and packing to bring grist to the mill. Meanwhile our local manufacturers have to import chilies from the West Indies. Twelve months ago we put up a quantity of chilies in a jar of salt and water to test their keeping qualities. They have retained their plump, fresh, red appearance, and all their pungent qualities, to the present day, thus proving that they can be exported to any distance in a fresh state.

Truly it does seem a little absurd that Australia should import chilies when they can be grown with such ease.

CROPPING

The period which the plant takes to produce its fruit is variously stated. In Ceylon, Drieberg says it takes two months; in the Malay Peninsula, about three months before the first crop commences. Mukerji, for India, gives about five or six months, *i.e.* from July or August to December or February, and a writer in the *Queensland Agricultural Journal*, vi., 1900, states that there they take eight months before they begin to fruit. This is certainly exceptionally long, especially as they only take five months, April to August, in Europe.

Of course, much depends on the climate in the damp, hot, equatorial rain forest region of the tropics; the growth of all plants is more rapid than in a country with dry seasons or a lower temperature. In the hotter and damper countries from two to three months, and in dryer or colder climates four or five is approximately what may be looked for.

RETURNS

The returns of capsicums and bird's-eye chilies are very variously given. A planter in Central Africa, as mentioned above, says he got more than 1 lb. weight per plant, but from 2 to 3 and even 4 lbs. is said to be a good production. These figures are for bird's-eye chilies.

In Montserrat, the Natal variety of *Capsicum annuum* gave 2,921 lbs. per acre dry, weighing when picked 4,850 lbs., the Nepal variety 2,710 lbs., weighing 7,396 lbs. when fresh.

Mukerji says that the yield per acre in India is from 6 to 15 maunds (a maund is 28 lbs.), which sell at 4 to 7 rupees each, giving a value of 24 to 105 rupees per acre, on a cost of production of 50 rupees per acre; not a very good business, and, as he says, unless a tract is known to be particularly adapted for chilies, it is risky growing this crop for profit.

PRICES

The price of bird's-eye chilies dried in London varies from £18 to £34 per ton according to their quality and the state of the market. Thus, in August 1900, fair red Zanzibar sold at £39 : 10s. per ton, good red Japan at £33 : 10s. per ton. A sample from the West Indies fetched £20 per ton.

Fresh chilies in Ceylon are worth on the land 10 to 15 cents per 1,000, and in the market 30 cents per 1,000.

Dried chilies are sold at 15 cents per lb., averaging 750 chilies to the pound. This appears to be the price given for *C. annuum*. Consul Cane, in a report in 1897, gives the average price of bird's-eye chilies in Zanzibar as 2·37 dollars per frasila of 30 lbs., against 2·57 dollars in the previous year.

N. Mukerji gives the price of capsicums (*C. annuum*) in Bengal as 4 to 7 rupees a maund.

Neff, in California, gives 35 to 75 cents (American dollar) as the value of sun-dried capsicums, and 1½ to 12½ cents for evaporated.

In Australia they are quoted as saleable at 3d. per lb. fresh and 6½d. dry.

In Singapore, dried capsicums cost for the last few years from 16 to 24 dollars a picul imported from India.

PESTS

Aloa lactinea, an Arctid moth, the caterpillar of which is very destructive to all kinds of herbaceous crops, attacks capsicums also in India, and has been reported very injurious in Baroda (*Indian Museum Notes*). The caterpillar is at first grey, then as it grows it becomes reddish brown, and in three weeks becomes sluggish, and dark brown sometimes, nearly black on the back. It is then 1½ in. long, and ¼ in. through. When full-grown it migrates to the hedge, where it pupates. The pupa is ovate, dark brown, ¾ in. long. After from two to ten months the moth comes out. The moth is 1½ in. across the wings. The upper wings are white, with a red margin on one side, and a few black dots scattered over them, one black spot much more distinct at the insertion of the wings; the lower wings are white with no red edge, and the dots larger and more pronounced. The body is striped alternately black and red.

The caterpillar eats all kinds of cotton plants, beans, tobacco, and attacks chiefly the seedling capsicums. The seedling beds can be protected by putting round them the leaves of *Euphorbia neriifolia*, which the caterpillars eat and which are fatal to them.

The birds known as Mynahs kill a great many, and a parasitic fly (a Tachinid) destroys a number of them. Removal of hedges and weeds in which the caterpillar can pupate will also be effective in driving them away.

Hemichionaspis minor, Maskell.—A very troublesome coccid also attacks the capsicum. This small white species injures many plants in the West Indies. It occurs also in New Zealand, North America, India, and Ceylon. It is devoured by the larva of a species of lady-bird.

Another injurious insect is one of the fruit flies, *Dacus caudatus*, the maggots of which feed on ripening fruits. They do not attack the seeds, but prevent the ripening of the fruit, so that the whole fruit is destroyed. It is rather difficult to deal with this class of insects, as it is impossible to catch these active flies in any quantity, and no insecticide will deal with a maggot inside a fruit. In the case of an outbreak of this pest, all infected fruits should be taken off and destroyed, care being taken not to leave any on the ground so that the animal can pass into the pupa state and hatch out as flies to continue the destruction.

Two or more species of *Epilachna*, *E. territa*, Muls., and *E. pusillanima*, Muls., attack the leaves of capsicums, as well as those of other plants of the order *Solanaceae*, by biting holes in them, and may do a good deal of damage. They are small lady-bird-like beetles, of a dull pinkish colour, and usually more or less hairy.

Fungi.—According to Tubeuf, the fungus known as *Gloeosporium piperatum* attacks the fruits of *Capsicum annuum*. It is closely allied to, if not identical with, *Gl. fructigenum*, the ripe-rot fungus of apples. This causes brown spots like decay on the fruit, but instead of being soft they are firm, and eventually develop pustules white or pinkish in colour, turning black.

A somewhat similar fungus I have also met with in Chinese gardens in Singapore. It appears as an oval or circular blotch gradually spreading, at first of a black colour, but as the tissue is destroyed becoming brown and dry with a black margin. The epidermis is cracked and pushed up, and the whole pericarp is affected and dies; eventually the fruit shrinks and withers up. This fungus the Chinese say is worse in wet weather, and causes a considerable loss. I have not seen the fruit of it, so am unable to identify it.

The treatment recommended is spraying with copper carbonate solution or potassium sulphide. Copper sulphate might also be used in the form of Bordeaux mixture. The Chinese leave the infected fruits on the plant, or merely throw them on the ground. They should be collected and destroyed.

Mukerji states that in India chilies are very subject to fungoid diseases, but less so to those of insects, and mentions two fungus diseases by local names, Dolbhanga-rog and Kutelaga, no description of which is given, and I am unable to find any identification of them, but of these he says: "When these overtake a crop it is not feasible to stop them. In fact, chili cultivation has to be given up for two years successively in a locality affected by either of these diseases before it can be taken up again. Bordeaux mixture and invigorating manures have been used in vain."

CAYENNE PEPPER

Cayenne pepper is the finely ground powder of chilies. The kind generally used is the bird's-eye chili, and this is the source of the Japan and Zanzibar cayenne pepper. Nepal cayenne pepper, remarkable for its violet odour, is made from a small variety of *Capsicum annuum.* Its colour is not bright red as is the case in Japanese, but brownish. A condiment, sold some years ago as Nepal pepper, and having the very pleasant characteristic flavour of that spice, was of a bright orange-yellow colour, possibly made from yellow capsicums.

Zanzibar is also said to give a brownish coloured powder.

The method of making cayenne pepper in the West Indies is described in Drury's *Useful Plants of India*, from Lindley's *Commercial Products of the Madras Presidency*.

The ripe fruits are dried in the sun, and then in an oven after bread has been baked in it, in an earthen or stone pot with flour between the strata of pods. When quite dry they are cleaned from the flour, and beaten or ground to a fine powder. To every ounce of this 1 lb. of wheat flour is added, and it is made into small cakes with leaven. They are baked again that they may be hard and dry as a biscuit, and then they are beaten into powder and sifted. They are packed in jars in a compressed state, so as to exclude air, for exportation.

USES OF CAYENNE PEPPER

The chief use of capsicums is as a spice on account of their pungency and pleasant flavour. The fruit is also used fresh or dry, cut up finely in curries, and is often used pickled, either alone or in a mixture of pickles. As a pickle it is often used green and unripe, as well as fully ripe. The cold chilies, such as *Capsicum grossum*, are a favourite vegetable. They are hardly or not at all pungent and have a thick rind, and are often stuffed with force-meat and cooked as a vegetable. They form an important part of the Hungarian dish Paprika, and are extensively cultivated in Southern Spain and Portugal for the vegetable market. Mr. MacEwen in the *Pharmaceutical Society's Journal* (December 11, 1897) says: "Probably more cayenne pepper is used for feeding birds than for any other purpose. The pepper used that way was tasteless, and seemed to contain a large amount of fatty matter. It was dark in colour, and the object was to whiten the colour of the feathers."

This pepper is supposed to be, and doubtless is, a variety of *Capsicum annuum*, and is not at all pungent, but has the pleasant capsicum flavour. It is chiefly, I believe, used for canary-birds, being accredited with giving the feathers a deeper and richer yellow.

In country places it used to be the custom to give hens, especially during the winter, a teaspoonful of cayenne pepper at intervals when they were not laying eggs, as it was supposed to act as a stimulant to induce them to lay.

In medicine it is chiefly used in the form of a gargle, and occasionally as a liniment, and internally to promote digestion. It is also made into a lozenge with sugar and tragacanth as a remedy for colds and hoarseness, and is thus used by public speakers and singers. It is used internally for gout, rheumatism, and dyspepsia, and is popular in India with asafoetida and sweet flag as a remedy for cholera. It is also valued highly in cases of delirium tremens. In the West Indies it is recommended in scarlatina, the fruit being bruised and macerated in boiling water with salt and vinegar added when cold. In Brazil a decoction in water is used as an enema for children in constipation.

The violent acridity of the fruit is caused by a substance known as *Capsicin*, a violent poison, the fumes of which when heated are extremely irritating to respiration.

GENERAL NOTES

Chilies and capsicums are cultivated all over the warmer regions of the world, and have a more extended area than any other spice. They grow well and readily in the hottest parts of the world, and in more temperate regions nearly up to the area of winter frosts. A very large proportion of the cultivated fruit is used locally and fresh, both green and ripe, for all through the tropics it is considered by the natives as a necessity of existence. There is therefore a good market for it, grown as a market vegetable near towns. For this purpose the greatest demand seems to be for *Capsicum annuum*, though the Malays at least seem to prefer the bird's-eye chili (*C. minimum*) on account of its greater pungency. Its easier cultivation perhaps accounts to some extent for its greater popularity.

The price of the garden vegetable varies according to its abundance at the time, and rises and falls constantly, and this abundance depends to a large extent on the weather, as unseasonable weather causes a great loss of fruit from fungus. In a good season, with not too heavy rains, the crop is good and the fruits cheap.

On such occasions, when the supply is in excess of the demand, the fruit is usually dried for storing and export to countries where the plant is little or not at all grown. There is a fairly steady demand for dried capsicums even in some countries where it can be and is easily grown. Thus in Singapore, in 1875, 2,526 piculs, and in 1880, 4,882 piculs of dried capsicums were imported from India, though the plant is commonly cultivated in the island by the Chinese.

There is also a considerable demand for capsicums by pickle manufacturers, who use both fresh and dried fruits, and finally there is a demand for the manufactured article, cayenne pepper.

The cultivation might well be taken up by the planters of permanent crops as a subsidiary or catch-crop, especially in cases where there is a good market for the fresh fruit accessible, but it should be in any case rotated at intervals with other crops, as it does not do well as a permanent annual crop, continuously grown on the same ground.

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CHAPTER XII

CORIANDER, ETC.

Coriander, the fruits of *Coriandrum sativum*, is a herbaceous annual belonging to the order *Umbelliferae*. It is apparently indigenous to the Mediterranean region and the Caucasus, and used to be cultivated in England, but is also largely cultivated in Northern India.

It is an annual herb, with a slender, solid, smooth stem, 1 to 2 ft. high, corymbosely branched in the upper part. The lower leaves are pinnate, on long petioles with nearly sessile rounded leaflets, the margins crenate-serrate, the upper leaves finely cut, with narrow, linear lobes, bi- or tripinnate. The flowers are borne in umbels $1\frac{1}{2}$ in. across, small, white or pink.

The fruit is nearly globular, $\frac{1}{6}$ to $\frac{1}{8}$ in. long, with two slender spreading styles on a short process, the stylopod. They consist of two halves, the mericarps, which easily separate, and are very concave within, with primary ridges, sinuous, and larger, straight secondary ridges on the outside. They possess a peculiar flavour suggestive of bugs, due to the aromatic oil contained in them when unripe; when ripe and dry it has a more pleasant aromatic taste.

The Bombay seeds (that is to say the fruit) are said to be larger and more elongate in shape than the European form.

HISTORY

This is one of the oldest known spices, being mentioned in early Egyptian papyri, and in Sanskrit authors, under the name of Kustumburu. It is also mentioned in the Bible as resembling the manna (Exodus and Numbers). It is mentioned, too, by Cato in the third century, and Pliny states that the best came in his time from Egypt. It has been cultivated to a larger or smaller extent in Europe, North Africa, and India ever since.

The name Coriander is derived from the Greek Coris, a bug, from its odour. In England, the farmers formerly called it Col.

