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OUTBREAK *PROMECOTHECA ANTIQUA*—LINDENHAFEN ESTATE.

Report by George H. Murray, F.R.E.S.

I left Rabaul on 5th January per M.V. *Macdhui* for an inspection of the Morobe District, calling at Lindenhafen *en route*, where I had an opportunity of seeing the outbreak of *Promecotheca* on that estate and discussing the question of control with the manager.

The pest has reached such plague proportions that it is quite impossible to cope with it in the ordinary method employed in isolated cases of cutting off the infested leaves and immediately burning them *in situ*. Spraying or dusting tall plants, like coco-nut palms, is out of the question, with other than power apparatus. This would be an expensive method, but in extreme circumstances like that on Lindenhafen, the cost entailed would be justified.

The estate presents a dreadful appearance and it is the worst infestation of *Promecotheca* of which there is any record in the Territory. When walking through the plantation one hears on all sides the continual dropping of immature nuts which the palms can no longer sustain. Many of the trees have already succumbed, 370 dead palms having been cut down and destroyed, while there is not a single flower spathe on the whole plantation, so that no crop can be expected for two years, even from those trees that do eventually recover.

In the absence of insecticidal power apparatus, nothing in the nature of control experiments is possible in a case of such severe infestation, but we have good reason to believe, from similar outbreaks elsewhere, that when the plague has reached its peak, it will decline, the result probably of entomogenous fungi, or bacterial disease, and the majority of the palms should eventually recover. It is not known exactly where the outbreak first started, but it was known to exist in a nearby village grove and at Ring Ring, before entering Lindenhafen.

On the outskirts of Lindenhafen there are considerable areas of sago palms, or sac-sac (*Metroxylon sagu*) which is a major host of *Promecotheca*; constant lookout, therefore, should be kept to see if the pest is breeding there in numbers, and as soon as it is noticed that the coco-nut palms are becoming infested, immediate steps should be taken to cut off the infested leaves and burn them as already stated. On no account should the leaves be carried to a central fire and if the weather is too wet for fires to burn readily, they could be assisted by the addition of oil or other inflammable material.

In all insect attack there is more hope of control if immediate action is taken, for prevention is better than cure. A kindred species, *Promecotheca cumingi*, reached such plague proportions, eight or nine years ago, over large coco-nut

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areas in the Philippines, as to become a matter of grave national importance, and there is every probability, if an attack like that on Lindenhafen should start on the closely planted east coast of New Ireland, it would spread from plantation to plantation, and it behoves planters, therefore, to keep a watchful eye for the pest and adopt preventive measures without delay.

The adult beetle feeds on the lower epidermis and internal leaf tissues of the leaf leaving the upper side untouched, which turns brown and withers, so that nothing but the midrib remains. The female beetle lays its egg singly on the underside of the leaf over which it immediately places a protective covering of partially digested particles of coco-nut leaf expelled as excreta. The larva upon emergence from the egg penetrates into the parenchyma or leaf tissue upon which it feeds, making elongated mines about six inches in length and one-third of an inch in breadth. The larva becomes a pupa within the mine from which the adult beetle in due course emerges by cutting a hole through the upper epidermis of the leaf. The female only lays about twenty eggs, and it is surprising that an insect with such a small egg capacity should ever become such a serious pest. Although the outbreak of this pest seems to come on with great suddenness, its small egg capacity and long life history would indicate that its development, at first, must be slow as to be hardly noticeable, which is all the more reason for watchful care.

Outbreaks usually commence in a small way over a limited area, and some time must elapse before the density of the population reaches maximum numbers sufficient to become a plague, but even a few adults on a plantation should be looked upon as great potential enemies and treated accordingly.

Biological Control.

A method of control employed by German planters in New Guinea is the establishment of the vicious predatory ant "Kurukum" (*Oecophylla smaragdina*) on the palms. Nests of these tree ants were placed in the crowns of the palms, and ropes or string placed from one to the other to enable the ants to spread, without having to come to the ground. This method has been adapted from that recommended by Dr. van Hall, for the control of pests on cocoa, a much more delicate plant than a coco-nut palm, and it has much to recommend it. It no doubt harbours certain scale insects, noxious to plants, but if they can assist in control of *Promecotheca,* their advantages far outweigh any disadvantages. I have myself seen *Oecophylla* destroying adult *Promecotheca,* and R. M. Paine, research entomologist, formerly in Fiji, with whom I discussed the matter, was also of the opinion that it was of some value in the control of *Promecotheca.*

As soon as the entomologist returns to Rabaul he will be instructed to carry out investigations with regard to the "Kurukum" (*Oecophylla*) as a predator of *Promecotheca* and other methods for its control.

The Department of Agriculture in Fiji seems to have had considerable success in the control of *Promecotheca* with *Pleurotropis parvulus,* a minute parasitic wasp, introduced from Java by Mr. Paine, for that purpose. A radio was sent a few days ago to the director of that department desiring to know whether a colony of *Pleurotropis* could be sent to Rabaul from Suva by one of the W. R. Carpenter's boats, and steps are being taken to have the insectaries ready for their reception. It will, therefore, be seen that this department is taking every possible means for the control of *Promecotheca.*

MANAM ISLAND VOLCANIC ERUPTION.

Extracts from Inspector's Journal by C. C. Marr, March, 1937.

Leaving again at daylight, we sailed for Manam Island (Madang) reaching it at a village called Tavele, at noon. During the afternoon a survey of the country in the immediate vicinity was conducted, to ascertain what damage, if any, was done or resulted from the recent volcanic eruptions in October, 1936.

There was no sign of any damage having resulted, though it was noticed that the ground everywhere—more particularly on open places, as around villages, and on roads—was covered with a thin layer of grit, resembling charcoal, in some places 2 inches deep and in others only ½ inch to 1 inch.

It was reported that taro gardens were spoiled owing to the withering or shrivelling of the leaves due to the heat, and in many places the crop rooted out, subsequently, and replanted. Many Kapiak trees (bread fruit) were noticed with their leaves perforated by many small holes, and it is thought that this resulted through the peppering received from falling gravel and grit from the mountain crater.

However, the trees were still in a healthy condition and commencing to bear prolifically.

Tobacco.

The crop which suffered most and the loss of which the natives felt more keenly than anything else was tobacco. This crop was apparently ready for harvesting at the time the explosion occurred, and although many plants were harvested, the loss must have been considerable.

On this island, tobacco is a crop which is used extensively for trade purposes with the mainland natives, and as the leaf on this island is of much better quality than that obtained on the Sepik, it is desired by many white traders.

It is fitting to mention here the method employed by these natives in the cultivation of this crop.

Seed is selected in the field from the best plants, is wrapped up and stored in natives' houses until ready to be sown. A rough seed bed is prepared wherein the seed is sown, and the resultant germinated seed pricked out and planted in the field.

After a period of about seven weeks the old leaves at the base of the plant are pulled, and ten leaves—counting from the bottom up—left, the bud being then pinched off. After a further six weeks or so, the stem is broken a few inches above ground, and the plant hung up in a house to dry by the aid chiefly of smoke from an interior fire.

The remaining stems in the field are then allowed to ratoon from which a further small quantity of leaf is obtained.

It will be seen from the above that the methods employed by these natives differ little from present-day European methods, and are therefore interesting.

The natives denied, on questioning, having ever received European tuition re the growing of their crops and the only reason supplied was that it was the "fashion belong papa before".

Note.—Evan R. Stanley, F.G.S., reporting on *The Salient Geological Features and Natural Resources of the New Guinea Territory*, (*see* appendix B., page 52, Report to the League of Nations on the Administration of the Territory of New Guinea 1921-1922), states Manam (Vulcan) Island, Madang, is about 18 miles in circumference and roughly conical in shape. It has four distinct rifts or breaches reaching almost to the apex. Huge landslips have occurred in the steeper portions of the cone near the summit exposing a dull brown bedded mass of ejectamenta with some layers of lava. The heavy rains have carried the debris down the ravines and spread it out in the form of a fan running into the sea. It appears as though the breach running north from the crater opened up first, probably caused by an explosive outburst followed by a lava flow. Later, and probably simultaneously, the breaches on the east and west sides were formed and finally the southern breach. It was probably during this latter disturbance that the other craterlets, three in number, were formed on upper portions of the northern breach. There are really four craters, several minor vents, and one small lava spire on the eastern breach near the summit. The natives tell me that the crater has erupted many times, usually four times a year, but their stories, although in a measure true, are to a great extent unreliable because they do not, as a rule, possess a knowledge of time in the sense we understand it.

COIR FIBRE.

By George H. Murray.

This article is based largely on my observations made on coir fibre preparations during several visits of study and travel in Ceylon and the East Indies during the past 25 years.

Many planters in Ceylon with whom I discussed the coir fibre industry informed me that the coco-nut husks on their estates were of more value to them as manure than the cash they would receive from coir mill owners, and from my own observations on the best managed estates I consider that such is the case. Still other planters, particularly small land-holders, consider it an advantage to receive ready cash for what may seem a waste product which is also the opinion of practically every native owner of coco-nuts grown in Ceylon and South India.

On the Malabar coast of southern India, which provides such a large part of the world's supply as a peasant industry, not a coco-nut husk is wasted; in every cottage almost, can be seen coir in some process of preparation, and no machinery at all is employed. The hand method may seem slow and cumbersome, but it has been the one used from time immemorial in these coco-nut-growing countries, where there is a considerable local demand for the product for rope, twine, boat caulking and other domestic purposes, and there is not likely to be any change in the existing practice.

The invention of improved machinery, about the middle of the nineteenth century, for processing the product brought it into more general use as a commercial commodity in other countries. The fibre has a special value for ropes subject to soakage in salt water, but, lacking strength, is of less value for general use than other rope fibres; it is, however, more elastic, and it does not therefore break so readily as ropes made of stronger fibre.

The industry is still of a minor character, but should be suitable for those natives of New Guinea who show sufficient enterprise and energy to apply themselves to such work.

When observing the amount of labour wasted by misdirected effort, mainly by women, and therefore not taken into account, in the production of native-cured copra, I could not but be struck by the fact that if the same time and energy were put into the preparation of coir fibre from the husks, there would be obtained good value from what is otherwise going to waste and probably as much money, if not more than for their labour put into copra, would accrue to them.

New Guinea natives are, however, so conservative that instruction, unless it can be backed by compulsion or authority, is of little advantage to them.

The fibre is of little value for textile purposes on account of its harshness and brittleness, and for its ordinary use in the manufacture of ropes, twine, and matting, the supply at present, is more than equal to the demand. There are, however, possibilities for new uses for coir fibre products on an extensive scale, in which research is now being carried out. Underground pipes for gas, oil, or water and cables subjected to the corroding influence of bacteria and electrolytic influences of tramways, &c., could be protected from such corrosion by the pipes being packed with lagging of such material. The expense of repairs to pipes involving the tearing up of roads could apparently be greatly reduced or eliminated by the use of such protective lagging. It is not an uncommon sight at present to see pipes protected in this way, and once the practice becomes general possibilities of the fibre for this purpose will be greatly increased.

Statements are frequently made by some planters that the millions of husks going to waste on plantations and native groves, in this Territory, should be turned into coir fibre as a subsidiary industry to copra-making, and one planter went so far as to purchase a small experimental machine with this object in view. Many coir-mill owners in Ceylon with machines of local manufacture produce fibre on a fairly large scale, but the small profits they receive would hardly be acceptable to most European planters in this Territory. Individual planters therefore would be well advised not to enter upon the industry in a small way. Preparation of coir fibre by small units in a territory like this might well be made a native industry, but, in an extensive way, it should be left to capitalistic enterprise, which, by careful management, and large-scale production by modern machinery, could expect reasonable profits provided their operations are carried on near large supplies of husks as in the Gazelle Peninsula, New Britain, or the east coast, New Ireland.

There is an assured market in Australia for approximately 1,800 tons of coir fibre. The *Papua and New Guinea Bounties Act* 1926-1936 of the Commonwealth of Australia provides for the payment of a bounty of £3 per ton on fibre produced in the Territory and imported direct into Australia for home consumption.

Native Cottage Industry.

I feel sure that a market could be built up for floor mats to take the place of, or compete with, the grass mats so commonly seen in bungalows to-day. I have in my possession a very fine large circular mat made from coir fibre by prisoners in a Javanese gaol. It is dyed in artistic designs with native dyes and has been in continuous use for the past six years, and is as good now as when first purchased, and far superior to any ordinary grass mat.

The preparation of coir fibre and the manufacture of such mats, and other similar articles of domestic use, would be quite suitable for a native cottage industry, fostered by the Government in its gaols, and native schools, or in industrial missions.

In the Malabar coast the husks in many cases are purchased by merchants and the preparation of fibre performed as piece work by peasants, the beating, clearing and twisting after retting, being done by old women. Surely this would be easier and more profitable work for women than carrying heavy loads of native produce many miles to sell for a few sticks of tobacco at the Bung (native market) in Rabaul and other settlements.

Harvesting.

The general practice in Ceylon and the Malabar coast is to cut the stalk of the bunch by means of a full-length bamboo to the end of which a knife is fixed. On palms too tall for the nuts to be harvested by bamboo poles, such work is done by coolies climbing the trees and cutting the bunches or single nuts, their ripeness being gauged by the coolie tapping one of the nuts with his finger nail. The sound produced indicates the quantity of moisture in the husk and the ripeness of the fruit, and the whole bunch is cut only when all the nuts have reached sufficient maturity. Payment in Ceylon for climbing is at the rate of two rupees (2s. 8d.) per 100 trees and the coolie usually climbs 50 to 60 trees per day.

By means of the bamboo about 150 trees can be picked per day per coolie, payment for which is made on the basis of 80 cents (1s.) per 100 trees, so that a man can pick by this means 900 to 1,000 nuts in a week. Contract labour is sometimes employed, when a contingent can pick an area of 10 to 12 acres in a day and will receive 15 rupees (£1 sterling) for the job. The work of collecting the nuts will be 1 rupee, and carting to the drying dump 3 rupees, or a further expenditure of 4 rupees a day.

Husking.

Nuts are allowed to lie stacked in a heap for a few weeks (a fortnight to a month) to partially dry out before husking, but one rarely sees heaps of "dries" as noticed in New Guinea.

The best coir fibre is prepared from nuts that have been harvested from the trees before the exterior of the fibrous covering is quite ripe, say, ten to eleven months old, as they are then most readily retted, besides producing better coir, colour being an important factor in assessing its value.

As coco-nuts are always harvested in New Guinea as "dries" there is little hope of our producing coir of extra good quality, but even the second quality (that which is coarse and hard), is still a good marketable commodity.