In India it is *Dhanya*, in Hindu, *Danga* (Nepal), *Kuzbarah*, *Kurbuzah* (Arabic), *Kotamalli* (Tamil), *Naunau* (Burma), *Jintan* (Malay).

USES

Coriander, as a spice, forms an important ingredient in curry powder, and there is a very large trade in it in the East. It is also used in confectionery, and in flavouring gin and other spirits.

In medicine, it is carminative and stimulant, and used in dyspepsia and colic by natives, and also in veterinary medicine. Its chief part in European medicine is to disguise the taste of unpleasant drugs, and it is used as a constituent of syrup of senna among other medicines.

The leaves are used by the Chinese cooks in Singapore and elsewhere for flavouring soups, and as a sumbul in curries.

The oil is obtained by crushing the fruits between rollers and distilling with water. It is pale yellow or colourless. The fruits chiefly used are from Russia, Moravia, and Thuringia. These give ·08 to 1 per cent of oil. The oil must be obtained from ripe fruit, or it has an unpleasant bug-like taste and smell.

The exhausted and dried fruit, after extracting the oil, is used as a cattle food (*Volatile Oils*, Gildemeister and Hoffmann).

CULTIVATION

Coriander is cultivated from seed as an annual. It is sown broadcast in sandy loam, or black soil. The sowing takes place in the cold or rainy season; sown in October, it ripens in January; occasionally sown in the month of June, ripening in September as a garden crop. When the weather is dry, it requires watering. No particular care seems to be taken with it. The fruits are merely gathered and dried.

The system of cultivation in Essex, England, used to be as follows:—The seed was sown with caraways, but, being an annual, was gathered the first year, the caraways being left in the ground. The seedling plants were hoed, so as to leave those that remained in rows 10 to 12 in. apart. In the autumn it was cut with sickles, and thrashed out on a cloth in the field. On the best land 15 cwt. per acre was a good crop.

In India, the fruit is rubbed in the hand till the two mericarps are separated, and sown broadcast. It germinates about the third day, and only requires weeding once or twice. It fruits in about four weeks. It is then pulled up and beaten with sticks on the floor or trodden by bullocks. It is dried in the sun for a day or two, and packed in bags.

It sells in Singapore for 3 or 4 cents per lb., and there is a large demand for it, as it is an essential ingredient in curries.

DILL

Dill, commonly known in the East Indies as cake seed, is the fruit of *Peucedanum graveolens*, L., an annual herb of the order *Umbelliferae*. The stem is from 1 to 3 ft. tall, slightly branched, finely striated. The leaves are stalked with the petiole flattened, the blade tripinnate or even more cut up with very fine segments, narrow, and light green. The small yellow flowers are borne in long-stalked umbels, 2 to 4 in. across. The fruit is about $\frac{1}{5}$ in. long or less, broadly oval in outline, rounded at both ends and flat, three dorsal ribs prominent, two side ones developed into a flat, thin, paler-coloured wing.

The plant occurs as a weed in cereal crops in southern Europe, and south to Egypt and Abyssinia. It was cultivated by the Greeks and Romans, and introduced into England in 1570. The Indian form has rather longer and narrower fruits.

It is cultivated in India in the same way as coriander, and the fruit when ripe is treated in the same method.

USE

Dill seed, as it is often called, Anethi fructus of the chemists, is used in curry powder, and also as a substitute for caraway seed in seed cakes. In medicine it has long been known as a cure for flatulence in infants, under the form of dill-water.

As a spice, it is rarely used in Europe. The oil is obtained by crushing and distilling with water, as in coriander. It is used in medicine chiefly in the manufacture of dill-water. Its price in Singapore is from 15 to 20 cents per lb.

CUMIN

Cumin is the fruit of a herbaceous annual known as *Cuminum cyminum*, L., a native of the Mediterranean region, Upper Egypt, and Arabia. It is largely cultivated in India, as the coriander and dill, for curry powder. It is a herb about 1 ft. tall, with a much branched stem, strongly striate or angular, with nearly sessile upper leaves, the lower ones with longer leaf-stalks, the blade divided into long, slender, setaceous, linear segments, pale green. The flowers are rose-coloured or white, in stalked umbels of few rays. The fruit, about $\frac{1}{4}$ in. long, oval, oblong, very little compressed, greyish brown, and the ridges finely hispid with papillose hairs. In some forms the hairs are quite absent.

Cumin seed was well known to the ancients, and is mentioned by Isaiah. It is exported to Europe from Morocco, Sicily, Bombay, and Calcutta.

It is cultivated in India in the same way as coriander and dill, as a field crop.

It is used, as above stated, as an ingredient in curry, and also to a certain extent in native medicine. It seems to have gone out of European medicine, being replaced by caraway seed, which has a more agreeable flavour. The oil has an aromatic, bug-like taste. East Indian cumin gives 3 to 3·5 per cent on distillation.

CHAPTER XIII

GINGER

The ginger is a herbaceous perennial plant, belonging to the order *Scitamineae*, and known as *Zingiber officinale*, Roscoe. It possesses a white, pungently aromatic rhizome, covered with scale leaves, which emits at intervals leafy stems, usually about 2 ft. tall, and rather slender, and covered with the sheaths of the leaves. The blades of the leaf are lanceolate acuminate, ending in a long point, light green and herbaceous, about 6 in. long and $\frac{3}{4}$ in. wide. The inflorescence is normally borne on a separate stem rising directly from the rhizome, but occasionally is found terminating a leafy stem. It is in the form of a cylindrical cone of bracts, about 3 in. long, pale green, and borne on a peduncle about 1 ft. tall. From between the bracts appear at intervals, usually one or two at a time, thin, yellowish white flowers, with a black and yellow marbled lip. The stamen projects over the lip, and has an oblong, yellowish white anther, terminated by a long white horn, the connective. The style, which runs up through the anther, is slender and filiform, with a small round stigma. The fruit, which is very rarely produced, is in the form of a thin-walled capsule containing a number of small, black, angled seeds.

VARIETIES OF GINGER

There do not seem to be many forms or varieties of the plant, as indeed might be expected on account of its always being grown from cuttings, that is to say, by asexual reproduction, and not or very rarely propagated by seed.

The Malays are acquainted with three forms, which they know as Halyia betul, Halyia bara or Halyia padi, and Halyia hudang.

Halyia betul (true ginger) is the name given to a form with rather broader leaves and white flesh to the rhizome. It is taller also than the others. It is the one used for making sweetmeats, and also as an adjunct to curry.

Halyia bara or Halyia padi (bara, hot coals; padi, rice), on account of the hotter taste and narrower leaves, is a smaller plant with yellowish rhizome. This is a more pungent variety, and is used in medicines.

Halyia hudang (prawn, *i.e.* red ginger) is a Sumatran variety used in medicine. It much resembles the last, but the base of the stem is redder. It is chiefly used in native medicines.

In Jamaica the planter divides the plant into "blue" and "yellow" ginger, so called from the colour of the rhizome. The names "turmeric" ginger and "flint ginger" are also used for the yellow and blue respectively. The turmeric ginger must of course not be confused with the *true* turmeric. Kilmer states that he cannot distinguish between the plant producing blue and yellow ginger, and says that many intelligent planters are unable to distinguish them apart without inspecting the rhizomes. He suggests that the "blue ginger" is a degenerate form. The root of the blue ginger is hard and fibrous, yields a smaller proportion of powder, is less pungent, and less valuable commercially. In another part of his paper he talks of the better quality as "white ginger." Yellow ginger of Jamaica has gradually, it appears, driven out the inferior blue ginger as being a more valuable kind, but where the ground is too poor to grow the best variety the inferior form may be grown. The blue kind seems to have been the first introduced into and cultivated in

Jamaica. In India, it appears that only one variety is cultivated, but the quality of the product varies with different localities, and such names as Malabar, or Cochin, Kumaon, or Bengal are names of the product as exported from those localities.

Canton ginger, the preserved or green ginger, seems to be a more distinct variety. The rhizome is thicker and more succulent, hence it is used for the sweetmeat, and it is said that it is not possible in Canton to dry it. It is probable that this, to some extent, is due to the absence of sufficient sun-heat in the season when the ginger is dug, but the rhizome is certainly more juicy.

There was formerly a little confusion as to the plant which was the source of the Canton ginger. In 1891, plants of what was supposed to be the Canton ginger were sent to Kew Gardens, and eventually turned out to be those of the greater Galangal, *Alpinia galanga.* Further investigation showed that by an error the wrong plant had been sent to Kew, and it was shown by Professor P. Groom, Mr. Ford, and others, both from the structure of the rhizomes and by the cultivation of the plant, that Canton ginger was *Zingiber officinale.* Mr. Ford showed, too, that there was a form of the same plant grown in the mountain districts of China, which had a smaller and dryer rhizome, and was prepared dry by the Chinese, who, however, valued it more as a spice.

NAMES

Ginger.—French, *Gingembre*; German, *Ingwer*; Hindu, plant, *Adrah*, dried rhizome, *Sonth*; Tamil, fresh root, *Inji*, dried, *Shukku*; Arabic, *Zanjabil*; Malay, *Haliya.*

HISTORY

Ginger seems to have been one of the earliest of the Oriental spices known to Europeans, and was certainly known to the Greeks and Romans. The name Zingiber (whence the word ginger) seems to be derived from the

Sanskrit Sanjabil, through the Arabic Zanzabil. The Greeks and Romans appear to have obtained it from the Arab traders to the East, who doubtless brought it from India. Its original home is unknown, as no one seems ever to have met with it in a wild state anywhere, and it was very early distributed over tropical Asia, from India to China. The spice was well known in England before the Norman conquest, and in the thirteenth and fourteenth centuries was nearly as common in trade as pepper, costing no more at that time, when spices were expensive luxuries, than 1s. 7d. per lb., or about the price of a sheep.

In the fourteenth century the Italians classified the spice in three forms :—

1. Belledi or Baladi, country or wild ginger.
2. Colombino, *i.e.* from Columbum (Quilon, in Southern India).
3. Mecchins, *i.e.* imported through Mecca.

Marco Polo is probably the first traveller who saw the plant alive, but he does not describe it (1280-1290). He met with it in China, Malabar, and Sumatra. It is first described by John of Montecorvino in 1292, and by the traveller Nicolas Conti.

Preserved ginger in syrup, known as green ginger, was imported into Europe as a sweetmeat as early as the Middle Ages. As the rhizomes of ginger are very easily transported in a living state for considerable distances, it is not to be wondered at that the plant was introduced into America very soon after the first discovery of the New World, and before any other Oriental spice. It was brought to New Spain (Mexico) by Francisco de Mendoça, and the rhizomes were exported from San Domingo as early as 1585, and from Barbados in 1694; and Renny (*History of Jamaica*) says that, in 1547, 22,053 cwts. were exported from Jamaica to Spain. Since that time Jamaica has been a continuous source of ginger, for which it has always been famous.

CULTIVATION

Climate.—The area in which ginger can be and has been successfully cultivated is perhaps larger than that occupied by any other spice; although there are a good many regions in which it might be grown, but which have as yet not produced any quantities. In India, both in the low country and up to an elevation of 4,000 to 5,000 ft. in the Himalayas, in the wet regions of the Malay Peninsula and the Malay Archipelago, in China round Canton, in Fiji and North Australia, in West Africa and as far south as Natal, and in the West Indies and Central America, it thrives and is cultivated successfully.

It does best, perhaps, where there is a resting period of dry weather, but samples grown in the rain-forest region of Malaya, where there is no dry season, would be difficult to beat anywhere.

It requires a tropical or sub-tropical region, where the temperature is high for at least part of the year, but it thrives at Canton, where the winter temperature is very low. Brilliant sunshine is necessary for it, as well as a heavy rainfall. In the ginger region of Jamaica the mean annual rainfall is given by Kilmer as 88 in., while that of the Malay Peninsula is about 98.

Soils.—The best soil for ginger is a light, free, sandy loam. Stiff clays or coarse sands are quite unsuitable for its cultivation. In the Straits Settlements, where the soil mostly consists of a stiff yellow clay, deficient in lime, phosphorus, and potash, the Chinese grow it successfully by thoroughly digging the soil over and working the manure, chiefly cow-dung, into the soil till it is thoroughly broken up and pulverised. Without such improvement the plant fails to grow or to produce good rhizomes. The ginger soil of Jamaica is thus described by Kilmer: "The underlying soil of this district consists of white and yellow limestone, with trappean formations. This is covered, in some of the nooks or valleys, with a pulverulent mould or loam deposit several feet in depth. The plant grows luxuriantly in such soil, but apparently will not grow in marshy soil, nor where there is present more than 10 to 20 per cent of clay or 30 per cent of sand."

It certainly seems to dislike more than a comparatively small percentage of sand. The sandy soils are more apt to pack after a heavy rain, and to become too dense for the rhizomes of the plant. Wet swampy ground does not suit it at all, and ground apt to be flooded is to be avoided.

In cases in which the ground becomes too dry in the dry season, a system of irrigation will be needed, and swampy ground may be utilised by systematic and careful drainage. But the ideal ground for ginger is good garden soil, rich in humus, light and well worked, friable and fairly dry. A very large proportion of the ginger produced in Jamaica is cultivated by the natives as a garden-plant in small plots, in much the same way as potatoes are grown in England.