The method of husking is to have a straight wooden or iron spike driven fast into the ground—a piece of 1-in. round iron, sharpened at the outer end to a knife edge, is admirable for the purpose. The coco-nut is struck with a straight blow against the point or edge of the spike, which penetrates to the shell and with a twisting movement the husk and shell are readily separated one from the other. A skilled coolie can husk as many as 2,000 nuts per day, but 1,000 to 1,500 is nearer the mark for the average worker, for which he receives 50 cents (8d. sterling) per 1,000. It has been proved on a well-known estate in New Guinea that after about three months' practice, our natives can husk as a maximum 1,500 per day.

Retting.

The process of soaking and retting husks before preparation of the fibre has been the practice for such a long time that one is justified in thinking that there must be some sound reason for doing so, but which, of course, does not preclude the modification of the principle involved.

There is considerable variability in the process of retting, according to local conditions. Still water is not generally considered suitable for the purpose, but husks are frequently retted in pits with brackish water, in the backwaters of lagoons. The pits are formed by making enclosures with stout bamboos driven into the mud and joined together with plaited coco-nut leaves, subject to the movements of waters by the flowing and ebbing of tides, like the fish traps placed across many small streams, by New Guinea natives, to catch fish on a falling tide. An outlet is provided to permit the accumulated dirty water to escape with the outgoing tide, and to fill again on the returning tide, and by this method a complete change of water is effected.

In selecting sites for such retting pits, considerable care is exercised not only for the necessary water conditions, but with regard to the proportion of mud and sand at the bottom of the pit, as this has a bearing on the brightness and strength of the fibre.

The methods employed in Ceylon and South India are the result of many hundreds of years' experience, and therefore entitled to careful consideration. In some places the husks are soaked for a few weeks in water, or even sandy mud; in others the retting lasts for nine months, or even longer, and the fibre is then rinsed, partly dried and beaten. This is followed by further soaking, drying and beating to get rid of the dust before the material is rough carded.

It is an advantage to crush the husks before placing in the retting pits. Crushing or breaking machines are easily constructed consisting of two heavy rollers as used in old-fashioned cane crushers, and by repeating the process of soaking and crushing the period of retting is greatly reduced. The retting pits are sometimes dug in the soil adjoining a backwater of sufficient depth to hold 3 or 4 feet of water at all times with an inlet permitting fresh water moving in and out of the pit. Stagnant water spoils the colour of the fibre, and under such conditions a pronounced odour of sulphuretted hydrogen is noticeable.

A pit of 250 cubic feet with a depth of 4 feet of water can hold the husks of 1,000 nuts. In pits of this kind the husks are placed in layers, one above the other, and weighed down in the water by heavy logs. In some places where slowly moving water is not available concrete tanks and ponds are filled with fresh water for retting. This was the method employed at Pekalongan Gaol in Java, which I visited specially to study the coir fibre industry carried on by the Dutch Government, in that institution.

The pits should be shallow enough to be thoroughly warmed by the sun as the retting is thereby expedited, and too rapid a change of water should be avoided, otherwise the temperature will be unduly lowered, thus retarding the retting process: this also diminishes the action of the bacterial organisms which disintegrate the matter binding the fibres together.

The general opinion seems to be that retting in purely salt water is not advisable, yet, if retted in fresh water ponds for a very long time, the fibre is damaged, as the epicarp or outer skin becomes rotten, and is not easily removable.

Burkhill, in his *Dictionary of the Economic Plants of the Malay Peninsula,* says—

> "The ability to produce good coir rests on the nice adjustment between the various bacteria and organisms which operate in the tanks and their surroundings; too little air fosters the wrong ones; a slightly saline medium seems to inhibit their action; too low a temperature spoils the process."

The discovery of some method of retting the husks by a chemical process on a large enough scale, would no doubt enable husks to be processed on an economic basis, but, so far, research has not gone beyond the experimental stage.

Extraction of Fibre after Retting.

Hand Extraction.

After removal of the husks from the retting pits the outer skin is removed and the fibre beaten out by mallet on a block of wood.

In the Pekalongan Gaol, Java, there were 1,000 prisoners all employed in preparing coir fibre, and weaving into mats and various other articles. Larmuth and Bulmer machines for processing the fibre were partly employed, but large numbers of prisoners were hard at work beating out the fibre by the hand method, producing about 5 lb. of clean fibre each, in a 10 hours working day.

In Malabar, South India, one woman will clean the husks of about 100 nuts per day.

Machine Extraction.

As already noted, the coir mills in Ceylon are comparatively simple. The machines known as breakers and finishers consist of drums set with coarse and fine iron spikes respectively. The husk being still wet from the retting is fed by the labourer between rollers of the breaker with the back or hard side uppermost, when at high speed. The husks are fed rather more than half-way, then withdrawn, and the other end inserted in a similar manner. The back of the husk is in this way broken and then passed on to the finisher machine. The labourer feeds the husk into this finisher machine in the same way, which removes the spinning or mattress fibre. The breaker and finisher are in pairs, so that the half-treated fibre is passed to the labourer serving the finisher for the final operation. The finisher also removes the greater proportion of the fibre from the remainder, and the husk left in the coolie's hand, which is not passed through the machine, is known as bristle fibre. This is put back into another tank to be washed and afterwards dried in the sun.

The fibres which have passed through the breaker and finisher, and known as mattress, are then dried, preferably in the shade, and afterwards threshed with poles to remove the remaining dust, when the fibre should be ready for the final operations of willowing. This machine consists of a revolving drum carrying a number of teeth set on its axis which pass through similar teeth on the inner side of the machine. The fibre which has passed through this machine is soft and clean ready for manufacturing purposes. By this machine two persons can willow 300 lb. in eight hours. Improved and more costly machinery is manufactured for the purpose, resulting in a very much larger output of clean fibre.

The proportion of the two products is usually one bristle and two mattress dried. One thousand to 1,200 full husks are estimated to give 1 cwt. dried bristle fibre and 2¼ to 2½ cwt. mattress fibre. By a Ceylon locally-made machine 2,000 husks per day are treated.

Mr. Bunting, of the Department of Agriculture, Federated Malay States, in an article on coir fibre, written after a visit to Ceylon, states that twenty of the Ceylon machines, working on a 16-hour day, produce 300 tons of bristle fibre and 600 tons of mattress fibre, from 7,250,000 husks. It is also estimated that 24,000 husks will produce 1 ton of bristle fibre, and about 2 tons mattress fibre. In large mills of this character the fibre is packed by hydraulic press into bales of 2½ to 3 cwt., roughly measuring 11 cubic feet. The price paid for husks ranges from Rs. 1 to Rs. 3 per 100, according to fibre market quotations, delivered at the mill.

Bristle Fibre.

This is the most valuable portion of the coir product, being graded into three grades, each in a different manner as follows:—

The longest bristle fibre with three (3) ties.
The medium length fibre with two (2) ties.
The short length fibre with one (1) tie.

Prices vary naturally, according to supply and demand, but the latest available prices are as follows:—

Long bristle fibre three (3) ties—£27 10s. per ton.
Medium bristle fibre two (2) ties—£26 5s. per ton.
Short bristle fibre one (1) tie—£24 per ton.

Mattress Fibre.

Fair ordinary brown fibre—£12 per ton.
Super quality brown fibre—£14 per ton.
White bleached fibre—£26 per ton.

Working Costs.

It is a very difficult matter to give an estimate of the working costs for the extraction of coir fibre by the modern machinery, as labour and other conditions vary even in any one country. However, to give some indication of the requirements to operate a plant such as manufactured by Messrs. Larmuth and Bulmer Limited, of Manchester, England, the following particulars are supplied:—

General supervisor	1	European or Asiatic.
Engineer or maintenance man	1	„ „ „
Boiler or maintenance man	1	„ „ „
Husk-crushing machines	2	„ „ „
Extracting machines	16	boys.
Willowing machines	2	„
Brush, combs (for bristle fibre)	4	„
(Also to attend to fibre-cutting machines.)		
Baling press	2	„
Milling machine	1	„
Eight 6-headed small spinning machines ..	48	„
Four 2-headed small cabling machines ..	8	„
Over and above these workers it would be necessary to have about six boys about the factory to aid in moving the material from place to place	6	„
Total	92	

Installation of Plant.

To ensure that the above machinery was installed in satisfactory working order, it would be advisable for a thoroughly competent erector and demonstrator to be sent out with the machinery from the makers, and remain for about a year to demonstrate to the operating staff of each machine, and produce goods such as the material affords. Such a demonstrator would instruct the various operators as to the operations they are required to fulfil, and he should stay on until the general supervisor and engineer have thoroughly mastered every branch of the plant, so that they would know how to get a full return from every worker on the staff.

Messrs. Larmuth and Bulmer Limited have supplied particulars of the machinery for the treatment of 10,000 coco-nut husks per day of ten hours, to convert the fibre extracted into yarns, complete with millwright work, boiler, engine, &c. Such a plant is only suitable for a company operating in a large coco-nut-growing district in Gazelle Peninsula and East Coast-road, New Ireland, where millions of coco-nuts are going to waste yearly.

Methods of extracting and processing coir fibre without previous retting have been invented or described, but the only one with which the writer has personal knowledge is the Van der Jagt, which claims to extract the fibre in the marketable form from the husk of dry nuts, in less than two hours.

This process was described in the *Engineer,* June, 1912. A full description with photos of the machinery supplied by Mr. Van der Jagt himself, was submitted to the head of this department in 1930. The fibre produced by this method is apparently softer and more easily worked than that of the older system, but renders it unsuitable for many of its ordinary purposes. While in Europe in 1931 I made certain investigations on this method, and saw samples of the produce (including gunny bags), made from the fibre, and they appeared quite suitable for copra and fertilizer sacks and similar purposes. The fabric for the copra and similar sacks is stiffer and harsher than that made from jute, and would hardly be acceptable for such purposes, unless obtainable at a considerably lower price.

The capital outlay for this plant to deal with 5,000,000 coco-nuts per annum is quoted at £40,000, including buildings.

The Australian Trade in Coco-nut Fibre.

The following article on the Australian aspect of the trade, reprinted from the *Malayan Agricultural Journal,* April, 1936, may be of interest to readers:—

> "An inquiry was recently received for information concerning the Australian trade in cono-nut fibre (coir). The following notes are drawn from a communication by H. M. Senior, Trade Commissioner in Australia, and from a letter from one of the principal importers.
>
> *Imports.*—In the year 1934-35, 24,189 cwts. of coco-nut fibre were imported into Australia, of which 22,301 cwts. were from Ceylon, and 1,630 cwts. from India. The total value of these imports was £5,522. Queensland was the largest importer (14,107 cwt.), while other States imported as follows:—Victoria, 4,593 cwt.; New South Wales, 2,494 cwt.; South Australia, 1,542 cwt.; Western Australia, 1,452 cwt.; and Tasmania, 1 cwt. The demand is regular, but, as will be seen from the above figures, not a large one.
>
> *Packing.*—There are two types of packing suitable for the Australian market. The first type is in hydraulically-pressed bales containing 2 cwt., 2½ cwt., or 3 cwt. The measurement would be about 12 cubic feet for a

2-cwt. bale. The bale type of packing is not popular with many manufacturers as they find that the fibre is exceedingly hard to tease; they, therefore, prefer to pay a little extra for a looser packing. As a result, in many cases, fibre in ballots is more popular. A ballot is a small bundle of fibre varying in weight from 12 to 15 lb., tied loosely with yarn made from coco-nut fibre. From 200 to 250 ballots weigh 1 ton.

Freight.—The freight rate on ballot fibre exported from Colombo to Australian ports is 30 rupees per ton of 6 cwt., equal to £7 2s. 6d. sterling per ton of 2,240 lb., while on bale fibre the freight is 40 rupees per ton of 50 cubic feet, equal to £5 sterling per long ton.

The freight on fibre is by far the largest item in the landed cost. Until recently, the f.o.b. price, Colombo, of ballot fibre was exceedingly low, and the price of £9 5s. c.i.f., Sydney, would represent an f.o.b. cost, Colombo, of £2 2s. 6d. Bale fibre at that time was quoted at £7 12s. 6d. per ton c.i.f., Sydney, representing £2 12s. 6d. f.o.b., Colombo. At the end of January, 1936, c.i.f., Sydney, price for bale fibre was £10 and ballot fibre £11 2s. 6d.

It is stated that the high freight charges on coco-nut fibre are made on the grounds that the fibre is hazardous cargo. They bear little or no relation to freight charges for other kinds of goods."

Summary.

1. On well-conducted coco-nut estates coco-nut husks can be put to best use as manure, but for those desirous of receiving an immediate return they can be sold to advantage to mill owners.

2. Coir fibre preparation is largely a cottage industry in southern India and Ceylon where these is a considerable local market for processing into rope, twine and boat caulking.

3. The invention of machinery in the middle of the nineteenth century for processing the fibre brought it into more general use as a commercial commodity.

4. The supply is fully equal to the present demand, but research has shown that it can be put to new uses particularly as lagging for oil, water or gas pipes to prevent corrosion and when this practice becomes general there should be a much greater demand for the product.

5. Coir fibre preparation cannot be recommended as an industry for individual planters, but should be suitable for capitalistic enterprise with the use of modern machinery in districts where there are large nearby supplies of coco-nut husks as in Gazelle Peninsula, New Britain and east coast, New Ireland.

It should also be suitable as a native industry in industrial missions or as work in government institutions like gaols and schools. The preparation of fibre by natives could open the way for a valuable secondary industry in the making of mats and other articles for which there would be a ready sale.

6. The best coir fibre is obtained from coco-nuts that have been harvested before being thoroughly ripe and as nuts in New Guinea are always harvested as "dries" it could not be expected that the finest fibre could be produced in this territory. Second grade is a thoroughly marketable commodity.

7. Preparation of fibre by retting is the general practice, but researches are being carried out with a view of expediting the process by technical means.

PIG RAISING.

By George F. Gee, H.D.A.

Introduction.

The economic principle underlying pig raising is the production of suitable material which is readily available for consumption, and quickly produced. Allied to this principle are factors which vary according to the country or state in which pig raising is an industry.

In Australia, the primary factor is to supply a market from which the producer attains a monetary gain, whereas in New Guinea the main consideration is local consumption, local sale, and barter. Consumption in the case of plantations and village natives, sale in the case of plantations, and barter in the case of village natives.

Should, however, a pig industry develop beyond the limits of local consumption, sale and barter, then an export trade becomes possible.

The pig occupies an important position in native sociology, being extensively used for consumption and barter, and could become quite a factor in estate economics, providing rations for labour, and material for local sale.

Broadly speaking, the type of pig bred in this Territory could not be regarded as giving satisfactory results where size, early maturity, rapid fattening, &c., are of paramount importance. This paper, therefore, is intended to discuss purely the fundamentals of pig raising and improvement by—

1. Introduction of suitable breed or breeds.
2. Housing.
3. Feeding.

Common diseases of swine also concern the pig raiser, but it is intended to dealt with this aspect in a later article.

It is apparent that points 2 and 3 will have little bearing on native pig raising at the present juncture, it being well known that the introduction of, and adoption by, the native of new ideas must be gradual and extend over a long period of years.

1. Introduction of Suitable Breed or Breeds.

The most suitable breed depends on the types needed and local conditions. In New Guinea the primary requirement is for a breed which will definitely improve the type already in existence, and the following popular breeds may be considered as having the necessary attributes, although the ultimate choice will depend on certain factors correlated with local conditions.

Berkshire.

The Berkshire is one of the oldest breeds in existence and although essentially a pork type is classified in Australia as a dual purpose pig, i.e., suitable for pork or bacon.

The pure strain is black, with a white blaze on the face, four white feet, and a white tip on the tail. The breed is noted for early maturity, hardiness, reliance to thrive under most conditions, high quality of meat produced, and high proportion of popular cuts which it yields. Berkshires are extremely suitable for cross breeding, transmitting these characteristics such as early maturity, hardiness, &c., for which they are noted, and should produce a most beneficial effect on the New Guinea pig.

The breed are good foragers, tractable, the sows are good mothers and regularly produce good even litters.

Tamworth.

The Tamworth is a direct descendant of the large, wild, red pig of Britain, is said to contain no alien blood, and has been bred pure for 150 years. The pure strain is large, long bodied, long snouted, slab sided, covered with coarse reddish hair on a flesh-coloured skin, free of black spots or hair, essentially a bacon type and proves exceptionally useful in improving the flesh, fining the shoulders, and reducing the jowl of many other breeds.

Tamworths are good foragers, hardy, robust in constitution, particularly free from disease, and prolific breeders; the sows are good suckers, and docile with their litters.

In Australia, this breed is used chiefly for bacon production; especially are the sows crossed with Berkshire boars. The Tamworth is not regarded as such an early maturer as the Berkshire.

Yorkshire.

The Yorkshire, as a breed, is generally divided into two types but is sometimes referred to as Large or Middle White. The breed is claimed to be directly descended from the large white pig of Britain, and improved by the introduction of Chinese blood.

1. *Large Yorkshire.*

The Large Yorkshire is essentially a bacon pig noted for its quality and conformation. Pigs of this breed are sound in conformation, good grazers, prolific breeders, and prepotent. In hot climates, owing to the white skin and hair, they are very susceptible to sunscald, a condition which considerably reduces their value for either pork or bacon.

They give very satisfactory results when used for cross breeding, but the progeny are always white since this is a dominant colour in pigs.

2. *Middle Yorkshire.*

The Middle Yorkshire may be classed as a dual purpose breed, approximating in conformation the Berkshire, and are very good feeders, turning their food to the best advantage. The breed is noted for its prolificacy, the sows being exceptionally good milkers and docile mothers. When used for cross breeding the Middle Yorkshire imparts to the progeny quick growth, good appetite, light offal, and hardy constitution, but like the Large Yorkshire the susceptibility to sunscald is ever present on the light hair and skin.

Any one of the foregoing breeds could be used to successfully improve the New Guinea pig. From the foregoing short descriptions it will be seen that the Tamworth would produce long snouted pigs of bacon conformation, which although larger and infinitely better than the New Guinea pig, would, in the eyes of the native, approximate his own breed, hence the tendency to consider them their own type.

The Yorkshire would produce a progeny, showing a vast improvement in constitution and conformation, but having the predisposition to sunscald on account of the white skin.

The Berkshire, although not so large as the Tamworth, would impart to the native pig desirable qualities such as blocky conformation, shortened snout, and early maturity, without predisposition to sunscald.

That the Berkshire will transmit characteristics of conformation more desirable than the Tamworth, and colour more desirable than the Yorkshire, shows that this breed is worthy of the utmost consideration for improving the New Guinea pig.

2. Housing and Sanitation.

The site for the piggery should be well drained, the contour of the land being considered to provide natural drainage if possible. An open, porous type of soil is to be preferred; stiff clay or soils with an impervious or heavy sub-soil should, where possible, be avoided as they soon become saturated with foecal and urinary matter, &c., which on decomposition creates unhealthy and objectionable conditions.

The aspect of the piggery is important so that full benefit of sunlight will be obtained, sunlight being the cheapest and best of disinfectants, thereby assisting to a great extent in keeping the surroundings in a sanitary condition.

Rising ground provides an ideal site for the piggery but does not infer that it should be placed on top of a hill, fully exposed to all winds, but on a rise where full benefit of the drainage may be obtained.

The roof of the sty should be of sufficient height to permit air movement and easy cleaning, while the stalls should be smooth, as a precaution against body parasites, and built to minimize draughts. The floor should be impervious to moisture.

The sleeping quarters should, for preference, have a wooden floor, at least six inches above ground level, slabs laid on the ground being little better than the earth itself.

Young pigs are very susceptible to dampness and draughts; these factors induce pneumonia which checks the pig's growth and considerably lengthens the fattening period. Even after recovery the pig may become such a bad doer that it can never satisfactorily be fattened.

The healthiest system of pig raising is to graze the pigs in paddocks supplied with an open-fronted shelter shed or a mobile house built on skids which may be easily moved from one paddock to another.

Where it is not convenient to run pigs on large areas, a commonly adopted and suitable method is to have alternate small yards. When one yard becomes fouled from constant use it may be turned over, limed for sweetening purposes, and a green or root crop grown. When the crop is ready it may be soiled or the pigs turned in, the yard then vacant being treated in a similar manner.

The planting of shade trees around the piggery and in the yard is important, particularly in the tropics where other forms of shade apart from the open-fronted shelter shed are necessary.

For the maintenance of cleanliness and sanitation it is advisable to supply a wallow for the pigs, rather than condone the use of a nearby hole, creek or watercourse, especially in a climate similar to that experienced in New Guinea.

Unfortunately, the usual type of wallow provided is a puddle hole into which is drained all the filth from the surrounding yards. As the pig is forced to seek relief from the heat, and such a wallow being the only one available, it naturally uses it, thereby creating a foul odorous mixture of mud and water and decaying vegetable matter, which provides an ideal spot for the incubation of diseases and pests. The ideal wallow is one built of concrete, which can be cleaned out regularly and kept in a sanitary condition.

Open drains should always be used so as to facilitate cleaning, but if closed drains cannot be avoided then ample provision should be made for frequent and efficient inspection and cleaning.

Water Supply.

It has been definitely proved that pigs cannot make rapid and economic gains unless a plentiful supply of clean fresh water is always available. Henry and Morrison state that the amount of water required by pigs ranges from 12 lb. daily per 100 lb. of animal at weaning time, down to 4 lb. per 100 lb. live weight during fattening period.

The water troughs should be kept clean and no opportunity allowed for the pigs to drink from stagnant pools. The water, in addition to that stored in tanks as a reserve, could be obtained from a creek or stream running through the property, by sinking a well, or by a spear pump. It is advisable not to allow the pigs access to a stream as a common method of carrying infectious, parasites and diseases is by means of running water.

Pigs fed on a dry feeding system require more water than those fed on a swill ration. In addition to the drinking water ample provision should be made for a sufficient supply for the cleaning of all utensils used in feeding, also cleaning the houses when necessary.

3. Feeding.

The economic importance of correct feeding in pig production is indicated by the fact that food represents so large a proportion of the total cost of production.

The pig is well adapted for the disposal of many waste foods, but unless such foods are in a sound and wholesome condition serious trouble will result from their use. Pig feeding is unlike feeding other farm stock because the relatively small capacity of the digestive tract, plus the animal's capacity for rapid growth, prevents the use of bulk or roughage and food containing a high fibre content to best advantage. Therefore, special care must be taken to ensure that the ration is complete in all respects. Generally speaking feeds are divided into two classes—

1. *Concentrates.*

Such as the seeds of all plants, and certain materials produced from the by-products of commercial establishments. Concentrates supply a large amount of nutriment in small bulk.

2. *Roughage.*

The fibrous portion of the ration consists of straw, green feed, pastures, and root crops, which give bulky feed.

The function of bulk in a ration is more than the mere furnishing of nutriment, as the stomach has to be comfortably filled to produce a state of contentment. The pig, however, requires less bulky feed than other animals; nevertheless, bulk or roughage plays an important part in profitable pig production.

To the pig raiser, a suitable ration is one that promotes and maintains health and growth, therefore, attention is given in the first instance to—

1. The nitrogenous substances generally termed proteins and used chiefly for development of flesh.

2. The starches, sugars, &c., called carbohydrates, which together with the fats and oils, develop and maintain the supply of body heat and energy.

3. Mineral matter and ash, which is valuable for bone forming and the normal functioning of every organ of the body.

The extent to which a substance or substances is incorporated in a food can affect its value, there being an optimum point where the fibre content or the laxative nature of the ingredients decrease the value of the ration. A ration should be properly balanced in respect to the amount of proteins, fats, and carbohydrates it contains. The ratio existing between the digestible crude protein, and the combined digestible carbohydrates plus fats, is known as the nutritive ration. (This may also be expressed as the ratio between the nitrogenous substances (crude protein) and the non-nitrogenous substances (carbohydrates, i.e., sugars and starches plus fat x 2.25 since fat produces 2.25 times as much heat, on being burned in the body, as do the carbohydrates.))

A ration having excess crude protein in proportion to carbohydrates and fat is said to have a narrow nutritive ratio, and if the reverse, it has a wide nutritive ratio.

Nutritive ratios suitable for different classes of pigs are—

Weaners	1 : 4.0
Fattening pigs	1 : 5.0 to 1 : 5.5
Baconers	1 : 6.0
Sows in milk	1 : 5.0
Stud boars	1 : 5.0

If the ration being fed does not have a nutritive ratio approximating these shown, then the ration is not properly balanced. An unbalanced ration can have serious consequences and may be responsible for paralysis and unthriftiness especially in young pigs, and the habit of a sow eating her young.

Suitable Feeds for Pig-feeding.

Maize is rich in carbohydrates and fats, and when fed alone is an efficient ration, especially for growing pigs, but must be supplemented with a food rich in protein. Pigs fatten well on maize, but if it should constitute more than 50 per cent. of the ration, then there is a tendency for the bone to become soft and the fat yellow.

Peas are rich in protein and useful in balancing grains with a high carbohydrate content. Fed alone they produce a very hard, lean flesh and young pigs do not thrive well. Good results will be obtained if fed with other grains but should never form more than 25-30 per cent. of the ration.

Rice, if fed in large quantities, will produce a flesh inclined to be soft. Owing to the large percentage of husk, rice should not exceed 25-30 per cent. of any ration.

Sorghums have a fattening value equal to 80 per cent. of maize. They produce a flesh inclined to be soft and of inferior quality, therefore should not constitute more than 35-50 per cent. of the ration. As the kernels are hard, grinding or soaking may be necessary for young pigs.

Potatoes consist of approximately 75 per cent. moisture and 25 per cent. dry matter which is mostly starch, so 4 lb. of potatoes are generally considered equivalent to 1 lb of maize. This brings into consideration the question of bulk, and while potatoes may be fed to all classes of pigs, best results will be obtained when the digestive tract of the pig is sufficiently developed to cope with the necessary bulk. One-third of the grain ration may be replaced by potatoes, and this amount gradually increased till two-thirds of the grain ration have been replaced. Usually potatoes are too valuable to be used as pig food, but when available they should always be boiled before feeding.

Among the potatoes may be classed sweet potatoes, yams, mamees, cassava, and taro, some of which, at least, are to be found growing throughout the Territory.

Peanuts can be fed to pigs of all ages, but in time produce a soft oily flesh due to their high oil content (approximately 36 per cent.), therefore should be eliminated from the ration at least six weeks before slaughter.

Meat meal, a protein rich food (40-60 per cent.), a product of the abattoir and meat works, is very valuable in balancing grain rations when milk or milk by-products are not available. Owing to its richness in protein, 10 per cent. of meat meal fed with 90 per cent. of corn is sufficient to balance the ration for pigs over 100 lb. in weight, but younger pigs require a little more.

Cocoa meal cannot be recommended as a pig food and has been known to cause abortion in sows.

Grazing and Suitable Crops.

There is nothing which will solve so many of the problems of profitable pig production as an abundance of good forage. All classes of pigs respond to good pasture, and it is especially valuable in the rations of young pigs because of the nature of the proteins, minerals and vitamines provided. Mature sows require little more than good pasture during the greater part of the gestation period. The amount of food saved by pasture depends on the quality of the crop; good pasture can result in a saving of one-half to three-quarters of the protein supplement. The carrying capacity of pasture or forage crops will depend on yield and palatability and the method of feeding to the pigs. One acre of good forage can usually be depended on to carry 11-12 cwt. of pigs for 120-180 days. In the tropics such crops as maize, sorghums, pumpkins, &c., are not rich in protein and for this reason a protein supplement must form portion of the ration if best results are to be obtained.

The following crops are suitable for growing in New Guinea, and two or more of these could be planted to ensure a continuance of good forage throughout the year: Cowpeas (a particularly valuable legume, rich in nitrogen), pumpkins, maize, millet, sorghum, sweet potatoes and other crops used for native foods.

Preparation of Feeds.

Most feeds require little preparation for pigs. Maize may be fed either shelled, on the cob, or the pigs may be turned into a field and the maize "hogged down". It is not materially improved by grinding; coarsely grinding or cracking small grains may result in a saving of food but the extent of the saving depends on the hardness of the grain and the method of feeding. When hand fed in groups, the pig eats rapidly and a large number of small grains escape being broken by the teeth, thus passing directly through the body. On the other hand, pigs accustomed to eating from a self feeder eat more slowly and masticate their food more completely, so that greater use is made of the food eaten than when hand feeding is practised. Tests indicate a saving of 15-20 per cent. of small grains by grinding, but later observations suggest that with self feeding, grinding saves little, if any, feed.

Soaking is a poor substitute for grinding small grains, and it does not improve the feeding value of maize and cracked grains.