The class of soil in which it is grown seems to have a considerable importance, not only in the amount of the crop, but in the size of the hands or rhizomes, and in their texture. Thus it is remarked that in rich cool soil, recently cleared of wood, "it grows so luxuriantly that a large spreading root will weigh near a pound. It is, however, remarked that what is produced from a clayey, tenacious soil shrinks less in scalding, while such as is raised in richer, free black moulds loses considerably in that operation."[1]

In Jamaica for many years the extravagant and ruinous policy of destruction of virgin forest by felling and burning, followed by cultivation of ginger for a few years and then abandoning the land, now spoilt and worn out, and destroying more forest, was pursued, as has been done in the Straits Settlements and others of our colonies. The soil of the virgin forest is rich enough for the growth of ginger, and will last for a few years, when, with the washing out of the nutritive elements

[1] Long's "Jamaica," quoted in *Kew Bulletin*, 1892, p. 79.

by the rains, the land becomes quite valueless, and Mr. Fawcett suggests that it would probably take 100 years to recuperate. "Fertilisation of the soil was rarely attempted, partly from the small profit made, and partly from local custom. The most that was done was to plough in the weeds and throw banana trash on the ground. There were no stables in Jamaica, so there was no such thing as the compost-heap. Sea-weeds and watering the ground with sea-water was tried experimentally, with good results, but the average planter would not take the trouble to cultivate the ground in a scientific manner" (Kilmer, in *The Land of Ginger*). "Dried-up streams, general barrenness, in fact a wilderness, marks the progress of ginger cultivation."

The accounts of the ruin of great tracts of country in Jamaica, as given thus by Kilmer and Fawcett, apply in equal force to many other of our colonies and to many other of the temporary crops. Such destruction and waste are not at all necessary, and are due to incompetency of the local governments, and especially to that of the land officer, whose duty it is to see that the land is cultivated properly, and not permanently destroyed in order to add a temporary increase to the land-revenue.

"Ginger can be and is," says Fawcett, "grown in many places year after year on the same ground. An intelligent cultivator at Borbridge stated that he knew of ginger growing for forty years in the same patch," and he mentions an old resident who cultivated ginger and arrowroot on the same ground since his youth. It is therefore quite unnecessary to destroy forests of great value in order to grow a few crops of ginger, in fact it is inexcusable.

It was Sir Henry Blake who strongly urged the arrest of the wasteful system of forest destruction, and the rational scientific cultivation of the old ground by the use of manures. The Jamaica Agricultural Society in 1895 commenced experiments in manuring. An examination of the exhausted soil revealed the fact that it was deficient in organic matter, lime, phosphoric acid, and sodium. Various market fertilisers produced no favourable results. Stable manure and bat guano, from the island caves, were also a failure. The use of a marl, when mixed with stable manure, was a partial success. The Society experimented on a limited area of worn-out ground, upon which a check experiment gave no return, and obtained by a suitable compost a crop equivalent to 2,500 lbs. per acre, and of a product of extraordinary size and quality. The fertiliser which produced such results was a mixture of marl with a compost of about 10 per cent of soluble phosphates, ammonia, and potash salts.

Preparation of the Soil.—The mode of preparing the soil depends to a considerable extent upon the actual conditions of the climate, and the planter must use his judgment as to the most suitable method.

In any case the soil must be broken up fine, either with hoe or plough, and if possible harrowed afterwards.

In Bengal, according to the Report of the Director of the Agricultural Department for 1886, the ground is ploughed in March or April, after every fall of rain, and altogether receives twelve or thirteen ploughings. It is then levelled, and water-channels are made in order to irrigate the ground. The water-channels are made from 60 to 80 ft. apart, and connected by smaller ones running at right angles to the main channels, about 8 ft. apart.

Planting.—Ginger is always grown from cuttings of the rhizome. Seeds of the plant seem absolutely unknown. The joints of the rhizome each contain an "eye," that is to say a bud, and from these buds the plant grows. Often the portions of the rhizomes cut off in peeling the ginger are used as stock. Frequently, however, a proportion of the crop is retained for planting stock. The cuttings should be from 1 to 2 in. long.

Planting in India and the West Indies generally takes place in March and April, but sometimes later, till June. This really depends on the time of occurrence of the wet season; where, as in the Straits Settlements, there is no great distinction of seasons, there is no special time for planting.

In Bombay, as the stock-rhizomes have to be kept for a month or two after digging, till the time for planting has arrived in March and April, the rhizomes when taken up are allowed to wither, then washed and dried in the shade, and piled in a heap on dry sugar-canes and ginger leaves. More leaves are thrown over the pile, and the whole is covered with an air-tight covering of clay. They are thus preserved till the time for planting is at hand, when they have begun to sprout.

Beds.—In the Straits Settlements the Chinese grow the ginger in the ridge-and-furrow system that we are accustomed to see in use in the cultivation of potatoes. The earth is thrown up in ridges about 1 ft. or so wide, and running to whatever length may be convenient. The intervening furrows act as drains to prevent accumulation of water in the ridges. In Jamaica, according to Mr. J. B. Kilmer, the planting process consists of burying the cuttings in trenches or holes a few inches below the surface and about 1 ft. apart. The small grower simply digs a hole in a convenient spot. The thrifty planter first burns over his plot to destroy weeds and insects, ploughs it over, and lays it out in beds and trenches.

In Madras the beds are made 10 to 12 ft. long, and 3 or 4 ft. wide, and in these small holes are dug $\frac{3}{4}$ to 1 ft. across, and filled in with manure. The sets are then buried in the holes, and the beds are covered with a thick layer of leaves.

In Bombay the land is ploughed into furrows $13\frac{1}{2}$ ft. long and $\frac{1}{2}$ ft. broad, 3 in. deep and 9 in. apart. The sets are then laid in the furrows at intervals of 9 in. and the earth between the furrows thrown into them, and the whole is levelled.

N. Mukerji (*Handbook of Indian Agriculture*) recommends the planting of ginger and turmeric under the shade of orchard trees, as benefiting the trees by preventing the development of insect pests and utilising the ground. He makes little difference between the cultivation of the two plants, and his general method is described under turmeric. He gives the output of ginger at 50 maunds (2,600 lbs.), but says that three times as much can sometimes be obtained. The ginger can be sold undried at 4 rupees per maund of 25 lbs., and the cost of cultivating comes to about 50 rupees per acre, which at 50 maunds to the acre gives 200 rupees, or a profit of 150 rupees per acre.

Growth of the Plant.—Some investigations were made in Jamaica with the object of securing a regular shaped growth, with more or less straight fingers, as this form commands a higher price in the market. In the growth of the plant, a stem starts from the eye or bud of the cutting, and from this stem in turn lateral shoots or branches develop in pairs, the pairs generally alternating on opposite sides. It was observed that if the soil was well worked and pulverised before planting, the growth was straighter than when planted in hard soil, and that if the parent plant was well developed and vigorous, the resultant root-stock was of a better type than when the parent was small, gnarly, and crooked.

To get the best results, therefore, the planter should carefully select his stock for planting, and should be particular about pulverising and thoroughly breaking up his soil.

The amount of rhizomes required for planting is estimated in Bengal at 4 maunds (100 lbs.) for 1 bigha (1,600 square yards), and in the Punjab twice that amount.

The cost of the rhizomes selected is estimated in Bengal at 4 rupees a maund, and in the Punjab 8 to 10 a rupee.

The planters in Jamaica distinguish between "plant ginger" and "ratoon ginger." By the former is meant ginger from fresh cuttings, which gives the best result, and is indeed the best method of cultivation. When the stock is left in the ground to throw up fresh stems, and produce fresh rhizomes, it is known as "ratoon ginger." Some planters leave the ratoons in the ground till they become practically exhausted, and then either fallow the ground or plant some other crop. Rotation of crops is seldom really practised in the tropics in the way that is considered essential in Europe. The usual way of the Chinaman in the Eastern tropics with such crops is to continue planting the same crop in the same ground till, gradually deteriorating, it ceases to be remunerative, or till the price goes down owing to over-production. He then throws it out and plants with some other crop which promises a higher remuneration.

Ginger is considered an exhausting crop, and would certainly pay best if grown in a rotation system with other crops.

Much of the ginger in Jamaica is cultivated as a garden plant, with bananas, chilies, etc. in small lots, and this lends itself better to rotation than cultivating it on a large area as a permanent crop.

The ginger appears above-ground about ten to fifteen days after planting, under good circumstances, but may be as long as two months before it begins to show. Planted ginger is dug in December or January, or on till March in Jamaica, and about the same time in most parts of India. Ratoon ginger in Jamaica is lifted between March and December.

During the period of growth little requires to be done beyond weeding. In the dry season of the Punjab, from October to January, the beds require irrigation. Manuring is not always continued after the plants are in the ground, but in Bengal the plants are top-dressed with 100 lbs. of oil-cake, consisting of equal proportions of mustard cake and two of castor cake.

Ginger is known to be ready for lifting when the green leafy stems turn yellow and wither, and this usually happens when the flowers are over. The plant does not always produce flowers. Indeed, in some places flowers are very rarely seen. In Canton it seems to flower somewhat regularly, and in Jamaica it is common, but it is seldom that one sees the flowers in the Malay Peninsula. When ready for lifting it is dug up carefully with a fork, care being taken not to bruise or break it in so doing. When lifted, the hands or rhizomes are thrown into heaps, the roots broken off, and soil and any other matter adhering to them at once removed. This must be done quickly as, if the ginger dries with the roots and dirt upon it, it will not become white. The rhizomes are thrown immediately into a dish of water in Jamaica, and are then ready for peeling.

Manures.—Ginger is a plant which requires a good deal of manuring, even in the best of soils, and even in India, where manure is comparatively seldom used for country crops, manure of some sort is invariably applied. In Malabar the manuring is done first, at the time of planting, the manure, cow-dung, being put into the holes when the sets are planted. Besides this, however, the beds are afterwards covered with a thick layer of green leaves, which protects the young plants from excessive dampness, which might be caused by the violent rainfall of the monsoon, while their decomposition gradually aids in supplying nutriment to the growing plants. The leaves for this purpose are carefully selected, as those from certain trees are supposed to form breeding-grounds for obnoxious insects.

In Bombay manure is first applied when the plants are about 1 ft. tall, and for this purpose oil-cake is used at the rate of 5 lbs. to each bed (the beds being 13½ ft. long and ½ ft. broad). This manuring is repeated twice more, in August and September. The first two layers of manure are not covered with soil, but the third one is covered in.

In the Khandesh district the manure used is stated to be equal parts of horse, cow, and sheep-dung mixed. In Bengal at the time of ploughing 30 maunds (840 lbs.) of well-rotted dung is applied to 1 bigha (1,600 square yards), and later the ground is top-dressed with 10 maunds of oil-cake.

In the Punjab the leaves are laid over the beds and the manure is laid on the top of them, so that under the influence of the heavy rains of the wet season it gradually soaks in.

The system of mulching with dead leaves, cut grass, etc., might be practised more largely for all crops in the East than it is, but it is desirable to bury the mulch with a little soil, as less of the products of decay are lost. It is not always possible, however, to obtain leaves and other vegetable debris to get a good, suitable mulch.

The Chinese in the Straits Settlements use only cow-dung for manure, and this they dig into the ground before planting. Oil-cake and other high-class manures are not within their reach. Horse-dung is rarely used here in any cultivation, unless it has been rotted for some years, as it is considered too hot, but old, well-decomposed stable manure, especially when mixed with cow-dung, is very suitable for all cultivations of this type.

PREPARATION OF THE SPICE

There are two forms in which ginger is usually prepared for the market, viz. dried or cured ginger and preserved or green ginger. In the West Indies and India the spice is prepared as dry ginger, while China supplies the greater part, indeed practically all, of the preserved ginger.

DRIED GINGER

√ After the rhizomes are dug up they are cleaned of dirt and the roots cut away, and then are sometimes prepared for market by merely gradually seething or scalding them in hot water, after which they are spread out every day in the sun till they are sufficiently dry, and packed in parcels of 100 lbs. for the market. This is called *Black Ginger*. In scalding the rhizomes, a large pot or copper is fixed in the field or some convenient place, and kept full of boiling water. The ginger, cleaned of roots and earth, is divided into small lots in baskets and plunged in the water, where it stays ten or fifteen minutes. It is then spread out on a platform to dry. During the process the water is occasionally changed (*Kew Bulletin*). According to Kilmer, however, scalding the ginger is not practised to any extent in Jamaica. The effect of this treatment is to swell the starch and bassorine-like gums. He found that by treating the ginger with boiling water for an hour the rhizomes are considerably swollen, and the water was filled with the aroma of ginger. Under the treatment with boiling water the skin comes off easily, but if the action is continued the starch and fibre are acted on, and the rhizomes dry hard and become darker in colour.

In Khandesh, India, the rhizomes are at first partly boiled in a wide-mouthed vessel, then after drying a few days in the shade they are steeped in weak lime-water, sun dried, and steeped in stronger lime-water, and then buried for fermentation. When the fermentation is over, the ginger, now called *Sonth*, is ready for market.

In some of the Indian bazaar ginger the rhizomes are roughly washed and then smeared with cow-dung and hung up in baskets, or placed on trays, among the rafters, where the smoke of the house cures it. This bazaar ginger is shrivelled, dirty, and most uninviting looking, and is very apt to be destroyed by the boring beetle. A writer in the *Pharmaceutical Journal* suggests that the ginger should be brushed first with a hard brush till every earthy particle is removed, and steeped for a night in a pretty strong solution of lime-water (1 ounce of unslacked lime to the gallon), then well rinsed in clean water and dried slowly in a brick oven at a temperature of 140° to 160°. Ginger prepared thus in one of the Sylhet plantations fetched nearly as high a price as the best Jamaica ginger.