Cooking reduces, rather than increases, the value of most feeds for pigs; hotel and slaughterhouse refuse, soy beans, potatoes and other similar foods being the exceptions. "Swill" feeding is an old practice, but tests have failed to justify its use for growing pigs and there is little evidence to indicate it is necessary even with breed sows.

Creep feeding is a method by which the suckers are fed separately to the sow, and is best carried out by placing across one corner of the pen, a hurdle with vertical openings of sufficient width to admit the suckers, while the sow is excluded. Young pigs commence to eat when three to four weeks old, and a little swill at this stage appears most palatable, while later grain may be added to the ration. This system relieves the sow of a large amount of unnecessary strain, the suckers will be healthier, and an increase of up to 10 lb. per pig may be obtained at weaning time.

Self feeding is a method of feeding in which the grain ration is always available to the pig. The grain is placed in a hopper, so constructed that as the pig eats the grain from the trough, more falls down and a certain amount is always in the trough. This method creates a considerable saving in labour where grains are being fed, and is intended more especially during the growing and fattening stages of pork and bacon production. It is not, however, recommended for breed sows, as they usually only require a limited amount of grain. Once charged with grain, a self feeder cannot be neglected, for the feeder may become blocked by mud carried on the pigs' feet, &c., thus the feed in the trough becomes spoiled, making it unpalatable.

It is essential that all feeding utensils and troughs be kept perfectly clean. Often the feeding trough is a hollow log which is difficult to clean, the food soaking into the crevices, putrifies, and becomes a suitable medium for the growth of germs, which, if taken into the digestive tract, may cause disease or gastro-intestinal derangements, especially in young pigs. Scours may often be traced to incorrect or filthy feeding.

Uneaten food should always be removed from the troughs, which should be cleansed before another feed is given.

Troughs may be of iron, concrete, or wood. Iron troughs are preferable as they may be kept clean with a minimum of trouble, but are fairly expensive. Concrete is good if well made and properly finished off. Acid in the food may attack the concrete causing it to disintegrate, thus the pig will eat lime and sand with his food. Concrete troughs should be given a rendering coat of a thin layer of one part of cement to two parts of fine sand and steeled to give a smooth surface.

A very good and inexpensive trough can be made from sawn timber, provided it is well joined and tarred thoroughly before use, to prevent food soaking in. If built at a slight slope, with a bung at one end, they are easily kept clean. All troughs should be heavy enough to prevent them being overturned, and so constructed to prevent, as far as possible, pigs standing in them.

Infection, and most parasitic diseases, occur through ingestion and if the pig, after tramping or lying in the dung or urine, stands or lies in the trough, the eggs of intestinal worms are conveyed to the food, to set up further infection.

There is no apparent reason why the apple and water, from coco-nuts being cut for copra drying, could not be successfully used in the Territory in pigs' rations as a protein supplement to the grain being fed. Chemical analysis, of both the meat and water, as shown in the following table, confirms this theory, which makes both these products of the coco-nut palm appear to have great possibilities in the founding of a definite pig raising industry in New Guinea. Unfortunately, no record is available of any feeding tests with these products having been carried out in other parts, but the writer hopes that in the near future the Department of Agriculture will have the opportunity of conducting feeding tests with both these products and also other foods.

ANALYSIS OF THE MEAT AND WATER OF COCO-NUTS.

From Sampson on "The Coco-nut Palm".

—	In Dry Matter.					
	Moisture.	Nitrogen.	Phosphoric Acid.	Potash.	Lime.	Magnesia.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Water ..	95.04	0.50	0.56	6.60	0.69	0.51
Meat ..	43.46	3.05	0.46	0.80	Trace	0.16

PROMECOTHECA ANTIQUA Wse.

Leaf Pest of Coco-nuts.

By John L. Froggatt, B.Sc., Entomologist.

The main features of the life history of this pest were given in the *New Guinea Agricultural Gazette,* Vol. 2, No. 1, pp. 10 and 11.

Parasites.

Egg and larval parasites have been bred from material collected in the plantations from several localities, but were comparatively rare. During a visit to Manus, March, 1937, a larval parasite was found in fairly marked evidence, judging from the number of emergence holes in infested leaflets, although nowhere was the pest serious. A few of the adult wasps were bred out and an attempt was made to breed through a life cycle in the laboratory, but without success. By comparison with broken specimens collected previously in that locality this appears to be the same species as was obtained at that time. This is the only parasite of *Promecotheca* that has been found in any number, and arrangements are in hand to make a detailed study of the species.

Mechanical Measures.

For any crop to be effectively protected from the depredations of pests, it is essential that control measures should be undertaken as soon as infestation is observed. In the initial stages, this is generally localized in one or more small areas, and from these centres the succeeding generation, greatly augmented in numbers, spreads far and wide, resulting in the development of a plague.

Attack by *Promecotheca* on young palms may be combated by not only collecting the adults, but by rubbing off the egg masses, which appear as small brown circular convex lumps on thes urface, and also by drawing the infested leaflets between the finger and thumb and crushing the young larvae inside. The collection of adults is certainly useful, but alone it does not prevent a considerable increase in the next generation, as is done by combining the measures referred to above.

On older palms, obviously, this will not be possible, but if taken in hand while infestation is localized, the cutting off and burning of the infested fronds, combined with the collection of adults coming down on the cut off fronds, has been proved to very materially check the infestation. Of course, if no action is taken until the pest is well established, any measures then instituted will be a big and costly matter, and will possibly fail to bring about effective control.

"Dry Spraying."

With the improved price of copra, methods that could not be considered before are now within the bounds of economic possibilities.

The application of insecticides as a dry powder has become of general use, not only for ground crops, but for tall trees. By this method, the dust is projected into the air as a cloud, by means of a forced draught, and drifts through the plantation with the current of air. Obviously, up to a point, the slower the dust cloud moves, the more perfect the settlement of the fine powder on the foliage; it is, therefore, advisable to carry out "dusting" in the early morning, or the late afternoon, or when there is but a very light breeze. The early morning is preferable as the foliage is then damp with dew, and this assists in the better adherence of the dust.

Dusting machines with a 3½ horse-power engine, suitable for young to moderate-sized palms, are now obtainable in England and America, at a cost of fifty (£50) to sixty pounds (£60) sterling, and larger machines (6 horse-power engines) for about ninety pounds (£90) sterling. A machine of the latter type has been ordered by the Department of Agriculture, for use against both *Sexava* and *Promecotheca*.

Details of these machines and suppliers can be obtained from the Department of Agriculture, upon application.

Utilization of the "Kurukum" Ant.

It is an old practice to run cane-ropes from palm to palm to facilitate the transference of this ant (*Oecophylla smaragdina*) to attack the *Promecotheca*.

One feature that must be borne in mind, with reference to ants, is that they transport and protect scale insects and mealy bugs for the sugary excretion given off by them. They may also deleteriously affect pollination in the blossoms.

EPHESTIA CAUTELLA Wlk.

Moth Pest of Stored Cocoa Beans and Copra.

By John L. Froggatt, B.Sc., Entomologist.

Complaints have been received over a considerable period from consignees in Australia, that cocoa beans from this Territory were arriving at the port of destination infested with "grubs".

Arrangements were made with consignors and consignees whereby samples of beans found to be infested both at ports of shipment and destination, were forwarded to the Entomologist, Rabaul, for observation and to enable breeding work to be done. It may here be stated that the samples received showed a considerable variation in the quality of the beans, but this was not a factor governing the insect infestation.

The same moth was bred out from all samples received, and specimens submitted to the Imperial Institute of Entomology, London, were identified as *Ephestia cautella, Wlk.* (family *Pyralidae*).

The adult is a small moth measuring about three-tenths of an inch in length over the folded wings, and is dark silvery grey in colour. The eggs are laid on the beans, and possibly on the outside of sacks containing beans, while in storage, and the small brown larvae burrow into and feed on the bean, ultimately leaving little more than a shell, in addition to creating a considerable amount of frass. Although only a comparatively small percentage of the beans are actually infested, the commercial value of the consignment is greatly impaired.

As this moth is a common pest of many dried foodstuffs, investigations were instituted to determine any possible sources of infestation. All suppliers of cocoa beans concerned were also suppliers of copra, which, at times, is also heavily infested with moth larvae. Samples of copra, so infested, were collected and kept under observation, and again *Ephestia cautella* was found to be causing the infestation.

It is thus feasible to conclude that dried cocoa beans had been stored in, or adjacent to, copra sheds, which was found, on inquiry, to be correct.

In the course of the breeding work, it was proved that infestation had occurred before shipment from the plantation, although infestation of clean beans, or re-infestation, could easily occur in transit, or in storage elsewhere than on the plantation.

Care in the storage of cocoa beans away from copra should, therefore, reduce infestation by this pest to a very great extent.

Fumigation could be resorted to, but if carried out in Rabaul, would possibly cause delay in despatch, and if carried out on the plantation would necessitate the erection of proper fumigation plant and insect proof storage space for after treatment.

EGG PARASITES OF *SEXAVA* SPP. IN THE TERRITORY OF NEW GUINEA.

By John L. Froggatt, B.Sc., Entomologist.

During the investigations into the "Coco-nut Tree Hopper" (*Sexava* spp.) several *Hymenopterous* parasites have been bred from the eggs of this *Orthopteron*, and the following notes constitute a record of their occurrence to date, with a brief statement of their relative importance, &c.

The richest field for *Sexava* egg parasites, to date, is the island of New Hanover, about 30 miles W.N.W. of Kavieng (situated on the northern end of New Ireland). Six species in all were bred out in the field laboratory, two of which vied for seniority of importance, while a third was but very little less common in occurrence. In order of importance they are as follows:—

1. *Doirania leefmansi* (*Trichogrammatidae*), *Leefmansia bicolor* var. (*Encyrtidae*).
2. A species of *Mymaridae* (not yet identified).
3. *Prosapegus attrellus* (*Scelionidae*). *Scelio* sp. (*Scelionidae*).
4. *Ootetrastichus dubius* *Waterst.* (*Eulophidae*).

In the Manus district four species have been bred from *Sexava* eggs, but none of them of apparent economic importance—

1. *Prosapegus attrellus* (*Scelionidae*).
2. *Scelio* sp. (*Scelionidae*).
3. *Ootetrastichus dubius* (*Eulophidae*).
4. A species of *Mymaridae* (as yet unidentified).

The last-mentioned is not the same species as that from New Hanover.

From *Sexava* eggs collected on the west coast of New Ireland, two species of *Hymenopterous* parasites have been bred—

1. *Scelio* sp. (*Scelionidae*).
2. A species of *Mymaridae* (not yet identified).

Neither emerged in any numbers.

With the exception of the two species of *Scelionidae*, these are all minute wasps, some being almost microscopic in size.

The only indigenous parasites that are apparently of economic importance are *Doirania leefmansi*, *Leefmansia bicolor* var. and the New Hanover species of *Mymaridae*. Although the other "wasps" mentioned play a part, they are numerically few, as judged by the numbers emerging from many thousands of *Sexava* eggs under observation in the field laboratory.

From the point of view of distribution from New Hanover to other parts of the Territory, although *Leefmansia bicolor* var. breeds freely in captivity, *Doirania leefmansi* has been very difficult to handle in the laboratory, and never developed strong colonies, while it was not found possible to breed the *Mymarid* through a single life cycle under similar conditions.

Collections of *Sexava* eggs made in the field, and transported direct with as little delay as possible, appear to offer the only satisfactory means of introduction of two or more of these parasites to other districts.

An interesting feature, entomologically, of the New Hanover species of *Mymarid* is that the male is apterous (wingless) and never moves far from the emergence hole in the host egg, and has apparently a very short life.

In the island of Amboina, Netherlands East Indies, two of the New Hanover species were bred from *Sexava* eggs, while a third is only a variety; these are—

1. *Leefmansi bicolor.*
2. *Doirania leefmansi.*
3. *Ootetrastichus dubius.*

SUITABILITY OF UPPER RAMU AREA FOR THE PURPOSES OF GRAZING SHEEP AND CATTLE.

R. F. Brechin.

Local climatic conditions and natural pastures appear to be favorable to both cattle and sheep grazing, provided suitable types of stock are selected.

In these highlands, where the average yearly rainfall does not exceed 80 inches and the temperature range is 45-75 degrees (shade) approximately, together with abundant natural pasture, I suggest that the Red Poll is a breed likely to surpass all others. This breed is the best of the dual purpose types, being a prolific milker and producing a beef that is of first class quality. In addition, the Red Poll is hornless and transmits this characteristic to all other breeds in the first cross. Both sexes are docile and are not likely to cause trouble in country that is heavily populated such as the Ramu.

An investigation into the natural grasses of the Ramu area is being conducted. This work is not yet complete but already ten edible grasses have been found. The condition of Mr. A. J. Peadon's herd of cattle suggests that natural grasses are not lacking in substance or fattening qualities. Mr. Peadon, I believe, has proved beyond any reasonable doubt that Ramu grasslands are well suited to cattle. His herd arrived from Madang four years ago in poor condition. To-day, it is in a good state of health and fat with upwards of 50 calves running on their mothers. The breed of these cattle would be hard to determine, but there is evidence of a fusion of Zebu blood. Provided this area is kept free of cattle tick (and I believe this is possible by subjecting all future importations to a strict inspection) it is unlikely that a dash of Zebu blood will be necessary as the climate is very mild.

There appears little doubt that natural pasture can be improved. Paspalum grasses planted on Mr. Peadon's property have grown well and are spreading under grazing. Here, at the station, plots of lucerne (*medicago sativa*), burr clover (*medicago denticulata*) and black medic (*medicago lupulina*) have been established. These have given encouraging results and have seeded heavily. Soy beans, too, under local conditions do remarkably well and have possibilities as a stock food.

In regard to sheep, Romney Marsh or a half cross of this breed with any of the English short-wools, should thrive in this country on the well-drained grassy slopes. Grass shelters could be constructed to which the sheep could retreat during heavy rain. Such shelters are widely used on Australian stud properties; these are cheap to erect and easy to maintain.

Following my own investigations in this area, I can confidently recommend these grass highlands to any settler who wishes to establish cattle and sheep, provided the correct breeds are introduced and care is exercised in the selection of the animals.

BABASSU OIL.

Extracted from Ceylon Trade Journal, October, 1936, and adapted from the September Number of "Soap."

Its Potentialities as a Competitor of Coco-nut Oil.

The import duties on oils and fats imposed by the United States of America have recently directed attention to babassu oil which is exempt from duty and carries no processing tax. Were it available in sufficient quantities to the American soapers and other consumers of oils and fats, the likelihood exists that babassu oil might quickly displace coco-nut oil in as much as coco-nut oil as well as most important oils and fats, including tallow, are subject to an excise duty of 3 cents or more.