In the Punjab, Baden-Powell says that the rhizomes are dried by placing them in a basket suspended by a rope, and shaking it for two hours a day for three days.

They are then dried in the sun for eight days, and again shaken in the basket, and after two days' more drying are ready for sale. The shaking in the basket is to remove the skin and scales. In Bombay the rhizomes are rubbed with tiles to remove the skin, and then baked and dried in the sun.

PEELING

In Jamaica the finest ginger is *peeled* or *uncoated.* The peeling of the rhizomes requires some care and skill. It is usual for the most skilful peelers to peel between the toes, the easier sides of the rhizomes being done by children or less experienced persons. The peeling is done with a specially made knife, with a narrow-edged blade riveted to a handle. Some attempts were made by the Jamaica Agricultural Society to invent a peeling machine, but I can find no record of success in this direction. After peeling the hands are thrown into water and washed. The purer the water and the more that is used the whiter becomes the ginger. The hands are peeled during the day, and are allowed to remain in the water all night. The water acquires a slimy feeling, and if concentrated becomes mucilaginous, and acquires a warm and aromatic taste. Kilmer put some pieces in a running stream for twelve hours, and found that the ginger became several shades lighter, but at the same time less pungent. Some planters use lime-juice in the water in which the ginger is washed; this makes it whiter, as the lime-juice dissolves out the colouring matter, but at the same time the ginger so treated is apt to grow mouldy. Kilmer then tried utilising citric acid, vinegar, and acetic acid; all worked well, but citric acid gave the best results. However, these processes were found both expensive and troublesome.

CURING

After washing the ginger is dried in the sun. Some planters made use of a barbecue, such as is used in coffee drying. It is made by levelling a piece of ground, covering it with concrete or broken stone, and overlaying it with cement; of course a spot exposed to full sun is selected, and the ginger laid on it to dry. Others use a frame-work of sticks, with boards or palm or banana leaves laid upon it, or, more commonly, a few large banana or palm leaves are laid on the ground, and the ginger laid on them. In countries where palm or pandanus-leaf mats are commonly used, these would doubtless be more convenient for drying the spice.

The rhizomes are put out at sunrise and turned over at mid-day, and taken indoors in the evening. In rainy or cloudy weather it is apt to get mouldy if care is not taken. It requires six or eight days to become thoroughly dry. During the drying the rhizomes lose nearly 70 per cent in weight. Ginger dried as for market contains from 7 to 12 per cent of moisture, as was shown when such ginger was dried at 100° C.; and some poorly dried specimens, some of which were damp and mouldy, when dried at 100° C. showed a loss of from 15 to 25 per cent.

As it happens that the weather was not always suitable for drying ginger, and prolonged rains make it impossible to sun-dry it, whereby the planters lose their crop, attempts were made to dry by fire heat. An attempt was made to dry without removing the coat, which if successful would have saved a considerable amount of labour. The result, however, of this was that the rhizomes became quite dark in colour, and the flavour was not as good as in sun-dried spice. Further experiments with an American fruit evaporator were also a failure, partly owing to the high temperature required, and partly from ignorance of the operator. The rhizomes lost much of their aroma, were darker in colour, and had a smoky, burnt flavour. Still, it is possible that a method of fire-heat drying might be evolved, which would save much labour and risk of loss from wet weather.

Attempts, too, were made by drying with calcium chloride, but these did not equal native sun-dried ginger, and slicing and drying resulted, as might be expected, in a loss of aroma.

SORTING AND SHIPPING

The buyers in Jamaica sort the spice, and value it according to condition, in the following grades. The highest grades are large-sized hands of light and uniform colour, free from any trace of mildew. They are brittle and crack easily, but broken pieces depreciate the value. They should be firm and full, without wrinkles or spots. Shrivelled and small hands form another grade, and dark varieties another; the heavy, tough, and flinty are another grade. Of these grades the best in texture and colour are selected for a second class grade. Ratoon ginger usually brings the lowest price, as the hands are small and soft and less aromatic. When gathered too young the ginger shrivels a good deal, and is less aromatic and pungent.

Mildewed ginger is spotted, and acquires a musty flavour, impossible to eradicate.

The dried ginger is packed for shipment in barrels, the common kind in bags. Formerly it was exported in casks of a size equivalent to four or five barrels.

PESTS

I do not find many pests recorded for this plant, nor have I seen any insects or fungi attacking the plant myself. The chief danger seems to be from one or more fungi, of which the worst is known as Black-rot.

This disease is described by W. Harris and Mr. Howard in the *Jamaica Bulletin*, 1901, p. 180, and 1902, p. 42.

The disease, says Mr. Harris, is well known in Jamaica, and affected plants are easily detected. The symptoms are sickly yellow foliage, the stem black and decaying, and the rhizomes also black and decomposed.

The rhizomes, on examination by Mr. Howard, showed dark areas containing the mycelium of a fungus with numerous chlamydospores, frequently arranged in chains, as occurs in *Allantospora radicicola*, a sugar-cane disease in Java, to which this fungus appears to be allied.

The disease is due to this fungus, which travels underground by means of rhizomorphs, or black mycelial strands. The rhizomes are filled with this mycelium, which collects in strands, and spreads to other roots through the ground.

The ginger growers carefully dig out affected plants and those next to them, even if they look healthy, and destroy them. It is recommended to wash the rhizomes thoroughly in clean water, and steep them for half an hour in Bordeaux mixture before planting them. This treatment has proved very successful in the case of sugar-cane cuttings liable to the attack of a similar fungus. A cemented tank was made and partially filled with a rather weak solution of Bordeaux mixture, and into this the cuttings were thrown for some hours, after which they were planted. The same might be done with any underground stems liable to fungus attacks, such as ginger.

Infected ground should be treated with lime, or a light dressing of sulphate of iron.

This disease spreads rapidly, and if neglected a whole patch may be destroyed.

Cork-rot.—This is another disease met with in Jamaica. Its origin appears to be unknown. The rhizomes when dug up are found to be corky in texture, and valueless. One planter stated that out of a crop estimated to yield fifty to sixty barrels of ginger, he only got five barrels of healthy rhizomes, the rest being spoiled by cork-rot.

Dried ginger, like many other products, is liable to the attack of the drug-store beetle, *Sitodrepa panicea*. This is a very small and destructive insect, about $\frac{1}{10}$ in. long, light brown in colour, and covered with a greyish pubescence. The larva is like a miniature chafer-grub. It tunnels through the ginger, and eventually pupates therein. It does not confine itself to ginger, but eats all kinds of spices, herbs, drugs, leather, etc. This beetle and other such pests are destroyed by enclosing the produce attacked in a closely covered tank, and putting some carbon bisulphide in the tank, the fumes of which in a few hours kill the insects.

RETURNS OF CROP

The yield of rhizome varies to a certain extent with the nature of the soil, as well as with the amount of care taken in its cultivation. The rainfall and sunshine also are important factors not only in the growth, but also in the value of the crop when gathered. In seasons of excessive rain at the time of digging the roots, it may be impossible to dry the rhizomes by sun heat, and they may suffer much from mildew.

In Jamaica the average yield is estimated at from 1,000 to 1,500 lbs. of dried ginger per acre, and in exceptional cases 2,000 lbs. has been obtained (Kilmer). In Bengal the yield is given as 40 to 60 maunds (1,000 to 1,500 lbs.) per bigha (1,600 square yards), and in the Punjab a good crop is 32 maunds (700 lbs.) per bigha.

A writer in the *Queensland Agricultural Journal*, 1906, p. 451, gives the returns as 1,000 to 1,500 lbs. per acre, and says that 2,000 lbs. are often obtained.

COST OF CULTIVATION

The exact cost of producing the crop is not easy to give an estimate of, as the expenses of labour, manuring, land, etc. vary so much in different parts of the world. Some estimates from various sources may be given as assisting in forming some idea as to its cost.

In Jamaica (from Kilmer's figures), per acre :—

Ground rent or tax	$5·00
Clearing, ploughing, and planting .	40·00
Cost of plants	50·00
Digging and preparing . . .	15·00
Peeling	45·00
Drying	25·00
Delivery at market	10·00
Fertiliser	50·00
Superintendence	20·00
	$200·00

Yield of one acre, 1,500 to 2,000 lbs. at 12 cents per lb., $180 to $300. The expenses here seem very high.

In Bengal (Murray's figures) :—

	Rupees per Bigha (1,600 sq. yds.).
Cost of plants . . .	16
Manure	7
Planting, etc. . . .	23
	46

In the Punjab a bigha requires 8 maunds of rhizome to plant it, and yields 32 maunds in a good year. Selected rhizomes for planting cost 8 to 10 seers for a rupee, and the ordinary crop 24 to 32 seers per rupee (Baden-Powell, in Watt's *Dictionary*).

A correspondent in the *Indian Planters' Gazette*, quoted in the *Tropical Agriculturist*, April 1903, p. 660, gives as an estimate for one bigha :—

	R.	A.	P.
10 ploughs at 4 annas	3	2	0
Manuring	8	0	0
20 coolies for preparing land at 5 for the rupee .	4	0	0
10 for planting at same price	2	0	0
Weeding, etc.	8	0	0
Digging and sorting, 16 coolies	3	0	0
Irrigating	6	0	0
Rent for one year	2	3	0
	36	5	0
Returns, 10 maunds green ginger at 6 rupees per maund	60	0	0
Profit for 1 bigha	23	11	0

He remarks that the preliminary cost of raising a crop of ginger of 1 bigha extent is far in excess of the cost of that of raising turmeric. But as ginger may be made to last three years, the average cost will be found to be lower, and the returns higher.

In Barbados, Mr. Bovell gives an estimate of the cost of planting and harvesting ginger in this island in the *Occasional Bulletin*, No. 9, 1898, Barbados Botanical Station. It is as follows :—

Expenses.		Dollars.
Forking 1 acre of land		2·88
Manuring—		
1,200 baskets of farmyard manure at 1 cent a basket	12·00	
Applying manure	·96	
Spreading and hoe ploughing in .	1·20	
	——	14·16
Planting—		
Liming	·30	
Digging Holes	4·35	
Planting	4·35	
Weeding	3·20	
	——	12·20
Plants 1,752 lbs. rhizomes at 2 cents per lb. . .		35·04
Digging and washing		88·44
Scraping rhizomes		176·80
Drying and filling barrels		3·00
26 barrels at 12 cents each		3·12
Heading barrels at 3 cents		·78
Freight to port (Bridgetown)		3·12
Total expenses for 1 acre		359·54
Sale of 3,435 lbs. after deducting freight, etc. .		446·55
Profit . .		106·55

In Ceylon a planter (W. M. P.), in *All about Spices*, p. 143, gives for 1 acre :—

	Dollars.
Land	10·00
Trenching	40·00
Carry forward . .	50·00

	Dollars.
Brought forward . .	50·00
Clearing jungle	25·00
Pegging	6·50
Price of plants	25·00
Keeping clean	6·00
Gathering crop	11·00
Attending kiln	6·50
Erection of kiln	25·00
First year's cost	265·00
2nd year.	
Keeping clean	6·00
Planting	10·00
Gathering crop	11·00
Attending kiln	6·00
Miscellaneous	25·00
Buildings	25·00
Total . .	348·00
Sale of two years' crops, say 8,000 lbs. dry ginger at 15 cents per lb.	1,200·00
Seen expenditure	348·00
Profit . .	852·00

The return, 8,000 lbs. per acre, seems very large compared with that of Jamaica and India.

REGIONS OF CULTIVATION

India.—It is cultivated in all the moister and warmer parts from the plains to 4,000 or 5,000 ft. in the Himalayas. In Malabar the best is said to be the produce of the district of Sherwood, situated to the south of Calicut. This part of India has been famous for its ginger for three centuries at least, its cultivation here being mentioned by Linschoten (1596).

In Bombay the crop is of considerable importance. In 1888 to 1889 it occupied 918 acres, of which 640 were in Gujarat. In Bengal ginger is largely grown, its cultivation extending to Nepal and other localities on the border of the Himalayas, and that of Nepal is especially highly spoken of and considered superior in its very high flavour to that of the Bengal low country.

In the North-west Provinces it is extensively grown in the hot valleys in Kumaon, and the Punjab also supplies a considerable quantity of good ginger.

The amount of land actually occupied by this spice in India is difficult to estimate as it is elsewhere, because in most places it is grown as a garden plant, that is to say, in small patches, the area of which is very difficult to estimate.

The amount exported from India is, however, large and important.

Milburn states that the amount imported by the East India Company in 1808 was 2,245 cwt., valued at £5629.

P. L. Simmonds in *Tropical Agriculture* gives the following export table :—

1869 . .	11,825 cwt.	valued at	£20,017
1870 . .	15,313 „	„	27,647
1871 . .	13,014 „	„	28,199
1872 . .	13,210 „	„	28,217
1873 . .	14,959 „	„	39,830
1874 . .	16,004 „	„	47,410
1875 . .	30,307 „	„	85,384

Murray (*Dictionary Economic Products*) gives the following as the quinquennial average exports :—

1875–1880 . .	6,691,867 lbs.	value	R.9,72,853
1880–1884 . .	5,421,379	„	8,89,016
1885–1890 . .	10,377,710	„	13,94,213

The trade suffered a large diminution during the years from 1880-1881 to 1883-1884, but received in 1884 and 1885 and in 1886-1887 a maximum of 14,927,926 lbs. In the following years it fluctuated considerably, and in 1889 to 1890 fell to 6,918,681 lbs., the lowest export since 1883-1884.

The price also showed a great diminution, for, at the same time, and about 1893, the price was 1 rupee per 10 lbs., or a little over 11 rupees per cwt.

The greater part of the Indian ginger goes to England, and the countries importing it are given (for 1893) by Mr. O'Conor (*Dictionary Economic Products Ind.*) as follows :—

	lbs.
United Kingdom . .	3,827,990
Austria	230,434
France	57,042
Germany	81,116
East Coast Africa . .	77,987
United States . . .	546,025
Aden	811,405
Arabia	708,682
Ceylon	106,609
Persia	328,198
Turkey in Asia . . .	121,569
Other countries . .	21,624
	6,918,681 lbs. valued at 7,03,981 Rs.

	lbs.
Of this Bombay produced .	3,120,555
" Madras " .	2,881,710
" Bengal " .	913,352
" Sind " .	3,164
	6,918,691

The prices given for this product differ considerably from different districts. Thus the above quoted quantities were valued at :—

Bengal . .	57,351 Rs.	10·6 Rs. per cwt.	approximately.
Bombay . .	3,17,245	9·9 "	"
Sind . .	280	11·6 "	"
Madras . .	3,29,105	8·7 "	"

Ceylon.—It does not appear that ginger has been cultivated to any great extent in Ceylon at any time. In Matale West it appears that it was a failure owing to unsuitability of soil. A few planters here and there seem to have had a try at it, but it gradually was abandoned. Only a few acres represent the planting area at the present day.

The records of ginger cultivation recorded give :—

In 1882	144 bags	valued at	Rs.	572
1883	198 ,,		,,	595
1884	319 ,,		,,	1327
1885	793 cwt.		,,	3475
1886	1732 ,,		,,	7802
1887	388 ,,		,,	1841
1888	276 ,,		,,	1440

MALAY PENINSULA

A certain amount is always cultivated, chiefly by the Chinese, in many parts of the peninsula, Singapore, Malacca, Penang, and Province Wellesley. It thrives very well with careful cultivation and good manuring, and excellent samples are often to be seen at the local agricultural exhibitions. It is cultivated only in small patches, as a form of garden cultivation, with chilies, sweet potatoes, etc., alternating with it. It is not dried, or frequently prepared as a conserve, but is generally used fresh locally, mainly in local medicines, and curries.

AFRICA

In Africa attempts have been made to cultivate the plant commercially in Sierra Leone (*Agricultural News*, viii., 1909, 56). In 1906, 618 tons of dried ginger, valued at £11,578, were exported, and in the following year an increase of 38 tons is recorded, with an increase in value of £699. Improved methods of preparation were introduced, and the produce realised 65s. to 66s. per cwt. as against 32s. 6d. prepared in the ordinary native way. The cultivation here seems to be increasing.

POLYNESIA

Fiji Islands.—Some correspondence on the cultivation in Fiji was published in the *Kew Bulletin* in 1892, p. 76.

Mr. Yeoward, the Curator of the Botanic Gardens at Suva, wrote to Kew that he found a large quantity of the plant growing in the Botanic Gardens there, and distributed some to planters, planting half an acre himself. After some difficulties in drying he managed to prepare samples which were attractive in appearance, and of good colour and flavour. Messrs. Lewis and Peat reported that it was good, plump, white, part hard and part soft, and valued at 40s. to 42s. per cwt. Messrs. W. and D. Harvest valued it at 34s. to 36s. per cwt., and considered it very inferior to the ordinary East Indian ginger, or to that produced in the island of Jamaica, being rather hard and unsuitable for many purposes for which ginger is used. It much resembled that from Japan. Shortly after this correspondence passed, a note on this ginger appeared in the *Pharmaceutical Journal*, March 26, 1892, p. 802, by Mr. E. H. Gane. This stated that it was "remarkable for its exceeding fine aroma and peculiar pleasant taste, recalling that of lemon," though it was not of such fine appearance as the Jamaica ginger. The rhizomes, which had been carefully dried, as was evidenced by the small amount of moisture present, were rather more fibrous that that of Jamaica, and some of the pieces were heavy and resinous, but otherwise the colour appeared similar. Its powder is of slightly darker colour than a fine Jamaica ginger, but about the same colour as the commercial article and, therefore, much lighter than either Cochin or African. The fine lemon-like odour is much more distinct in the powder. A tincture of ginger made with alcohol was found to be darker than that of Jamaica ginger, and more aromatic and pungent.

Some interesting analyses of the different kinds of ginger are given :—

	Jamaica.	Cochin.	Africa.	Fiji.
	per cent.	per cent.	per cent.	per cent.
Volatile oil	0·64	1·35	1·615	1·45
Fatty matter	0·92	1·200	1·225	0·86
Resins	1·76	1·815	3·775	4·17
Acid and neutral gingerol .	0·84	0·600	1·45	1·82
Moisture	1·366	13·53	14·515	11·25
Ash	4·53	4·8	4·27	4·00

The Fijian ginger is thus seen to be the richest in active constituents.

WEST INDIES

As has been previously mentioned, Jamaica has been the most important island for the ginger industry, and holds a very high rank in its production. The cultivation commenced before 1547, and has been steady ever since. The actual area under cultivation is difficult to estimate, as a very considerable proportion is in small areas, in fact, in garden plots.

The government returns only give, according to Kilmer, 250 acres under ginger, but this amount of acreage would not yield the crop harvested. Many cultivators have beds from 6 ft. square to the size of a building lot, and a few cultivate from 1 to 6 acres. For the most part it is put in the ground in any convenient spot, alongside pineapples, yams, cacao, cassava, or other plants, often in the midst of a dense growth of bush or weeds. Mr. Kilmer judges "that from 25,000 to 50,000 persons are, more or less, dependent on the ginger crop for such ready money as is essential to maintain their existence."

The following are records of exports from Jamaica. It is noticeable that there is a very considerable fluctuation :—

In 1866	1,550,166 lbs.	In 1887	1,121,827 lbs.
1867	1,728,075 ,,	1888	1,141,877 ,,
1868	2,036,921 ,,	1889	1,002,653 ,,
1869	1,261,873 ,,	1890	554,193 ,,
1870	680,492 ,,	1891	1,219,197 ,,
1871	632,031 ,,	1892	1,822,531 ,,
1872	599,766 ,,	1893	1,526,884 ,,
1873	815,659 ,,	1894	1,672,384 ,,
1874	1,881,789[1] ,,	1895	1,736,460 ,,
		1896	1,960,609[2] ,,

Santa Lucia.—Some years ago two planters shipped a quantity which realised 70s. per cwt. I have no

[1] Simmonds, *Tropical Agriculture.* [2] Kilmer, *Land of Ginger.*

record as to whether the cultivation has been carried on later to any extent.

Barbados.—Mr. J. R. Bovell gives some account of cultivation experiments here in 1898 (Barbados Botanical Station, *Occasional Bulletin*, No 9, 1898). The object of these experiments was to find a payable substitute for sugar in fields affected by a cane-disease, while the fields were recovering from the presence of the fungus. The first experiment was made with blue ginger, which gave a return of 19,420 lbs. an acre. Next year both blue and yellow were tried, with the result that the blue gave a crop of 18,150 lbs. to the acre, the yellow 17,226 lbs. When the ginger had been scraped and dried it weighed, of blue 3,076 lbs., of yellow 3,794 lbs.

For valuation four samples were sent to Messrs. Wilkinson and Gaviller, London, who reported on them as follows :—

Sample	1.	Whole rhizomes of	yellow	valued	75s.	per cwt.
„	2.	„	blue	„	73s. to 74s.	„
„	3.	Pieces of	yellow	„	70s. to 71s.	„
„	4.	„	blue	„	68s. to 70s.	„

The average value was 70s. per cwt. The firm recommended that ginger of these qualities should not be sorted into grades, but should be sold without sorting, as this ginger would only do for grinding. Only very carefully selected ginger of the finest quality should be separated out as a grade.

About this time a consignment of nine barrels of Barbados ginger was sold at auction in London (June 15, 1898). The parcels were not of first quality, but fetched 73s. 6d. per cwt.

The reporters said: "The parcels showed a large proportion of nearly green ginger, which of course lessens the value, as dry hard ginger of good strength will always command a market, whereas on a slack market undesirable stuff, viz. green or dirty, is very difficult of sale." The value of Jamaica ginger of middling quality was then 80s. to 85s. per cwt.

The gentleman who shipped this ginger wrote that he shipped seven barrels and one box containing 9 cwt. 1 qr. 2 lbs. The produce of the barrels sold at 73s. 6d. per cwt., that of the box 73s. per cwt. Though the yield of his plantation was a poor one, it gave a net profit of £10 per acre. If, remarks Bovell, the yield had been as good as that of the Botanic station it would have been equal to £22 : 5 : 6½ per acre.

USES

Spice.—Ginger is one of the most popular flavouring agents known, and has been so used for very many centuries, entering into confectionery, ginger beers, ginger champagnes, and other beverages. In most of these confections the dried rhizome, ground fine, is used, and most of the inferior grades of the spice are sold in the form of ground ginger. The highest grades are, however, commonly sold as imported, and grated for use as required. Like all ground spices, ground ginger is apt to be largely adulterated with wheat flour, ground rice, potato flour, sago, turmeric, mustard husks and cayenne pepper.

In the East, fresh ginger rhizomes play an important part in curry, and in the Malay peninsula most of the ginger cultivated is used for this purpose locally.

Preserved Gingers.—Practically all the commercial preserved ginger, *i.e.* ginger preserved in syrup, comes nowadays into the market from Canton. The ginger for this purpose is grown in alluvial flats round Canton, and seems to be a more fleshy variety. The season for preserving in China is July to October, and the United States Consul there gives an account of its preparation in a report quoted in the *Agricultural News*, viii. 121 (1909), as follows :—" The rhizomes are first thoroughly cleaned in water and boiled in earthenware pans for two or three hours. Afterwards transferred to copper pans, in which is put sufficient water to cover the rhizomes, and a quantity of white sugar in the proportion of 5 lbs. of sugar to 10 lbs. of ginger. The mixture is then boiled for two hours, at the end of which it is put into large jars and allowed to stand for seven days, when it is again boiled in sugar and water in the same proportions as before, after which it is packed in jars or tins, or occasionally packed in barrels."

Another method is described as follows:—"For preserving ginger the rhizomes are taken up as soon as they are formed, while they are young and tender. The time for this varies according to the season in which the ginger is planted, but usually about two months after the young plants are put down, when the stalks are not more than 5 or 6 in. tall. The rhizomes are scalded, washed in cold water, and peeled clean. The water in which they are washed is frequently changed. A syrup is made of a pound of sugar to a pint of water, into which the beaten white of two eggs is gradually stirred. The syrup is boiled and skimmed, and when cold poured over the rhizomes. After two or three days the syrup is poured off, re-boiled, skimmed, and when cold poured over again, and the whole is left for three or four days."

The next process is to re-boil and re-clarify the syrup, and then pour it over the ginger hot. This is repeated till the syrup has thoroughly penetrated the rhizomes, evidenced by the taste and transparency of the rhizomes, and until the syrup has become thick and rich. The syrup is not applied hot in the first instance, as if this is done the ginger will shrink and shrivel (Bernay's *Cultural Industries for Queensland*).

Candied Ginger is made by drying preserved ginger made as above, a little dry powdered sugar being added to it in drying.

Medicine.—Ginger is comparatively little used in European medicine, but it is valued everywhere as a stomachic and internal stimulant, especially in flatulency and colic. It is also used as an adjunct to purgatives to correct griping. Fresh rhizomes pounded and the juice drunk is a common native remedy for colic and dyspepsia. It is also used to relieve toothache by chewing it, and in the same way for relaxed uvula and tonsils. It produces a flow of saliva when chewed. Powdered ginger taken in boiling milk has had a great reputation for gout. Externally it is used as a rubefacient for headache or toothache in the form of a ginger plaster, made by spreading the powdered ginger with warm water on a piece of cloth.

Oil of Ginger.—This is often extracted from the rhizomes to serve as a basis for tinctures or essences of ginger. The alcoholic extract known as "Gingerine" does not contain all the aromatic principles, as most of the essential oil is carried over in the recovered alcohol. T. H. W. Idris (*American Journal of Pharmacy*, *Jamaica Bulletin*, 1898, p. 207) writes that acetone proved to be the most suitable solvent, boiling as it does at 56° C. and being miscible with water in all proportions. The apparatus used was a modification of a Soxhlet on a manufacturing scale. The acetone extracts the whole of the aromatic and pungent properties, and does not appear to lose any of its volatile oil in the process of recovery, as happens so markedly in the case of the use of alcohol. The acetone extract is a dark brown substance of a treacly consistence, intensely pungent and possessing a full ginger aroma, the quality of which depends on the variety of ginger used. It is readily soluble in alcohol, forming a deep brown liquid. The difference in the aromas of the various kinds of ginger, noticeable enough when examining the rhizomes, is more apparent when dealing with the oils themselves. The various tinctures and essences of ginger may be conveniently and readily prepared from this extract without the usual loss of alcohol, and syrup may be flavoured with it without the use of any spirit.