For several years the soap industry has been aware of the existence of babassu oil as a potential raw material. The oil is obtained from the kernels of the nut of the palm *Orbignya Speciosa,* a subdivision of the family *Attalea,* which is very abundant in some parts of Brazil and represents one of the greatest sources of agricultural wealth in many regions of that country. It grows mainly in the States of Maranhao, Amazonas, Para, Piauhy, Ceara, Bahia, Espirito Santo, Sao Paulo, Minas Geraes, Goyas and Matto Grasso. It appears that no attempts have been made to cultivate the babassu palm elsewhere. It remains doubtful, however, whether the same results could be achieved with the fruit were it produced under different climatic and soil conditions. At the present time Brazil has forbidden, by decrees, the exportation of babassu trees and whole nuts, the object being of course to prevent planting and cultivation elsewhere. Commercial development has centered chiefly in Maranhao. It is estimated that there may be over 200,000,000 babassu trees in this State alone. It is possible that the tree may grow wild in other regions of Brazil.

The babassu kernel itself, from which the oil is obtained, is found in a nut which is made up of a pericarp, a fibrous material; mesocarp, which contains considerable tannin and starch; and endocarp, in which the kernel is embedded. The nuts are borne in bunches or "heads", each palm bearing from two to four of these heads twice a year. Each bunch contains 200 to 600 nuts, each nut containing two to six kernels, usually three or four. The kernels, which weigh about three grams each, make up about 15 per cent. of the weight of the nuts. The nuts themselves vary in size and the number which is required to make up a metric ton may range considerably, anywhere from 2,500 to 20,000 nuts being required. The nuts are extremely hard and require a pressure of from 10,000 to 25,000 lb. to burst them. They fall to the ground from June to the end of December, the exact period depending upon weather conditions.

Babassu kernels contain about 65 per cent. of oil, which is obtained in a manner similar to that employed in the preparation of other oils from palm kernels. The preparation of the oil is carried on almost wholly by natives. Attempts have been made to organize the industry but have not met with much success, and to-day the industry is practically just as it has been for years. The natives gather the fruits which have fallen to the ground, selecting the best nuts to give them the richest product. The de-kerneling is done mainly by hand labour performed by women and children who use hand axes. The kernels are very much cut up when they are obtained by the primitive hand method, and decay sets in quickly, making the nuts mouldy and increasing the fatty acid content of the oil obtained from them.

For many years a great deal of effort has been put into the development of some mechanical means for de-kerneling babassu nuts. The nuts are so hard, however, that most attempts have been unsuccessful.

To obtain the oil, either pressing or extraction with solvents is practicable. When the oil is to be pressed, the kernels are ground, heated, and crushed in hydraulic presses. The press cake and meal generally have a protein content of 20 to 23 per cent. and are used for feeding stock.

Crude babassu oil, which is light amber in colour, is used for soap making. It is somewhat similar in chemical composition to coco-nut oil and palm kernel oil, but has a higher content of lauric acid than these oils. The lauric acid content makes the oil particularly valuable for soap making as it imparts a high saponification value and gives a soap which produces a profuse lather. It is refined to a pale yellow colour and sweet odour and in this condition makes a valuable edible product, taking the place of olive and coco-nut oils. It has been claimed that babassu oil is the best of the oils which can be obtained from many species of palm oil seeds. Babassu oil also has a very high value as a fuel for internal combustion motors of the diesel and semi-diesel type. Experts claim that it is superior to crude oil and even refined petroleum.

Germany used to be Brazil's best customer in babassu oil, purchasing as much as from 20,000 to 25,000 tons annually. Most of this oil was used for margarine manufacture. About 1927, however, when exchange difficulties began to be critical, Germany started to withdraw from the market. Holland and Belgium now buy some quantity of babassu oil and French soap-makers are using it in increasing amounts as a substitute for palm kernel oil. Babassu oil has been sold on a commercial scale in the United States for only the past two years.

The future consumption of babassu oil in America seems to hinge on the ease with which the oil can be made available in commercial quantities. This, in turn, rests on several factors among which is the devising of a machine to crack and handle the nuts in large quantities in some manner which will not break them up and injure the quality of the oil obtained. Another factor which stands in the way of progress in the direction of a great babassu industry is a satisfactory solution to the problem of whether the nuts should be cracked in Brazil and the kernels imported here for crushing, or whether the oil should be prepared in Brazil and shipped as such. The drawback in the first case is that the kernels having been carelessly obtained, are broken and decompose sooner than sound kernels.

At the present time the markets in the southern part of Brazil have been absorbing most of the production for home consumption. The development to be looked forward to in bringing back stocks in the United States is a saturation of these southern markets in Brazil. At the present time high costs almost preclude imports of babassu oil.

An interesting sidelight in the building up of the babassu industry lies in the value which is held to exist in the husk. This is supposed to break down into many valuable chemical substances when distilled and yield a residue of fine metallurgical coke. The complete husks make an excellent fuel, B.t.u. value of more than 50 per cent. that of good coal being claimed for them. As a matter of fact, the babassu nut first attracted universal interest in 1914 when the shortage of coal led to the use of whole babassu nuts in boilers of Brazilian steamships. Brazilians, however, have long been aware of the versatility of this product and have used it in many ways as far back as they can remember. It has been used in the smoking of rubber in the Amazon Valley, excellent disinfectant value being claimed for the smoke as far as the animal life which exists in the rubber latex is concerned.

In addition to the value inherent in the husks of the nut, the babassu palm itself serves many purposes. The leaves are used as a roofing and thatching material and for making hats, baskets, and similar things. The sap of the tree is used as a food and for feeding stock. It is also a raw material for the manufacture of a type of sugar, the fibrous material, or pericarp, is used for making cord, brushes and mats. The mealy mesocarp is also used by the natives as a food, as well as a feed for cattle. The shell of the nut is made into articles for domestic use, such as buttons, and holds promise of being valuable for the manufacture of activated carbons. The trunk of the tree supplies building posts and the bunch stalks yield an excellent fertilizer after they have been allowed to rot. As a matter of fact, no part of this palm is wasted.

Exports of babassu nuts from Brazil since 1922 are given in tons in the following table:—

	Tons.		Tons.
1922	21,958	1929	8,700
1923	35,281	1930	12,296
1924	18,313	1931	14,212
1925	10,909	1932	6,917
1926	22,687	1933	623
1927	25,977	1934	217
1928	19,266	1935	9,966

The potential production of babassu oil is tremendous—probably much greater than coco-nut, but the present production is very small—so small that for some time to come babassu cannot make even a small dent in the demand for coco-nut oil. Nevertheless, among all the oils and fats, the potentialities of babassu stand out in the present situation.

NOTE.—Leo Schnurmacher Inc., brokers of the Manila Stock Exchange, in their *Review of Coco-nut Products* for 1936, made the following interesting remarks regarding babassu oil in the United States of America:—

"After February, 1936, a main reason for the sluggishness in the oil market was attributed to the increasing importation into the United States of America of Brazilian babassu kernels, which give a substitute for coco-nut oil of satisfactory quality; the fact that under the terms of the commercial treaty concluded between the United States and Brazil, neither these kernels nor the oil expressed therefrom could be taxed, and reports about tremendous numbers of babassu palms existing in the primeval forests of the Amason Valley, evidently influenced buyers to take a waiting attitude. The scare proved to be rather exaggerated, as the extraction of the kernels from their extremely hard shells, increased the cost of production considerably, as do the primitive methods of harvesting and transportation to shipping points; besides, the bulk of the kernels is being consumed in the soap industry in Brazil, and the exportable surplus is not of a size to make considerable inroads into our coco-nut oil market likely."

INSTRUCTIONS RE MOUNTING RAIN-GAUGES AND TAKING RAINFALL OBSERVATIONS.

Issued by the Commonwealth Meteorologist.

Unscrew the lid from the side of the box, and remove the lid and the gauge. If obtainable in your town, give the part of the box to be sunk into the ground, also the lid, a coating of anti-white-ant preservative, and paint the part of the box to be exposed above ground. The lid should then be dropped on to the beading in the bottom of the box, and the gauge placed in the box, when the receiving surface will be found to be about 3 inches above the top of the box. The box should then be sunk into the ground, so that the receiving surface of the gauge is just 1 foot above the level of the ground. Use a spirit level in order to see that the top of the gauge is placed perfectly level.

This rain-gauge is used for measuring any form of precipitation, be it rain, hail, or dew. A gauge of special pattern is supplied for measuring snow.

The exposure of the rain-gauge is a very important matter. A too-sheltered position is as objectionable as a too-exposed one.

The wind is the most serious disturbing influence. Driving rain will fail to reach the opening of the gauge, if it is placed too close to buildings or trees. On the other hand, if it is in a very open position, the wind blowing against the gauge causes eddies, which occasionally carry away considerable quantities of rain; as much as 20 per cent. has been known to be lost at times.

The site selected, should, if possible, be an open one, unobstructed by high trees or fences. Low fences, structures, or hedges are, however, an advantage, if at a distance not less than the height of the surrounding objects.

The British Rainfall Organization has framed rules for securing uniformity in recording rainfall on which the following are based, and observers are requested to adhere to them where practicable.

1. *Selection of Site.*—A rain-gauge should be placed on a level piece of ground, not upon a slope or terrace, and certainly not on a wall or roof. It should be at a distance from every object higher than itself and should never be nearer to a wall or house than a distance equal to the height of that object, nor nearer to a growing shrub or tree than a distance equal to twice that height. Care should be taken to keep flowers or vegetables away from the gauge for a distance of at least 3 feet all round. The height above sea-level should be determined, if possible, by levelling from the nearest bench mark. The approximate height may be easily ascertained in many cases by reference to the maps of the official survey department. A specific name should be selected by each observer for his station.

2. *Mountain and Moorland Sites.*—Care should be taken that mountain or moorland gauges are not unduly exposed to the sweep of the wind. A level patch of ground or a very slight hollow should be selected, and a turf wall about 2 feet high, surrounding the gauge at a distance of from 6 to 10 feet, is recommended.

3. *Placing the Gauge.*—The gauge should be fixed so firmly that it will neither be blown over nor tilted by the strongest wind, and it is best to be surrounded by short grass. The gauge should be occasionally examined, and repaired if any leakage or other defect is detected, and a report made of the circumstances to the Central Bureau.

4. *Change of Gauge.*—When an old established gauge has to be discontinued for any reason a new gauge should be established on a proper site one year, or, if possible, two years, before the old one is removed, so that the readings of both may be compared and the continuity of the record ensured. This rule does not apply to the substitution for an old gauge, which has become defective, of a new gauge of the same size and pattern on the same site. It is most convenient to start a new gauge on 1st January. The fact of a change, with date, distance, and direction from former site, should be reported to the Central Bureau when it is made.

5. *Absence of Observer.*—An assistant should, if possible, be trained to measure the rainfall in the absence of the observer. When no such provision can be made it should be arranged to have the gauge visited at the usual hour, and the water bottled and labelled, to be kept until the observer returns.

6. *Hour of Observation.*—Rainfall should be measured at 9 a.m. daily, and the amount entered against the date on which it is measured.

7. *Reading the Rain Glass.*—In measuring rain by means of the graduated glass the observer must pour the water carefully from the gauge into the glass measure. The reading should be taken by holding it upright or setting it on a level slab, then bringing the eye opposite the level of the water so as to fix the nearest line on the scale to the water surface, not necessarily the line next above or the line next below the surface; but the one of these which is nearer. Each division represents one point. If there is more water in the gauge than can be measured at once, the glass should be filled up to the 50 mark, emptied into a jar, and filled up again as often as necessary, counting the number of times, and finally measuring the residue in the usual way. The water in the jar may be measured again roughly to make sure that no mistake has been made in counting the number of half-inches. The amount should be written down before the water is thrown away. Every measuring glass supplied by the Central Bureau is certified.

8. *Heavy Rains.*—Although a self-recording gauge affords the fullest information as to heavy rains in short periods, an ordinary gauge can also be utilized. The gauge shauld be examined immediately on the cessation of heavy rain, the amount and the time of commencement and cessation noticed, and the water returned to the gauge, so as not to interfere with next morning's reading. As a fall of 4 inches or more may occur in one day in any part of Australia or New Guinea (though few observers believe this until they experience it), no gauge of less capacity should be used. If after heavy rain there appears to be any likelihood of the gauge overflowing, it should be measured and emptied, and the amount added to the next morning's reading.

QUALITY AND REPUTATION IN COPRA FROM THE MARKET VIEWPOINT.

By E. T. Caulfield-Kelly.

The object of this article is, primarily, to convey to owners and managers of coco-nut plantations in this country some indication of how the more common and easily recognizable defects in copra produced in the Mandated Territory of New Guinea, affect the appraisement and valuation of the commodity by consumers in the world's markets.

An endeavour will be made at the same time to show how "reputations" are achieved for certain brands of copra such as Malabar and Ceylon, amongst consumers, especially in Europe and the United States, and how this "reputation" commands such a tremendous priority of demand for the produce of these countries, as to raise the price per ton from £2 10s. to £4 on parity above the Rabaul hot air dried copra in European and American markets.

To understand clearly the value to the consumer of "quality" in copra, it is necessary to have some idea of the many essential commodities in general domestic use to-day, which contain the principal product of copra—viz., coco-nut oil. Of lesser importance, although still vital to the maintenance of "quality", is the by-product—viz., copra cake, which is the residue, after the expression of the oil, from the copra.

Up to a few years prior to the war, or rather more than a quarter of a century ago, the principal use of coco-nut oil was soap-making. For this purpose the oil possesses special advantages; clean, odourless oil free from smoke, scorching or discolourations, produces a hard white soap, and was, therefore, much in demand by toilet soap manufacturers; lower grade oils containing free fatty acids, smoke or creosote discolourations, and other impurities, were still of considerable commercial value in the manufacture of low grade soaps, soft soap, patent cleansers, &c.

Hence there was a good market for coco-nut oil amongst soap manufacturers, but it is important to notice that for this purpose any grade of oil had its commercial value, adulteration and impurity notwithstanding. Even rancid or foul smelling oil could be utilized in such cleansers as were used on vehicles, railway trains, and heavy machinery.

Under these conditions it will be obvious that no great attention was paid to "quality" in copra on the world's markets, and there was little, if any, inducement to planters to produce a good grade produce.