Kilmer describes some experiments in extracting the oil with ether and with alcohol (*Land of Ginger*), and records that the finer grades when carefully dried contained a higher percentage of volatile oil. Ginger dried without removing the peel gave somewhat higher results than the peeled ginger, and the loss of the oils was greater when the rhizomes were dried by artificial heat than when they were dried by sun-heat. Extracts from ratoon ginger had a more fiery taste and less flavour than those from planted ginger, and yellow ginger had a better and finer odour and taste in the extracted oil than was the case in blue ginger. Upon the addition of water to the extracts to precipitate the resins, it was found that a delightful aroma, a true ginger flavour without fire or pungency, was imparted to the water. But in extracts from old ratoon ginger or mildewed specimens spoiled in drying the aroma was changed, being musty and weak. 95 per cent alcohol was found to give a better result as to flavour than that of a lower strength.

Cheap ginger for distilling purposes has been obtainable from Africa at advantageous rates in Liverpool and Hamburg (*Schimmel's Half-Yearly Circular*).

CHEMISTRY

The rhizomes of ginger contain three constituents of value, viz. starch, oil, and resin. It is to the oil of ginger that the odour of ginger is due; the pungent taste is due to the resin. Mr. J. C. Thresh (*Year-Book of Pharmacy*, 1879, 1881, 1882) very completely analysed the gingers of commerce, and describes gingerol, the active principle of ginger, as a viscid fluid of the consistency of treacle, of a pale straw colour, devoid of odour, and with an extremely pungent and slightly bitter taste. The essential oil is of a pale straw colour, a somewhat camphoraceous odour, and an aromatic but not pungent taste. He discovered the fact that a selected sample of Jamaica ginger contained only about half the quantity of essential oil found in the Cochin and African samples, and less of the active principle than the African, though about as much as the Cochin gingers. Though less, however, in quantity, the volatile oil of the Jamaica ginger possessed a finer bouquet than the others (Watt's *Dictionary of Economic Plants*).

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CHAPTER XIV

TURMERIC

The turmeric plant belongs to the same order as the ginger, viz. that of the *Scitamineae*, and is known as *Curcuma longa*, Linn. Though it has long been cultivated in India and has a Sanskrit name, no one seems to have met with it in a wild state, and it seems most probable that it is a native of Cochin-China.

Like the ginger, the plant possesses an underground stem or rhizome which is thick and rounded, with short blunt fingers. It also emits slender branches which develop into thickened tuberous portions. The outside of the rhizome, which is usually rather closely ringed, is brown and scaly; the inside is of a bright orange colour, and possesses a very distinct odour and taste. The rhizome is the portion used as a spice, under the name of turmeric. The main part of the rhizome is known as *long* turmeric; the tuberous portions are known as *round* turmeric. The leaves are borne in a tuft, and are about 2 ft. tall, but frequently shorter. They are thin, rather flaccid, and light green in colour, lanceolate acuminate, with rather a long leaf-stalk. There are usually six to ten to a tuft, and several tufts to a rhizome. The flowers are borne in cone-shaped spikes in the tuft of leaves. The spikes are shorter than the leaves and supported by a stout peduncle. They consist of a great number of thin, greenish-white, ovate bracts, the uppermost ones being usually pink and rather longer than the lower ones. In each bract are two flowers, opening one at a time, thin-textured and fugacious, white or yellowish white, with a broad yellow band down the centre of the lip. The fruit does not seem to be known.

TURMERIC.

NAMES

The names in different languages are very different, which is somewhat unusual in well-known Oriental products.

It is called *Haridra* in Sanskrit, *Haldi* in Hindu, *Halud* in Bengal, *Kurkum* and *Zarzud*, Arabic; *Zardchobah*, Persian; *Marinalu* in Malayalam, *Manjal* in Tamil; *Katha*, Cingalese; *Kunyet* in Malay, *Kuong-huyuh* in Cochin-China, and *Kiang-hoang* in Chinese.

The English word turmeric is of unknown derivation, and the old word for it, terra-merita, seems rather to be derived from it. From the Arabic *Kurkum*, we get the Latin *Curcuma*.

HISTORY

Turmeric does not seem to have been known as early as ginger, and never ranked in importance as high as that spice, being chiefly valued for its colour. Dioscorides, A.D. 77 or 78, mentions a kind of "cyperus" which resembles ginger, but when chewed has a yellow colour and bitter taste,—doubtless turmeric. Marco Polo mentions it as occurring at Koncha (the neighbourhood of Fokien, in China) in 1280, describing it thus: "There is also a vegetable which has all the properties of true Saffron, as well the smell as the colour, and yet it is not really Saffron. It is held in great estimation, and being an ingredient in all their dishes, it bears on that account a high price." This could only refer to turmeric, though it is used more as a dye-stuff in China nowadays than a spice. In medieval times it was commonly known as Indian Saffron (*crocus indicus*), by which Latin name Garcia da Orta mentions it. He states that in his time much was produced in Cananor and Calicut, and a small quantity from Goa. Great plenty was imported by the Arabs, Persians, and Turks, who obtained it from India.

VARIETIES

There does not seem to be much variation in the plant or its produce. In the trade, however, it is distinguished into China, Madras, Bengal, and Cochin. China turmeric is the most esteemed, but is seldom to be met with in the market. Madras and Bengal are the ordinary trade turmerics. Cochin turmeric does not appear to belong to *Curcuma longa* at all, but to be the produce of *C. aromatica*.

Sawyer, in the *Agricultural Journal of India*, iv. p. 87, mentions three forms known from Toungoo with local names—Sanwingale, the lesser turmeric; Sanwingye, greater turmeric (perhaps the tubers and rhizomes respectively); and Sanwinpyi, white turmeric with buff-coloured rhizomes and a scent of mangos (perhaps *Curcuma amada*). It is not used, and is considered to be injurious when it appears with the true turmeric. The first named is considered the best, the second is coarser. The form used in India for drying, known generally as Lok-nandi-haladi, seems to be a distinct variety with harder rhizomes and richer colouring matter.

CULTIVATION

The soil selected for turmeric should be rich and friable. Loamy soil, even of very inferior quality, however, will give good results, and even where the ground is sandy it does very well. "In Toungoo," says Mr. A. M. Sawyer (*Agricultural Journal of India*, 1909, iv. p. 87), "the Shans prefer light, free, sandy loams, overlying the yellowish and reddish sub-soils of the Toungoo district. The turmeric," he says, "is cultivated by the Shans very carefully. The locality consists of forest-clad hills and dales intersected by winding streams whose waters are clear in the dry months. When it rains, the streams carry a good deal of silt which fertilises the cultivated land in the low valleys." In the Malay peninsula, the Chinese grow it in the same kind of land as they use for ginger, and treat it in the same way. The stiffer clays they break up with the hoe and render friable, and by adding manure obtain good results. The low-lying black soils of old rice fields or river alluvia seem to suit it equally well. Compared with ginger I find it is a stronger plant, and will grow well where the soil is quite sandy, which ginger will not. In parts of India it is grown as an alternate crop with pulses. In Coimbatore it is stated that it is generally grown as a mixed crop with yams, maize, castor-oil, brinjals, onions, etc. (Watt's *Dictionary of Economic Products*).

It is often planted on old sugar-cane fields, and is considered an ameliorating crop. Most Bengal native gardens have a patch of turmeric to supply the native curry powder, for which it is much in demand.

Turmeric will grow luxuriantly in shade if not too dense, but it produces larger and better rhizomes in the open ground, exposed to the sun. Low-lying wet ground does not suit it, and it will not stand being flooded. In ground too dry, and in dry seasons of considerable duration, irrigation is necessary, and as this supplying of the plant with water makes a considerable difference to the cost of cultivation, damp soils are preferred when obtainable.

Preparation of the Soil.—In most parts of India where the plough is commonly used, the ground is ploughed over as for ginger, and all weeds cleared away. In the Malay peninsula, the Chinese, the usual cultivators, hoe the ground and make it loose and friable, in the same way as they prepare the ground for ginger. It is said that lands intended for turmeric do not require so much working over as those for ginger, but six or seven ploughings are sufficient for the crop.

Planting.—Turmeric, like ginger, is propagated by small pieces of the rhizome. These are usually in India planted in the early part of the year; in Patna, about the 20th of May; in Bengal, from February to June; in Madras, in June or July. These various dates, given in Watt's *Dictionary*, seem to suggest a difference in the time of rainfall, as it is essential that it should be planted when the soil is damp. In the Malay peninsula, no special time is selected for planting, as the rains are pretty constant throughout the year and it can be planted at almost any time.

The principle of planting is much the same as for ginger. The ground is dug into ridges and furrows. In Bengal, the ridges are made 9 or 10 in. high and 18 or 20 in. wide, with trenches 9 or 10 in. wide between, or, according to some accounts, 1 ft. to 2 ft. wide. One foot apart is, however, quite enough for the ridges in ordinary circumstances, but where irrigation between the rows is necessary it would be advisable to make them wider.

The rhizomes are set about 1 ft. apart, in holes dug for the purpose, and are covered with soil from 4 to 6 in. deep. In dry places and seasons watering is required at first, and often even later, *e.g.* in the North-west Provinces as often as once a week.

The amount of sets required is variously given as 900 sets, or three maunds (250 lbs.) to the acre.

The returns are given as from 2,000 to 5,000 lbs. of fresh rhizomes per acre.

In Coimbatore, a somewhat different system is adopted. The ridges are made 2 ft. apart, and the rhizomes are planted in June or July, at a cubit's distance apart, and watered every three or four days from then to the end of December, and then less often to March and April, when they are dug up.

Between the ridges or on different ridges other crops such as onions are grown, so as to shade and somewhat protect the plants. As a rule, turmeric is not grown more than once in three years, and is followed by rice or ragi (*Eleusine coracana*) (Watt's *Dictionary*).

During its growth weeding is more or less necessary, according to circumstances. The plants spring up in about a fortnight. The rhizomes are usually dug about a year later, or even less, generally between October and April of the following year, according to the date at which it is planted.

In some parts of Bengal it is not considered good practice to lift the roots the first year, but they are kept growing for a year and nine months. It is said that the produce when raised the first year is less in quantity and inferior in quality than when it is left in the ground for a second season.

In the Toungoo district, according to A. M. Sawyer, the rhizomes are selected for planting in January to

December and stored under soil, being kept thus till April or May. During this time the plant remains dormant, and the rhizomes, though watered from time to time, do not send up shoots or suckers. At the time of planting, they are taken up and broken up into sets of suitable size. The ground used is generally forest ground newly cleared and burnt; the large logs and stumps are not removed, but left to lie as they are, and the rhizomes planted between them. When the South West monsoon rains commence, holes from 3 to 6 in. wide and deep are dug about 12 to 15 in. apart, and one or more sets are put into each, covered with earth, and pressed down by the foot of the planter. The crop is weeded once or twice, but no other cultivation is found requisite. In harvesting the crop the rhizomes are dug up, stored for seed or prepared for market, as the case may be. Those intended for sale are carried in baskets to the nearest stream and thoroughly washed. They are then boiled in spring water until they yield to pressure between the thumb and finger, when they are spread out on mats to dry in the sun, and then sorted into classes.

In Bengal, Mukerji points out that both turmeric and ginger can be grown, not only with success, but with benefit to the trees, if planted in the fruit orchards. Orchard ground would otherwise be uncultivated, and harbour insect pests. Stiff clay soils, he says, are not suitable for any root crops, but the soil under trees is neither too heavy nor too light; any soil which is not too gritty, stony, or gravelly will do for turmeric.

In opening up soil under trees for this plant, it is desirable to plough up the ground in October or November, or after the rainy season is over, and while the land is in a fit state for ploughing; one ploughing and cross ploughing followed by harrowing should be sufficient cold weather preparation for the crop. In April, after the first shower of rain in the hot weather, another similar ploughing and harrowing will render the land fit for planting. The rhizomes should be set 9 in. apart, and the beds should be 25 or 30 ft. apart. About 2 maunds of turmeric roots are required for planting an acre. When the plants have come up, and before the approach of the rainy season, ridging or earthing should be done to exclude the water from the immediate surroundings of the plant. Water should be drained off if necessary. Manuring is hardly ever done in Bengal, but 1 maund of ashes and 3 maunds of oil-cake per acre would benefit the trees as well as the turmeric. It should be given soon after planting and before earthing up. Two hand-weedings or hoeings are necessary, one in July and one in September. The roots should be lifted up after the leaves have completely withered in December and January. Some small sections of the rhizome should be set apart for seed. These, before being planted in April or May, should be kept under a heap of dry straw to hasten sprouting (*Handbook of Indian Agriculture*).

Manuring.—Turmeric, unless in especially good ground, however, requires manure of some sort. Farm-yard manure is perhaps the best if procurable, and is what is used by the Chinaman in the Malay Peninsula. In Coimbatore, municipal sweepings and ashes are a favourite manure. Burnt earth and wood-ashes I have found very effective, especially in soils weak in potash. Sir E. O. Buck (*Dyes and Tans of the North-west Provinces*) says: "In June the land is well manured, forty cart-loads being thrown into 1 acre of land. It is then watered twice and well ploughed." He is speaking here of Cawnpore, where, from its dryness, irrigation is necessary. In an account of some field experiments with sewage made on the Bombay farms, J. W. Mollison, in the *Agricultural Ledger*, 1901, vol. ii. p. 52, shows the value of sewage in turmeric cultivation. A comparison was made of the crops produced after manuring with several different kinds of manure. These were watering with the effluent from septic tanks of night-soil, in Poona farm-yard manure, poudrette (*i.e.*

dried night-soil), and fresh night-soil. They gave the following results :—

Farm-yard manure, 10 tons to the acre .	6,388 lbs. per acre.
Effluent from septic tanks, 11 waterings	5,544 ,,
Poudrette, 10 tons	5,088 ,,
Fresh night-soil, 4 dressings . . .	3,547 ,,

Farm-yard manure gave the best results, and it does generally seem the most valuable manure for the tropics for any form of cultivation, but the effluent is superior to the other two.