But early in the present century coco-nut oil commenced to take its place amongst the world's principal fats, in dietary and technical usage. Prior to this, animal fats held the entire demand; butter and lard were the important cooking and edible fats, choice beef and pig fats were the principal ingredients in butter substitutes; tallow was the main constituent of soaps and candles; fish oils (notably sperm and whale) were used for a variety of purposes, of which illumination was perhaps the most important; mineral oils were used extensively for illumination, lubrication, paints, &c. The only vegetable oils of note, and which could be obtained in quantity, were cotton seed oil and linseed oil, and these were considered adulterants in the food industries. Refinement could have been effected by very lengthy processes of hydrogenation, &c., but these were so costly that the introduction of the refined oil into general manufacturing use was economically prohibitive.

With the shortage of dairy fats, came strenuous endeavours in Europe especially to find a substitute for butter, and lacking an indigenous oil-bearing product, scientists were obliged to look abroad for their requirements.

By far the most important of the imported products were copra, palm kernels and pea-nuts, all produced in the tropics where land was relatively plentiful and labour relatively cheap.

It was found that vegetable fats as a group, and in particular coco-nut and palm oils, were wholesome edible fats, could be produced more cheaply than animal fats, and, being primary materials, were not subject to the cost of conversion entailed in the animal industries.

Thus began a new era for copra as an import into European and American countries, and here at the same time, commenced the demand for a high grade product, capable of yielding a clean, pure oil at the minimum economic cost.

To-day large quantities of coco-nut oil are used in the manufacture of margarine, vegetable butter, and the essential vegetable fats which form the materials used by chocolate manufacturers, biscuit bakers and general confectioners.

For these purposes an oil of the greatest possible purity, free from colour, taint, odour, and acid or other impurities is demanded. The old and crude methods of curing copra (principally smoke drying) had, therefore, to be completely revolutionized, and a clean, well-prepared copra evolved. This process of evolution had naturally to be a slow one, and attractive price ranges had to be made to establish the line of grade and priority in the markets. Certainly the demand for the lower grade article continued to be considerable, but manufacturers had to recourse to considerable and costly processes of refinement to clean and prepare the oil for edible purposes. It had to be freed from acid, smoke taint, odour, discolouration, &c., all of which work tended to considerably increase the cost of production of the refined oil.

Added to this it now became increasingly apparent that the residue press cake left from clean white copra and representing between 37 and 46 per cent. of the total weight of the copra itself, had valuable commercial possibilities as a cattle food, containing as it does, some 5 to 8 per cent. of coco-nut oil, which it would not be economically worth while to extract.

It will be at once obvious that this press cake must be pure, clean, and have that pleasant nut-like smell of pure coco-nut oil. Any condition of the copra which would cause a rancid, odoriferous or smoke tainted product in the press cake, would render the residue useless as a feeding stuff, as stock would not consume it, and when one considers that present market value of copra press cake is more than £7 10s. per ton on the British markets, some conclusion can be drawn of the difference in value to copra buyers between a clean white copra from the residue of which, after expression of the oil, a good wholesome and saleable cake can be made, as against a rancid, mouldy or smoke tainted residue which will have to be discarded as useless for feeding purposes. No further argument need, therefore, be advanced to show that any circumstances which would interfere with the value of the press cake as a feeding stuff must necessarily be reflected in the value of the copra in open market. To emphasize this let us take the case of one sample of South Seas copra analysed some time ago, which contained only 79 per cent. of copra, 3 per cent. of sea sand, 1 per cent. of pumice, 10 per cent. of coral and sea shell, and the remaining 7 per cent. consisted of coco-nut shell, husk, wood, straw, twine, and what looked like floor sweepings.

Let us now proceed to an examination of the common defects in our local copras, shipped from the Territory to overseas markets. The principal and greatest defect in copra is the presence of what is termed "free fatty acid" and this is the first defect which is looked for during appraisement and valuation of a sample on the markets. We shall come later on to the method generally employed by experts and judges to extract from a shipment, what they term a fair average sample for purposes of appraisement, analysis, valuation, &c.

Most oils and fats are similar in chemical composition and consist of glycerine in combination with fatty acids. These fatty acids, of which there are a considerable number, are grouped together because of their analytical similarity. Some such as stearic acid and palmitic acid are solids; others are liquids, such as oleic acid and butyric acid. Under certain conditions of decomposition the glycerine and the acids become split up and this liberation results in what we term free fatty acids, which cause a breakdown of the fats by decomposition, and a rapid destruction of the cell tissue (leaving holes in the copra), accompanied by rancidity and disagreeable odour, which in time renders the eventually expressed oil quite useless for edible purposes.

The decomposition of the oil into free fatty acids is caused by various moulds which grow on the copra, and any circumstance which favours or promotes the growth of moulds tends to increase the percentage of free fatty acids in the contained oil.

Moulds, of course, thrive best in moist conditions, and in the case of copra, where 10 to 15 per cent. or more of moisture is present.

It has been established by exhaustive experiment that where the moisture content in copra is below 6 per cent., the conditions are no longer favorable for the growth of moulds, and decomposition is therefore arrested, but, unfortunately, many of our local producers do not take the trouble to keep this moisture content down to the safety margin of 6 per cent.; moulds, therefore, form; free fatty acids are liberated; and decomposition, decay, rancidity, odour, and discolouration result. This process goes on until the copra becomes rotten and its usefulness limited to the production of crude and cheap commodities. The longer the product affected by mould and consequent free fatty acid is kept in storage, the greater the destruction of the oil content, for, not only do moulds cause the formation of free fatty acids in the copra, but they utilize the oil as food material for their own continued growth. To instance this it has been found, by experiment and analysis, that as much as 30 to 40 per cent. of the oil content in a South Seas sample of copra had been destroyed by mould and acids when the product reached the presses, and the rancidity of the remaining oil then expressed, prohibited its use for any other than crude saponification purposes.

Local experiments have also been conducted on South Seas copras from time to time, and one instance alone will serve to illustrate the rate of decomposition when moisture is present in quantity. A sample of copra when analysed immediately after it had been cured was found to contain 11.79 per cent. of moisture and the oil contained 7.3 per cent. of free fatty acid, at that stage invisible to the naked eye. On keeping this sample in the laboratory for one week it became covered with mould, and it was then found that the oil contained 15.7 per cent. of free fatty acids. This indicates how rapidly the free fatty acids will form when conditions are favorable to the growth of moulds.

On the other hand four further samples analysed were found to contain 6.10, 4.83, 4.58, and 3.84 per cent. of moisture. These four samples were kept for several weeks and when analysed after that period the average oil content of the four contained only 0.4 per cent. of free fatty acid.

Perhaps a short description of a few of the more common of these moulds will not be amiss here.

The most destructive is the brown mould (*Aspergillus flavus*) which appears on the concave surface of the copra as a russet brown discolouration, sometimes deeply pitted or honeycombed into the meat. This mould requires a moisture content of at least 15 per cent. and may result in a loss of anything up to 60 per cent. of the oil content, according to the period in storage or transit, before the expression of the oil. A piece of copra affected by this mould when snapped across in the fingers will reveal on the split surface small intrusions, or spear heads of a brown colour, penetrating into the meat.

The next important common mould in order of destruction is the black mould (*Aspergillus niger*) which is easily recognizable on the white surface of the meat as a dirty black coating. A moisture content of at least 12 per cent. is required to grow this mould but it is quite as destructive as the brown mould although its progress is rather slower. In advanced stages pink and reddish intrusions into the meat will be observed when a piece of copra affected is snapped across, and when stored in bags over long periods, large quantities of dust and impurities will be shed by the affected copra, necessitating sieving and reconditioning with resultant loss in value.

Another common mould is ordinary green mould (*Penicillium glaucum*), but this is nearly always superficial and results in very little loss of oil. Its presence, however, is a danger signal indicating the presence of moisture, possibly favorable to the growth of other and more destructive moulds. Green mould in itself is not a very bad defect but where long periods of storage and long voyages to the markets are involved, dust, and a sort of "cob-webby" substance is shed by the copra, involving a certain amount of processing at the other end to remove these impurities, and thereby reducing the value to the consumer of the product.

Green mould may be promoted by a variety of circumstances. Humid weather conditions during the storage of the hot cured copra from the driers and before bagging; bagging hot cured copra before it has had time to cool off, and whilst in its warm state is still absorbing moisture from the atmosphere; exposure of copra to rain, or other circumstances which may set up superficial moisture; all of these circumstances will tend to encourage the growth of green mould and should be guarded against.

One further mould which may be worth mentioning but which should never concern careful producers is white mould (*Rhizopus* sp.). This requires an atmosphere saturated with moisture, and so would only develop on freshly cut green coco-nut meat. It commences to form as soon as the nut is split and its meat exposed to the atmosphere, but is killed at once as soon as the drying process is begun. If left long enough before drying is commenced, white mould will manifest itself in the form of a fleecy downey covering like fine cotton wool, on the meat, and it is at this stage that its danger to the copra begins. It has very rapid penetrating powers, and unless specially treated before drying, the copra will inevitably develop brown mould during and after the drying process, and decomposition will be rapid, but with care, especially to ensure the commencement of drying as early as possible after the nut is opened, white mould should not prove of any consequence to the producer.

Further risks of destruction to imperfectly dried or mouldy copra are those of bacterial attack and insect infestation. Investigations in Ceylon and Malaya indicate that partially dry and mouldy copra is liable to serious bacterial attack, which, if allowed to develop (the alternative is reconditioning), will result in serious loss of the oil content. In addition, it has been observed that copra which has suffered cell deterioration and softening, through bacterial attack, has considerable attraction for copra consuming insects, such as the ordinary copra bug (*Necrobia rufipes*), which invades sheds and concentration depots in terrific numbers. These insects destroy the web, break down small irregular pieces of copra, and are largely responsible for the production of dust, which is a very common cause for arbitration between shippers and buyers.

The foregoing deals in a general and brief way only with the primary causes of deterioration and defects in copra when marketed, viz., the loss in oil content, and the adulteration of the expressed oil, occasioned by free fatty acids, and bacterial destruction, &c.

There are, however, other avoidable local defects which influence assessors of value when examining or analysing samples of copra submitted to them by consumers.

The principal of these minor defects is discolouration, occasioned either by scorching, burning, smoking, or dirt. Whilst discolouration in copra may not affect the volume of the oil content it may seriously impair its utility for a number of purposes. A discoloured oil yield will need much processing and consequent cost to clarify and refine it, for the higher purposes for which manufacturers require the oil.

In the case of considerable discolouration by scorching and burning and invariably in the case of smoke dried copra, the clarification and refining processes would involve prohibitive cost, and the utility of the resultant oil, therefore, becomes limited to the production of crude products such as inferior brands of soap and cleansers, where large quantities of caustic soda and potash are blended with the oil.

The resultant press cake is also affected, frequently to the point of uselessness as a feeding stuff, which may mean a loss of anything up to 45 per cent. of the weight of the copra.

Grit, dirt, sea sand, shell, &c., are other factors which if present in any quantity, occasion much expense in refining and purification on the part of the consumer, before the oil is usable, and, therefore, detract from market desirability in brands of copra which contain them.

We come now to the question of "Reputations" and priority of places which copras from the various countries in which they are produced have achieved for themselves in the world's markets.

Reputations, once established, are difficult things to assail in the case of good ones, and still more difficult things to "live down" in the case of bad ones, and copra reputations are no exception to this rule. But even an indifferent article can sometimes achieve a good reputation by a system of extensive advertisement and propaganda.

In this country we are deprived of such possibilities owing to the insignificance of our total output, computed as a percentage of the world's copra supply.

On the basis of statistical data obtained from official documents supplied by Government representatives in the producing countries, it appears that the area cultivated for the coco-nut palm is probably not more than 6,250,000 acres. This, of course, does not take account of self-planted or small groves, the extent of which cannot be even roughly estimated. The acreage actually reported is approximatly 6,000,000, which may be roughly divided as follows, viz.:—

India	1,330,000
Philippine Islands	1,200,000
Dutch East Indies	1,000,000
Ceylon	1,000,000
South Sea Islands	540,000
Malaya	510,000
Africa	160,000
Tropical America	150,000
French Indo—and Cochin—China	110,000

This summary although it places India an easy first as individual producers, should be qualified by stating that Indian production of copra is relatively unimportant in international trade, owing to its huge domestic consumption. The Philippines, Dutch East Indies and Ceylon are, therefore, the principal exporters, with an acreage under coco-nuts of roughly 3,200,000 acres. The term South Sea Islands or (as some statistical works allude to the area) Oceania, covers the following, in their order of area, viz.:—

Territory of New Guinea (Australian).
Fiji (British).
Tonga (British).
Western Samoa (New Zealand).
Tahiti and French Oceania (French).
Marshall and Caroline Islands (Japanese).
New Hebrides (French and British).
Papua (Australian).
Gilbert and Ellice (British).
New Caledonia (French).

This huge area of the South Pacific, broken up by millions of square miles of ocean surface, has an area of only 540,000 acres under coco-nuts, from which to obtain its produce for the world's markets, and if we continue to eliminate, we leave ourselves with an area of only 225,000 acres representing the Territory of New Guinea alone.

With this small acreage we seek to advertise our wares on the world's markets, and it must be obvious, therefore, that on volume of business alone, we have no earthly chance of competing with the larger producing countries mentioned above. Our place of preference in so far as demand and consequent preferential price is concerned, must, therefore, depend solely on the sterling quality and merit of the product itself.

Of the copra exported to the international markets something like 85 per cent. is the product of natives, who under the tutelage of their various Governments here come to look upon coco-nut production as a business and who, therefore, produce painstakingly and with an eye to the market. This large group has, undoubtedly, made inroads on the more casual producers of the remaining 15 per cent. of the produce, viz., European, American and other foreign owners of coco-nut properties in the tropical belt.

As recently as 1910 coco-nut oil was scarcely known in America, because of the abundance of cotton seed oil and packing house fats available to supply requirements. But when, as stated earlier in this article, the value of coco-nut oil as an edible fat became appreciated, the Americans were the first to get the Philippine Islands into line to produce a first grade article. Exhaustive research experiments were made and the native owners of land in the islands were instructed untiringly in the art of producing a good clean wholesome and unadulterated product. To-day the Philippines produce one-third of the world's copra supply, with a growing rather than a diminishing reputation for purity, and quality, and more than 90 per cent. of this is cured by hot air driers, of either mechanical or kiln type—the meteorological conditions of the group are much similar to our own

The copra which commands pride of place and consequently the highest price in the international market, is produced on the Malabar coast of India. This is technically referred to on the market as "F.M.G.W.S." (fair merchantable good white sundried) and its reputation goes back to the early part of the present century when coco-nut oil began to become recognized as a valuable edible constituent. With this recognition came the sudden demand for the high grade copra, and in those days when little or no effort was being made to produce a good clean copra, Malabar was in the unique position of having a climate and soil which made failure almost impossible. For centuries the natives of India had been using coco-nut oil for most of their needs, animal fats being forbidden by most of their religious observances, and in the six to eight months per annum of sizzling sunshine on the Malabar coast, huge quantities of copra were produced and stored against the monsoon periods. Up to then there was little or no copra exported from India, the internal demands being more than adequate to cope with supplies. But with the attraction of unheard of prices for this, then, excellent copra, from European and other markets, a limited export of specially selected grade began, and up to the present time has continued. Thus Malabar copra attained its place, and held it, in the international market, even though it is now generally acknowledged that superior hot air dried copra has distinct advantages over even very superior sun dried, particularly as regards the reduction of moisture content.

With the boom in Malabar copra came the slump in South Seas copra, at that time the most inferior grade in the market.

These widely spread small groups, throughout Oceania, with only sparsely dotted plantations amongst them had no regular shipping services and the greater part of the copra produced and exported from them was made by natives under very crude and primitive conditions, and "traded" to owners of small schooners, and watercraft, who exchanged "trade goods" with the natives for their copra. This is the origin of the term "Trade copra" in these parts, and indeed it is not misapplied. Added to their desire for cheap European-made baubles, cloth, knives, axes, &c., the natives in these groups had a lively respect for the small trader who landed on their islands with rifles, and other lethal weapons, to enforce the delivery of produce like copra and shell to him. They had no recourse to authority for protection and so these traders imposed their will, and the produce was generally forthcoming if trouble were to be averted.

Under such conditions it needs no further argument to show that quantity rather than quality in the produce was what was most desired, and quantity won the day.

Consider then the conditions under which the bulk of South Seas copra was cut and cured, having regard to weather, humidity, &c., its transportation in leaky and unseaworthy small craft to a point of concentration; the conditions of storage at that point; the probable period of such storage before an overseas vessel was available to ship it; its subsequent long voyage to the market more often than not with several transhipments; then some idea can be obtained of the condition of that produce when it reached the consumers. Add to this again the greed and cupidity of a few of the more unscrupulous traders, who placed coral, sand, stone, &c., in their bags, to make weight, and who even resorted to drenching a shipment with seawater a few days before sealing, with the same object. Happily these cases were not numerous, but it seems little wonder that South Seas copra acquired the unenviable reputation it did on the markets.

This then was the grade or classification of New Guinea copra when the Expropriation Board disposed of the ex-German holdings in the Territory, and it was in the category of "South Seas copra" that our produce was being marketed up to 1928.

In that year the *Copra Ordinance* 1928 was enacted and it provided that all copra exported from the Territory was subject to examination by inspectors of the Department of Agriculture. Four classes were instituted—

(1) Hot-air-dried copra of good quality and free from adulteration, dried by artificial means;
(2) Sun plantation copra, of good grade and colour, well dried, and free from adulteration;
(3) Smoke-dried copra, well dried and free from moulds or acids;
(4) Sun-dried copra, which was the class in which inferior hot-air and sun-plantation copra could be shipped, provided it was well dried and reasonably free from moulds or adulteration.

Copra of lower grades than these was pronounced unfit for shipment, and so did not reach the markets.

When this measure was well-advanced steps were taken to institute a propaganda scheme whereby the consideration of buyers and consumers was invited to the improved quality of copra exported from the Territory, as against the quality of other consignments of copra shipped as "South Seas", and a plea was entered for a distinguishing designation for New Guinea copra. But bad reputations die hard, and it was some time before a different status could be established.

The introduction of more and more hot-air driers into the Territory and the gradual abandonment of the sun and smoke drying processes on plantations in favour of hot-air driers, made possible a further attack on the designation "South Seas", as applied to New Guinea copra. The principal exporting firms in the Territory added their weight to the plea, and eventually the term "Rabaul hot-air dried" became a market designation. This had the very desired effect of raising New Guinea copra from 19th to 9th place in trade price lists.

It is, however, a regrettable fact that the Copra Ordinance, with its attendant compulsory inspection of produce sold for export, was not generally popular. Producers, and managers of properties especially, considered it a nuisance, instituted for their especial inconvenience, and what is still more regrettable, a large section of the planting community still regard it with great disfavour, despite the improvement in market preference for New Guinea copra. The interest of the producer seems to be completely absorbed in turning out copra which will just "get past" the inspectors. With few exceptions, there seems to be little or no ambition to improve the quality or to study the production of a better article.

In contrast to this attitude of indifference, let us take the examples of the native Malayan, Javanese, and Cingalese producers of copra whose interest in the markets is so keen that they vie with each other for preferential status for their products, and this without any need for government jurisdiction over the quality of their exports. The same interest in their produce is displayed by natives of the West Indies, the Cocos Islands, the Mozambique, Seychelles, and Mauritius groups, the copra from all of which sources commands a higher price in London than does "Rabaul hot-air dried".

All of the latter-named export much less copra than does New Guinea; the percentage of their individual contributions to the world's supply is almost negligible; yet they have preference of place—on quality and merit alone.

First quality New Guinea copra, therefore, occupies only ninth place of preference in the international market to-day, and the probabilities are that it will remain there unless concerted action is taken by every individual producer in the Territory to improve the quality of his produce, and when he has done so, to seek by experiment and advice every means to still further improve it, until perfection is reached.

There is no doubt that the establishment of an experimental and demonstration plantation in New Guinea, by the Department of Agriculture, would be of immense value and interest to the planters and producers, although it must be remembered at the same time that conditions for copra production differ very widely and fundamentally in various parts of the Territory, according to geographical position. The advantages, however, for experimental and research work would be infinite, and a good deal more practical "local" advice could be given to producers, as first-hand experience.

The Director of Agriculture is a staunch advocate of this policy, but it is to be feared that he is not greatly encouraged by the general attitude of producers towards his efforts, so far, for the betterment of the industry in the Territory.

In conclusion, a glance at the methods of appraisement and valuation of copra samples in general usage by experts in the principal markets may be of some interest.

A shipment of copra is usually submitted for inspection in lots of a certain number of tons each, and of a certain grade.

Let us suppose that 500 tons of Rabaul hot-air dried is submitted as a "lot". Of this 10 per cent. (say, 700 bags) are opened, and about 2 lb. of copra from each bag are removed. The 1,400 lb. thus obtained is well mixed and placed on a large tray-table where is is divided into four equal parts, of which two are discarded and the remaining two again well mixed and placed in the tray. This 700 lb. is again sub-divided into four equal parts, two parts again being discarded, and the remaining 350 lb. being again well mixed. This is now deemed to constitute a fair average sample of the 500 tons lot. About 25 lb. of this is placed on the inspection table and for most practical purposes this is judged by visual test.

The factors which now influence the examiner are in a more or less set routine. Country of origin is one of the first, and here commences the depreciation, in the case of notoriously inferior copra—an argument which should influence producers in this country to make a united effort to improve the general average quality of their copra.

Colour, odour and appearance are then considered, as potential factors towards the yield of a pure and unstained oil. The presence of free fatty acids at this stage is easily detected (the copra will, naturally, be several months old) and any deterioration as the result of excessive moisture and consequent mould and decay will be very apparent. The presence of scorched or burnt pieces and all the other factors previously mentioned in this article will all be considered as additional drawbacks from value, according to the additional processing which will be necessary to refine or clarify the oil. Each blemish or defect, taken on the percentage of its presence in the sample, will carry a certain unit of depreciation, so that a sample may be subjected by arbitration to a penalty of 2 per cent. or 2½ per cent. of its value for a combination of defects at the conclusion of an inspection or appraisement, according to the cost involved to the consumer to eliminate or overcome these defects, or should they be economically impossible to surmount, the difference in value of the inferior oil, &c., yielded.

Where very bad samples are submitted, laboratory tests to fix the oil content and the free fatty acid content are made, but for most practical purposes, these examiners through vast experience and usage are qualified to judge to a very close approximation by visual test. It is almost a sixth sense with them, and they can estimate to a fraction the actual cost of refinement, &c., involved to consumers, or to firms who deal only in the oil, and press cake.

The processes of extraction, refinement, distillation, clarification, &c., are all standardized, and a computation of cost is, therefore, quickly arrived at, and the shipper, who, as a general rule, is paid for the copra on its outturn, must bear the penalty for defects imposed on the copra at examination.

Thus it will be seen again that "reputation" continues to affect a copra, even to the examination table. Our supposititious 350 lb. sample out of a 500-ton lot, is too small to take risks with in the case of a copra with a bad reputation, and so the sample loses "marks" at once whatever its quality on the bench.

The reputation of New Guinea copra on the market must, therefore, be enhanced if we are to get out of the "rut" in which we have been content to remain since 1929. This will not be achieved until "general average quality" is vastly improved. It is not sufficient that a proportion of our exported copra should be superior or even *non plus ultra.* It is not even sufficient that every bag of hot-air-dried copra exported be of first grade quality, if the general average quality of the whole of the export is to be discounted by the inferiority of the lower grades. The general aim should be, more and more, to eliminate the lower grades, so that in time they should become only a negligible proportion of the total exported.

The opinions recently expressed by experts and buyers of New Guinea copra in the London markets, were invariably to the effect that it was "general average quality" which kept New Guinea copra in its present low place of preference. The proportion of low grade to high grade was much too great in favour of the former, to allow of any serious consideration by buyers, for preferential status.

THE GERMINATION OF CACAO FOR PLANTING.

By E. C. Green, H.D.A., A.I.C.T.A., Superintendent, Government Demonstration Plantation, Keravat.

Introduction.

The development of a cacao industry in the Mandated Territory of New Guinea is proceeding fairly quickly, therefore, costs of establishment are of primary importance, and every aspect of cacao cultivation from clearing the bush to production must be considered.

The future of the estate in the first instance is closely correlated with the seedlings transplanted from the nursery to the field, strong, sturdy, well-formed plants being required. The greater the percentage of suitable seedlings raised in the nursery the cheaper this factor of establishment becomes, and the quicker the estate is planted. Weak, badly formed, stunted seedlings should never on any account be planted in the field, and when the percentage is high the planter must, from necessity, raise more plants for replacements, thereby increasing his seedling costs.

Visits paid to nurseries throughout the Territory at various times, and observations made at the Demonstration Plantation, Keravat, show that a varying percentage of seedlings have twisted and distorted stems, also many seedlings fail to break through the surface.

In order to ascertain if the reason for twisting, also failure to break ground, was due to practical causes, a series of experiments was conducted, and the results are set out in this paper.

Apparatus.

Empty preserved meat cases, measuring 15 inches by 12 inches by 8 inches were used, the bottom of the box contained ⅜ inch holes bored at random to

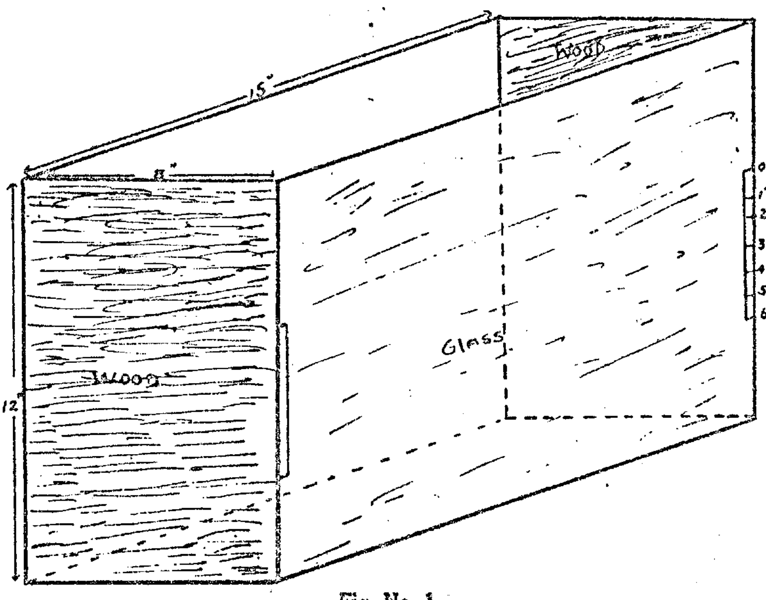


Fig. No. 1.

facilitate drainage, the ends were wooden, the sides ordinary plate glass, and the top was open. A scale from 0 inch to 6 inches was attached to each side as shown in Figure No. 1.

Media.

Soil was taken from underneath a growing crop of *Tephrosia candida,* and represented the material generally used at the Demonstration Plantation, Keravat. Before placing in the boxes, the soil was sieved to remove any stones, sticks, leaves, &c.

Method of Planting.

Pods were taken at random from bearing trees, and the seed after extraction was thoroughly mixed. The seed was planted at depths of 1 inch, 2 inches, 3 inches and 4 inches below the surface, with the hilum or scar end upwards, downwards, and sideways.

Observations.

Germination commenced on the fifth day after planting, and at seven days germination was general. The following table (No. 1) shows the percentage germination at each depth, and the position of the hilum on the eighth day.

TABLE No. 1.

Depth.	Original position of hilum.	Position of hilum at 8th day.	Per cent. Germination.
1″	side	side	100
1″	down	down	100
1″	up	up	100
2″	side	side	100
2″	down	down	100
2″	up	up	100
3″	side	side	100
3″	down	down	100
3″	up	up	100
4″	side	side	100
4″	down	down	100
4″	up	up	100

In Table No. 2 will be seen the maximum, minimum, and average length of the hypocotyl at the different planting depths and hilum positions, after nine and twelve days.

TABLE No. 2.

Depth.	Original position of hilum.	Maximum cm.	Minimum cm.	Average cm.	Remarks.
1″	down ..	3.0	2.0	2.4	9 days old
1″	up ..	1.7	1.2	1.4	9 ,, ,,
1″	side ..	2.3	1.0	1.8	9 ,, ,,
2″	down ..	*7.0	3.0	4.8	12 ,, ,,
2″	up ..	3.3	1.5	2.25	12 ,, ,,
3″	down ..	3.0	2.5	2.8	12 ,, ,,
3″	side ..	4.1	2.8	3.4	12 ,, ,,
4″	down ..	4.1	3.5	3.7	12 ,, ,,
4″	up ..	4.0	2.0	2.9	12 ,, ,,

* Above ground.

The following Table (No. 3) shows the total maximum, minimum, and average length of the seedlings at the varying depths and original hilum positions, after nine and twelve days:—

TABLE No. 3.