Cost of Planting and Curing.—The Director of Agriculture in Bengal gives an estimate as follows :—

For 1 acre.	R.	A.	P.
6 Ploughings	2	4	0
3 maunds of seed at 3 rupees	9	0	0
Planting, 8 men at 4 annas a day . . .	2	0	0
To earth up four times	4	0	0
Four weedings, 3 men at a time . . .	3	0	0
Repairing the furrows, 4 men	1	0	0
Digging, 6 men	1	8	0
Cleaning, 3 men	0	12	0
Boiling, 6 men	1	8	0
Drying, 8 men	2	0	0
Rent	4	0	0
Earthen pots	1	0	0
	32	0	0

Major Garstin (Duthie, *Field and Garden Crops*, vol. iii. p. 42) estimates cost of 1 acre's cultivation :—

	Rupees.
Sowing	5
Planting out	3
Seed	20
Weeding and hoeing	$4\frac{1}{2}$
Harvesting	$2\frac{1}{2}$
Curing and drying	8
Rent	1

	Rupees.
Yield 30 maunds fresh, value	60
Cured and dried $7\frac{1}{2}$ maunds	75

	Rupees.
Profit	31
Duthie gives cultivation of 1 bigha, $\frac{4}{7}$ acre	19
Yield	36
Profit	17

Dr. McCann (*Dyes and Tans of Bengal*) gives the cost of cultivation of 1 bigha, thus: in Hugli, 6 to 8 rupees; in Rajshahi, 7 to 8 rupees; in Monghyr, 10 rupees; and Bhagalpur, 15 rupees.

Watt's *Dictionary* gives for Coimbatore:—

	R.	A.	P.
Manure	10	0	0
Six ploughings	3	0	0
Ridging and sowing	3	0	0
Hoeing and weeding	14	0	0
Fifty waterings, allowing for rainfall (gardens only)	40	0	0
Digging	6	0	0
Sizing and preparing	14	0	0
Cuttings	25	0	0
Assessment	1	8	0
	116	8	0
Value of crop, 3,000 to 5,000 lbs.	120 to 200 rupees.		

To this, however, must be added the value of the intermediate crops, usually here grown with the turmeric.

A writer in the *Indian Planters' Gazette* (quoted in the *Tropical Agriculturist*, 1903, vol. i. p. 660) gives for 1 bigha:—

	R.	A.	P.
Ploughs (8), ploughing at 5 annas each	2	8	0
Manuring	6	0	0
16 coolies preparing land, 5 for a rupee	3	3	3
8 coolies planting	1	9	9
Cultivation, weeding, etc.	5	0	0
Digging and sorting, 10 coolies	2	0	0
Rent for one year	2	3	0
Total	22	8	0
Returns 16 maunds of fresh turmeric at 3 rupees per maund	48	6	6
Profit	25	8	0

N. Mukerji says the out-turn of turmeric boiled and dried comes to about 16 maunds per acre, but as much as 50 maunds has been obtained. The prepared dry turmeric may fetch as much as 5 rupees per maund. The cost of cultivation comes to 50 rupees.

PESTS

There are but few pests recorded as attacking turmeric. Injuries caused by a species of thrips is mentioned in the *Indian Museum Notes*, vol. i. p. 109. The thrips is a very small black insect, which attacks the leaves. The eggs are laid on the back of the leaf, and the insect when hatched sucks the sap of the leaf. They become rolled up and turn yellow, eventually dying. This spoils the crop, as the rhizomes are not developed. The insect is known in Madras as "Sulta-thegulu." It is suggested that the best way of dealing with the pest is to destroy it by the use of whale-oil soap solution, in the proportion of 1 lb. of soap to 4 or 5 gallons of water, or Pyrethrum powder may be used ; 1 ounce of Pyrethrum in a gallon of water.

The *turmeric moth* (*Dadessa evaxalis*). The caterpillar of this little moth inhabits the stem of turmeric and other plants of the family of gingers, and is often troublesome, boring up the leaf-stems and causing them to fall and die. It is about $\frac{3}{4}$ in. long when full grown, smooth, except for fine scattered hairs on its back and sides. The head and the first segment are black, the body of a pale semi-transparent pinkish colour, with grey or black dots on warts down the back, and a row just above the spiracles on each side. A pink line just above the spiracles runs the whole length of the body.

The insect lives in a burrow in the stems, and can be detected by the exudation of its excreta from the holes in the stem, and the withering of the leaf. The chrysalis is about 1 in. long, and remains in the tunnel bored by the caterpillar. The moth, which is 1 in. across the wings when expanded, is entirely ochre-yellow above, sprinkled all over with black spots and short black streaks. The body is long and slender, and the legs and antennae long and delicate. The underside of the upper wings and a bar across the thorax are sooty in colour.

This insect does not seem particular as to what ginger plants it attacks, so long as the stems are not too thick. Stems attacked by it should be cut off and destroyed. It is not, however, easy to see it till it has thoroughly bored through the stem and practically killed it.

PREPARATION OF RHIZOMES

For local use in curry, turmeric is generally used fresh without any preparation except washing, and quantities are sold for this purpose in the native markets of Singapore and elsewhere in the East.

In Bengal, it is said that after the roots are dug out of the ground they are freed from the fibrous roots and cleaned. They are then put into earthen pots, the mouths of which are carefully closed with earthenware covers and cow-dung. The pots are very gradually heated. The turmeric is made to boil in its own juice, which process gets rid of the raw smell of turmeric. It is then dried in the sun for a week or nearly as long, during which it requires to be covered in the night to protect it from dew. In some places it is boiled in water in which a little cow-dung is mixed (*Report of the Agricultural Department*, p. 55).

Sir E. C. Buck says in the north-west provinces the roots are boiled and dried in the sun, and in this form they are the turmeric sold in the Indian bazaars. For making the yellow dye the roots are boiled again, and powdered while wet and made into a paste. In the Kumaon district the roots are soaked in lime-juice and borax before being powdered instead of being boiled. In the Punjab, Baden-Powell says the rhizomes are taken up in November, and dried partly by the heat of the sun and partly by fire. In Coimbatore, it is said that the roots are carefully dried and separately boiled in a mixture of cow-dung and water, then dried and sent to market (Watt's *Dictionary*).

A planter in the *Indian Planters' Gazette* says the rhizomes are sorted into two sizes, the smaller and larger ones, as the latter require more boiling. They are then thrown into separate pots filled with water, with an admixture of cow-dung and tamarind leaves. They are then boiled for two or three hours according to their size and spread out to dry. The boiling and drying makes them shrink to half their original size, and the loss in weight varies from 30 to 40 per cent.

Mukerji says that the rhizomes are to be cut in two if too fat, dried and boiled in water mixed with cow-dung, but that as soon as the water begins to boil it should be taken from the fire, and the turmeric taken out and put out in the sun. The heap should be stirred and turned two or three times a day, and the smaller pieces sorted out as they dry, leaving the thicker pieces to dry for another day or two. Daily in the evening the turmeric exposed to the sun should be rubbed, the rubbing making the rhizomes clean and smooth.

AREAS OF CULTIVATION

There has never been any great amount of cultivation of turmeric outside the East Indies. Its demand is, except for its use as a dye, almost exclusively for curry powder, which has always been associated with the East Indies, and has not found favour in the western world. Nor is it to any great extent in demand in Europe. Its cultivation and use in Western India may be of comparatively recent date, as Linschoten, who spent several years on the Malabar coast from 1596, does not mention it while describing the curry stuffs of that region.

The plant has been introduced from the East Indies into most of the Botanic Gardens of the world, but in the greater part of the tropics curry is not the common food of the native, and there has been no demand for the spice.

India.—Turmeric is cultivated in most parts of India, and proves a very remunerative crop, at least to the natives. It does not seem ever to be cultivated by Europeans. It is difficult to get an account of the area under cultivation, but Dr. McCann (Watt's *Dictionary*) gives the following estimates as approximate :—

	Acres.
Bengal	30,000
Madras	15,000
Bombay	6,000
Berar	2,000
Punjab	3,500
	56,500

The trade in India is, of course, largely local, as so much is used all over the East in curry stuffs and in native medicines and dyes. The export trade is chiefly to England, France, and the United States, and it seems to be there more used as a dye than as a spice. It is said also to be used to adulterate mustard.

The exports from Bengal are given by Mr. O'Conor in his *Review* of trade in 1876 to 1877 as 123,824 cwt., valued at 10½ lacs of rupees. It fell off in demand next year, and in 1881 to 1882 the exports were 70,783 cwt., valued at 3,66,047 rupees. In 1885 to 1886, it so far recovered that the exports amounted to 156,287 cwt., valued at nearly 14 lacs of rupees. In 1888, they amounted to 140,994 cwts., valued at 10,32,025 rupees.

The exports to Europe have never been very large, for, in 1869, we find that only 64,280 cwt. and in 1870, 44,900 cwt., were imported into Europe; Calcutta exporting 59,352 cwt. in 1870 to 1871, and Bombay, in 1871, 29,780.

In Ceylon, I find no record of cultivation except very locally, nor does it seem ever to have been exported. In the Malay peninsula and islands it is cultivated for local use only, and consumed fresh; very little is now grown in the peninsula, though it does grow remarkably well, and very fine samples are to be seen at the local Agricultural Exhibitions, but a good deal is imported into Singapore from Rio, Galang, and other islands to the south.

VALUES OF TURMERIC

The local values of fresh rhizomes in Singapore is from 6 to 10 dollars a picul, the usual price being about 6 dollars (the dollar is now valued at 2s. 4d., the picul is $133\frac{1}{3}$ lbs.), or a little over 1 penny a pound. In the North-west Provinces of India, Atkinson gives the value at 60 rupees for 30 maunds fresh, and 75 rupees for $7\frac{1}{2}$ maunds dry ($2\frac{1}{2}$ to 3 annas a pound).

These values really depend, to a large extent, on the demand being local or for export.

USES

As a spice or condiment, turmeric is chiefly used as an ingredient in curry powder, and also for colouring various sweetmeats, on account of its bright yellow colour and pleasant musky flavour.

As a dye it is still largely used in Europe as well as in the East Indies, though the aniline dyes have somewhat supplanted its use. A special variety is used in dyeing in India which has a harder rhizome than the aromatic one used as a spice. The colouring matter is only produced with age, and it is probable that the dye-yielding forms have been obtained by careful selection of hard, well-coloured rhizomes. The colour is rather fugitive, especially in the presence of sunlight and when acted on by alkalis, and the Malays say that the dye from Zedoary (*Curcuma Zedoaria*) is preferable as being much more durable. It seems, however, to be still used in India commonly for dyeing calico and paper. The colouring matter is known to chemists as Curcumin.

A good account of its properties as a dye and the chemistry of its colouring matter is to be found in Watt's *Dictionary*.

Medicine.—As a drug, turmeric is no longer used in European medicine, except as a colouring matter. It is extensively used in native medicine, especially in skin disease, and as a powder for sores among the Malays. Children with excessive perspiration are often covered with the powdered rhizomes used in much the same way as orris root is in England. Women after confinement are often rubbed all over with it, and it is used largely as a cosmetic. In Java, I have seen children on the way to a circumcision ceremony so coated with turmeric that they appeared entirely of a bright yellow colour, giving them a most extraordinary appearance.

It is recommended both in India and Malaya for bruises, leech bites, and skin diseases, but so far as I have seen in the case of sores, with more injurious than beneficial effects. It is said to relieve pain in purulent conjunctivitis, and to be beneficial burnt as a fumigation in catarrh and hysteria, and as powder with alum is blown into the ear in chronic otorrhoea.

OTHER SPECIES OF *CURCUMA*

There are several other *Curcumas* which are more or less cultivated and also wild in India and the Malay region, and which are used for various purposes by the natives, chiefly as drugs, dyes, and as starch producers, but not as spices, and so need be no more than mentioned.

Curcuma Amada, Roxb., mango ginger, is used in medicine and as a condiment and vegetable in Bengal.

C. angustifolia, Roxb., East Indian arrowroot. Cultivated for its starch.

C. aromatica, Salisb., yellow zedoary. Cochin turmeric, used as a dye and cosmetic and as a drug.

C. coesia, Roxb., black zedoary.

C. caulina, Gresham, and *C. leucorrhiza*, Roxb., and other spices are used to make a form of arrowroot.

ZEDOARY

Zedoary, the rhizomes of *Curcuma Zedoaria*, is one of those spices which attained its greatest popularity in medieval times, but practically dropped out of commerce many years ago. It is still, however, cultivated by natives of the East Indies, and used in curry powder, as well as medicines.

The plant is a very handsome one, and to some extent resembles turmeric, but is larger. The leaves are produced in a tuft, and are about 18 in. tall and 6 in. wide, erect, oblong, ovate, acuminate, bright green, with a slash of purple brown colour running up the centre. The flower-spike appears from outside the leaves, and with them or frequently alone after the leaves have withered. It is borne on a stout peduncle 18 in. long, and has the form of a cylindrical cone, 6 in. long, of spreading bracts.

The lower bracts on the spike are bright green tipped with pink, gradually passing upwards into deep crimson ones forming the top of the spike. The flowers, of which there are four to each bract, are pale yellow, and produce one or two at a time on the spike. The rhizome is large, fleshy, and rounded, like that of turmeric, and bears also oblong, rounded tubers, whitish orange to orange inside, less brilliantly coloured than turmeric, and often nearly white. They possess a distinct aromatic taste, not, however, very strong, and not at all pungent.

Cultivation.—The plant is grown in just the same way as turmeric, but is even stronger in growth. It is even found growing in abandoned cultivations covered with the rank Lalang grass (*Imperata cylindrica*), having persisted and thriven long after the cultivation has been abandoned.

Use.—Zedoary is more used as a drug than as a spice, even in the East, and as a perfume. There seems to be somewhat of a trade in it in America, as it is quoted in the *Midland Druggist of Columbus*, Ohio, April 1910, at 25 cents U.S.Cy. per lb. The root has a musky odour, which is not appreciated as an adjunct to curries. As, however, the plant is commonly grown with turmeric, I include it here.

GALANGAL

There are two spice plants known as galangal, the lesser and the greater galangal. Both are species of the genus *Alpinia*, viz. *Alpinia officinarum*, Hance, and *Alpinia Galanga*, L. The former is the lesser galangal, and is the most important of the two.

THE LESSER GALANGAL

Alpinia officinarum, Hance (*Scitamineae*).—This plant, which belongs to the same order as the ginger, is a herb with smooth, cylindrical, reddish brown rhizomes, about ½ or ¾ in. through, covered with large pale sheaths, which leave a scar when fallen. The stems are 2 to 4 ft. tall, with numerous narrowly lanceolate acuminate, sheathing leaves, the blade 9 to 14 in. long. The flowers are arranged in a terminal raceme 3 or 4 in. long, of a medium size and white, with narrow petals and an ovate, entire, or bilobed lip, with a crisp or denticulate edge, ¾ in. long, white, with dark-red veins coalescing into a fan-shaped spot near the tip. The fruit is ½ in. long, brown, tomentose.

The part of this plant which is used is the rhizome, and though the spice has been known for very many centuries, the plant itself was only discovered in 1867. It was first found by Mr. Sampson at Tung-sai, on the peninsula of Lei Chan-fu, at the extreme south of China, opposite to Hoihow in Hainan, but apparently only an escape from cultivation. It was discovered later by Colonel Swinhoe, wild, in Hainan itself.

History.—The earliest reference to this spice is that of the Arabian geographer Ibn Khurdabah, who wrote a work on the products and tributes of the Khalibs in A.D.

869 to 885. In a list of produce from a country he called "Sila" (probably China), he mentions galangal. Edrisi, in 1153, mentions it among the productions of the Far East brought from India and China to Aden, the port then used for Asiatic produce coming to Egypt and Europe. Garcia da Orta says it was unknown to the ancient Greeks, and only imperfectly to the Arabs. He distinguishes between the greater and the lesser galangal, giving the correct Malay name Lancuas (Lankwas) to the former.

Marco Polo mentions it as produced in abundance at Kachanfu (near the Hoang-ho), at Kinsai (Tokien), and Kuelin-fu (Kien-ning-fu) in the same province. It was imported very early into England with pepper and other spices, and is often mentioned in the literature of the Middle Ages. It was then mainly used as the culinary spice.

In England it was called galingale, a name which has also been applied to the sedge, *Cyperus longus.*

Cultivation and Use.—The plant seems never to have been cultivated elsewhere than in Southern China. Like all plants of the ginger tribe, it is easily propagated from portions of the rhizome.

The commercial spice consists of pieces of the rhizome $1\frac{1}{2}$ to 3 in. long, rarely $\frac{3}{4}$ in. through, and commonly much less, brown, cylindric, often branched, and marked with the rings left by the fall of the scale leaves. It is dry and firm, tough and shrivelled, rather paler inside (but never white, or buff colour, as in the greater galangal), with a darker central column. It is aromatic and spicy, somewhat pungent in taste.

The rhizome contains $\frac{1}{3}$ to $\frac{1}{2}$ per cent of volatile oil, an acrid soft resin, an extractive, gum, starch, a fixed oil, and a peculiar crystallisable body, Kaempferid, which is tasteless. The odour is due to the essential oil. This oil is a greenish yellow, slightly viscid liquid of a camphor-like odour. Its only known constituent is Cineol.

Oil of galangal was manufactured very early, and is first mentioned in a price ordinance of Frankfurt in 1587.

Jahus extracted from galangal, galangin, camphoride, and alpinin. The latter, according to Testoni, is, however, a homogeneous mixture of the other two. *Chem. Centralblatt*, 71, 26.

Use.—The galangal was formerly used in medicine, as an aromatic stimulant like ginger, but its use in European medicine, except as a flavouring, has become nearly obsolete. It is still used, however, in Russia as a drug, and also in veterinary medicine. As a spice it is chiefly used in the manufacture of vinegar and beer, in cordials, and in liqueurs, especially in Russia in a liqueur known as Nastoika.

Commerce.—It is shipped from Canton to other ports in China, to India, and Europe. It is difficult to get statistics which give any idea of the total production, but in 1869 Hance gives in the official returns the export of the year as 370,000 lbs., which seems to have been exceptionally high. In 1877, 281,733 lbs. were exported from Kung Chow in Hainan.

THE GREATER GALANGAL

The greater galangal, *Alpinia Galanga*, L., is a very common plant in cultivation in Java and the Malay Peninsula, where it forms an ingredient in curry, and is also used as a local medicine. It is generally used fresh and appears seldom to be dried, but packages of its dried rhizomes occasionally appear in the London market.

The plant is much larger than the lesser galangal, attaining a height of 6 or 7 ft. The stems are numerous, forming a thick clump, and bear numerous leaves, lanceolate acute, about 18 in. long and $3\frac{1}{4}$ in. wide. The stems are terminated by panicles of flowers about 6 in. long, with short branches bearing numerous fragrant small flowers with a white calyx, green petals, and a white spathulate lip ornamented with red streaks, and about 1 in. long. It has small red fruits about as big as a large pea, with one or two seeds. The rhizome is much larger than that of the lesser galangal.

The plant is known as *Lankwas* by the Malays.

Garcia da Orta distinguishes it from the lesser galangal, and gives a rough woodcut of its rhizome dried. As he says, it is inferior to, and weaker in strength than the true galangal.

The dried rhizome is readily distinguished by its greater size, and the pale buff colour of the inside contrasting conspicuously with the orange brown outer skin. It seems to be little used except as an inferior sort of galangal. Pomet (*Livre des drogues*) says it is used in the manufacture of vinegar. It is sold in the Singapore markets in a fresh state for use in curries, being considered a necessary ingredient.

CALAMUS ROOT—SWEET FLAG

Calamus root is the rhizomes of *Acorus Calamus*, L., of the order *Aroideae*, a native of northern Asia from the Black Sea to China and Japan and North America. It occurs also in Europe as far north as Scotland and northern Russia, India, Burma, Ceylon, and the Malay region, but is probably introduced into these countries. Although, especially in the Indo-Malay region, it is chiefly valued as a drug, it is in some request for flavouring beer, and hence may be classed as a spice.

Acorus Calamus, L., is a herb with a cylindrical rhizome, branched and emitting numerous roots, and erect, narrow, sword-like acute leaves, about 3 in. long and 1 in. wide, arranged distichously. The inflorescence is a dense cylindric spike, borne laterally upon a flattened leaf-like stem, which is terminated by a short sword-like leaf, so that it appears as if the spike were borne on the side of a leaf. The flowers are very small and closely packed together, of a green colour.

The plant grows on the margins of streams, lakes, or ponds, or in damp ditches, and is commonly cultivated in small patches all over the Eastern tropics.

History.—If the calamus of the Bible is the sweet flag (*Acorus Calamus*), the mention of it in Exodus xxx. 23, Canticles iv. 14, and Ezekiel xxvii. 19 are the earliest records of its use, but there is some doubt as to what was intended in these passages. The plant "Acoron," a native of Colchis, Galatia, and Crete, mentioned by Dioscorides and Pliny, A.D. 23 to 79, seems certainly to refer to it. Celsus (25 B.C. to A.D. 50) mentions *Calamus Alexandrinus*, probably brought from India by way of the Red Sea. It is said to have been introduced into Western Europe in the thirteenth century. But it first is recorded as abundant in Germany in 1588. The Indian rhizomes, however, were imported extensively till long after it was common in Europe. At present most of the drug is brought from Southern Russia through Germany to the London market, though occasionally a little still comes from India.

Names.—The plant and its rhizome has many names. In English it is known as *Sweet Flag*; French, *Acore odorant* or *vrai*, or *Roseau aromatique*; German, *Kalmus*; in the druggist's Latin, *Calamus aromaticus* or *acorus*, the rhizome, *Radix Calami aromatici*; in Malay, *Jeringu*; Tamil, *Vasambu*; Hindu, *Gorbach.*

Cultivation.—The plant is propagated very readily by portions of the rhizome being planted in damp muddy spots, and is of rapid growth. In the tropics it seldom flowers, and fruits sparingly everywhere. Common as it is in the Malay Peninsula, I have only seen flowers and never fruits. It is never cultivated on a large scale in tropical countries, but it is found in most village gardens. No trouble is taken with it. It is merely planted and left to itself, and the rhizome taken up when required and dried. Dr. Dymock (Watt's *Dictionary*) says that it is imported into Bombay chiefly from the Persian Gulf and brings about 3 rupees a maund of 37½ seers. There is a very considerable trade in this article done in Calcutta.

Use.—The rhizome of sweet flag is largely used in native Oriental medicines for dyspepsia and bronchitis, and chewed as a cough lozenge, and in Europe for masticating to clear the voice.

It is said also to be used by snuff manufacturers, and Mr. A. D. Machado of Perak, Malay Peninsula, found that the powdered rhizome sprinkled round a tree attacked by white ants (termites), destroyed those that were near the surface and prevented others from attacking.

As a spice, it is used in the manufacture of certain beers, and for this purpose the oil is used. Mr. Machado exhibited at the Agricultural Exhibition in Singapore in 1906 some samples of calamus oil, which on being sent to England were pronounced to be very good and much in request for beer flavouring. The oil was obtained by distillation of the rhizome. The rhizome in commerce occurs in tortuous sub-cylindrical or flattened pieces a few inches long, and from ½ to 1 in. in diameter, marked on the upper surface with the leaf-scars, and beneath with a zigzag line of elevated dot-like rings, the root-scars. It is usually rough, shrunk, and dark brown, or orange brown in colour, breaking easily with an aromatic agreeable scent and a bitterish pungent taste. In the outer part are oil-cells containing essential oil, so that peeling the rhizomes before shipping or distilling, as is often done on the Continent, should not be resorted to.

The rhizome yields 1·3 per cent of a yellowish neutral oil of an agreeable odour, containing a bitter principle Acoria, a semi-fluid brownish glucoside.

As the oil of sweet flag is wholesome and agreeable in flavour, and is suited for flavouring beers, cordials, and other drinks, and the plant is very readily established in the tropics and grows fast, it might very well be worth while for a distiller to prepare the oil for these purposes.

APPENDIX

NUMBER OF PLANTS TO THE ACRE

This table is intended to show what number of plants or seeds are required for an acre of any crop, according to the distance apart at which they are planted :—

Distance apart.	Number of Plants.	Distance apart.	Number of Plants.
6 in. by 6 in. . .	1,045,440	12 ft. by 12 ft. . . .	302
1 ft. by 1 ft. . .	43,560	13 „ 13 „ . . .	257
2 „ 2 „ . .	10,890	14 „ 14 „ . . .	222
3 „ 3 „ . .	4,840	15 „ 15 „ . . .	193
4 „ 4 „ . .	2,722	16 „ 16 „ . . .	170
5 „ 5 „ . .	1,742	17 „ 17 „ . . .	150
6 „ 6 „ . .	1,210	18 „ 18 „ . . .	134
7 „ 7 „ . .	881	19 „ 19 „ . . .	120
8 „ 8 „ . .	680	20 „ 20 „ . . .	108
9 „ 9 „ . .	537	25 „ 25 „ . . .	69
10 „ 10 „ . .	435	30 „ 30 „ . . .	48
11 „ 11 „ . .	360		

TABLE OF WEIGHTS, MEASURES, AND COINAGE

The following table will be of use to those working in the tropics, where weights and measures commonly in use are different from those in use in England :—

WEIGHTS

French—

1 gramme	15·432 grains Troy
1 kilogramme . . .	2 lbs., 3 oz., 43 drams.

Indian—

1 tola	180 grains
1 seer	14 oz.
1 maund (Madras) . .	24 lbs., 10 oz., 15 drams.
1 maund (Bombay) . .	28 lbs.

Malay—

1 tahil	$1\frac{1}{3}$ oz.
1 kati	$1\frac{1}{3}$ lb.
1 picul (100 katis) . .	$133\frac{1}{3}$ lbs.
1 koyan	$5333\frac{1}{3}$ lbs.

MONEY

	s.	d.
1 rupee (Indian) . .	1	4
1 anna		1
1 pie		$\frac{1}{12}$
Dollar (Malay) . . .	2	4

Cents, 100 to the dollar.

MEASURES

French—

1 millimetre . . .	·039 in.
1 centimetre . . .	·393 in.
1 metre	1 yd. 3 in.
1 kilometre . . .	1093 yd., 1 ft., 10 in.
1 hectare	2·47 acres
1 litre	1·760 pints

Dutch—

1 bau (bouw) . . .	1·75 acres

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THE END

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