Depth.	Age in days.	Original position of hilum.	Maximum cm.	Minimum cm.	Average cm.	Remarks.
1"	9	down ..	9.2	6.2	7.7	
1"	9	up ..	8.0	3.4	5.7	
1"	9	side ..	7.5	5.6	6.8	
2"	12	down ..	*17.5	5.0	12.8	* above ground
2"	12	up ..	9.5	8.0	8.9	
3"	12	down ..	11.5	9.0	10.3	
3"	12	side ..	13.0	6.5	11.4	
4"	12	down ..	16.0	13.5	14.6	
4"	12	up ..	15.5	6.0	9.9	

It will be seen from Table No. 1 that the depth of planting and position of the hilum do not affect germination. After germination, however, growth of the seedling appears to be influenced by the original position of the hilum at planting. At all depths the average length of the hypocotyl was less when the hilum was planted upwards (Table No. 2). Again, as will be seen from Table No. 3, the average total length of the seedling was also less when the hilum was planted upwards.

Nine days after planting, a number of seedlings was removed from the 1-inch depth, and representatives are shown in the following illustrations (Figures Nos. 2, 3, 4).

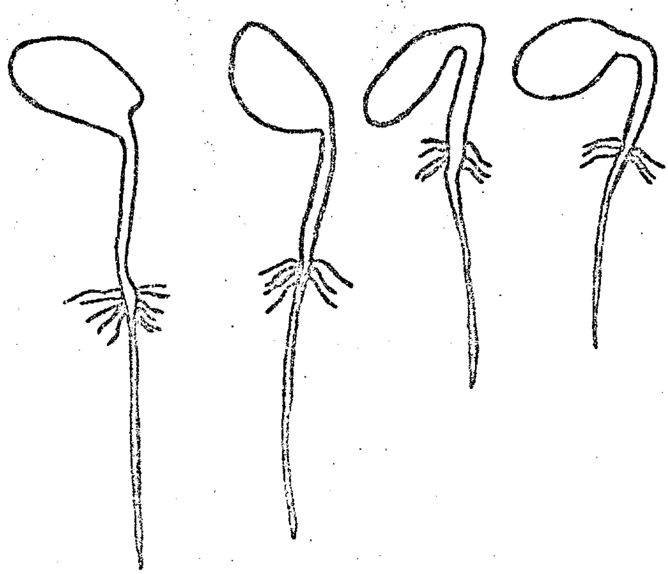


Fig. No. 2.—Hilum planted downwards, 1 inch deep. Age, 9 days.

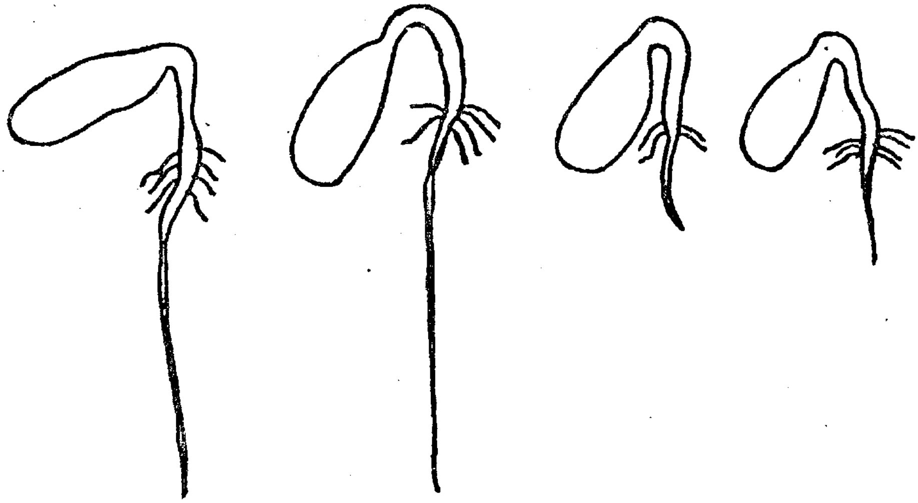


Fig. No. 3.—Hilum planted upwards, 1 inch deep. Age, 9 days.

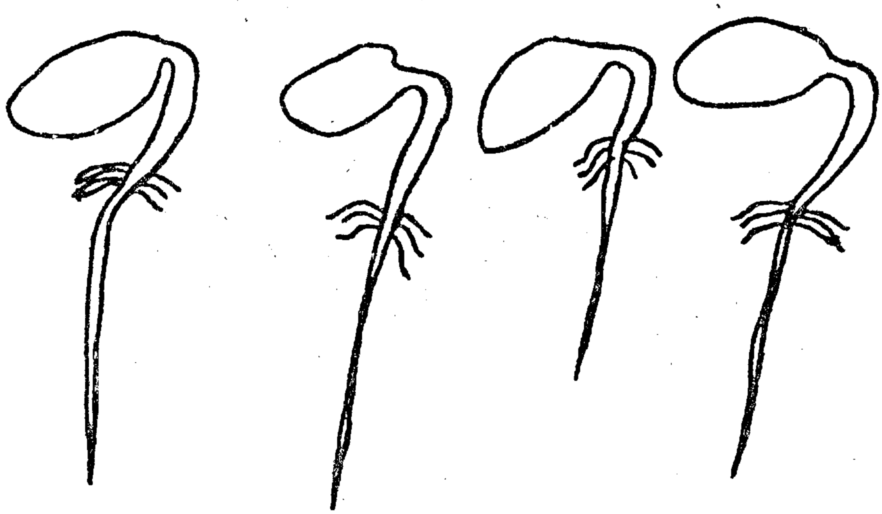


Fig. No. 4.—Hilum planted sideways, 1 inch deep. Age, 9 days.

It will be seen from Figures Nos. 2, 3 and 4 that there is little evidence of distortion appearing at nine days, although where the hilum was planted upwards (Figure No. 3) a tendency towards future distortion may have occurred as the hypocotyl did not appear to have the same freedom.

Twelve days after planting, a further number of seedlings was removed from depths of 2 inches, 3 inches and 4 inches, representatives of which are shown in the following illustrations.

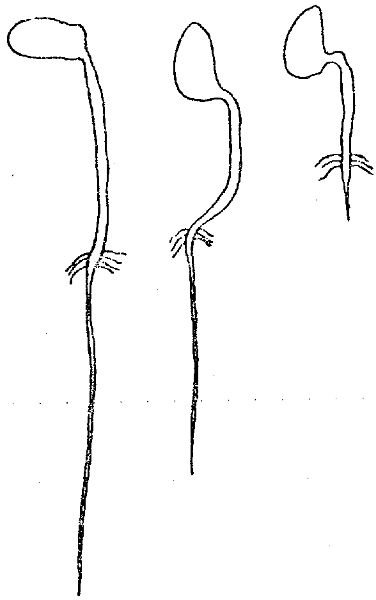


Fig. No. 5.—Hilum planted downwards, 2 inches deep. Age, 12 days.

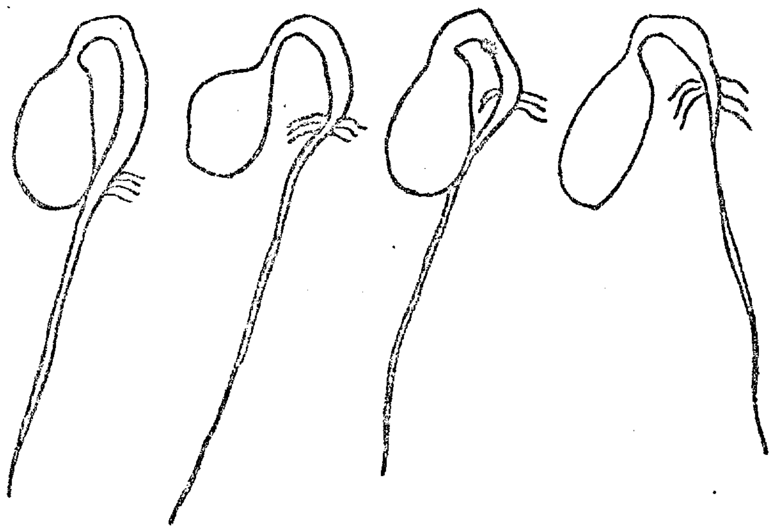


Fig. No. 6.—Hilum planted upwards, 2 inches deep. Age, 12 days.

A comparison between Figures Nos. 5 and 6 shows that where the hilum was planted upwards the position of the bean remained the same and was still below ground level, whilst where the hilum was planted downwards one seedling was above ground, and others just breaking through.

In the following illustrations (Figures Nos. 7 and 8), seedlings taken from a depth of 3 inches are shown. Although none had broken the surface no distortion is evident, and the hypocotyl shows a tendency to straighten. Certain seedlings, as shown by the two centre illustrations in Figure No. 7 (hilum planted downwards) would have broken the surface if the planting depth had been shallower. From Figure No. 8 (hilum planted sideways) it will be seen that the bean position remained the same, and probably indicates that the soil pressure above was too great to permit of movement.

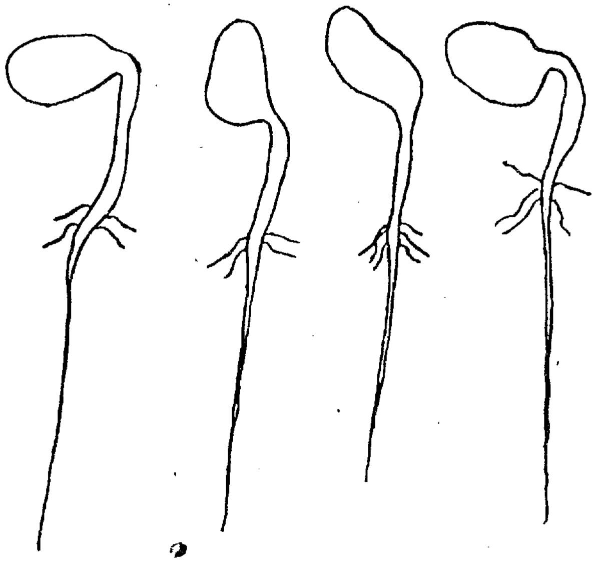


Fig. No. 7.—Hilum planted downwards, 3 inches deep. Age, 12 days.

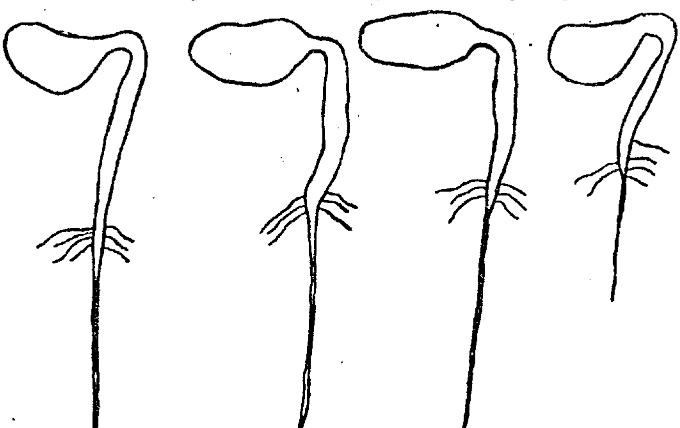


Fig. No. 8.—Hilum planted sideways, 3 inches deep. Age, 12 days.

A comparison between the following illustrations (Figures Nos. 9 and 10) of seedlings taken from the 4-inch depth, shows no indication of distortion, but the seed has moved to an angle of nearly 45 degrees where the hilum was planted downwards, whereas it has remained practically in the same position where the hilum was planted upwards. It will be noticed from Tables Nos. 2 and 3, that although the maximum lengths are practically the same the average lengths show a big difference.

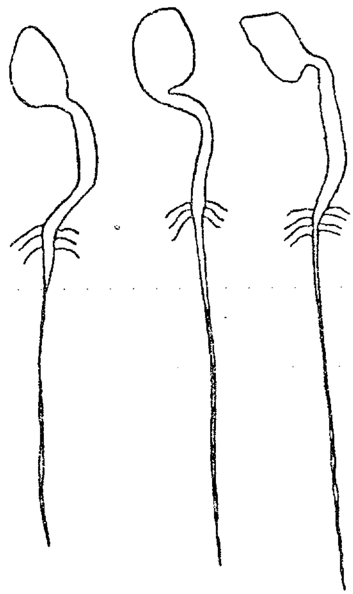


Fig. No. 9.—Hilum planted downwards, 4 inches deep. Age, 12 days.

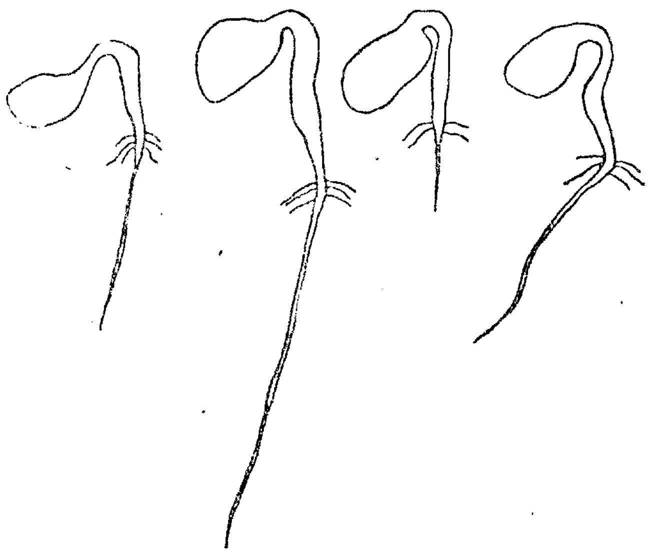


Fig. No. 10.—Hilum planted upwards, 4 inches deep. Age, 12 days.

After allowing a period of 30 days to elapse, seedlings were removed from all depths and examined. The following illustrations (Figures Nos. 11, 12 and 13), are representative of seedlings, planted 1 inch deep. The rooting system is not shown.

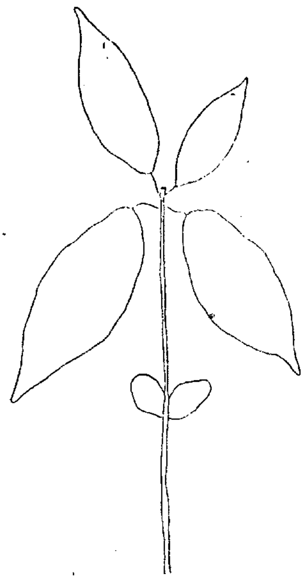


Fig. No. 11.—Above ground, hilum planted downwards, 1 inch deep. Age, 30 days.

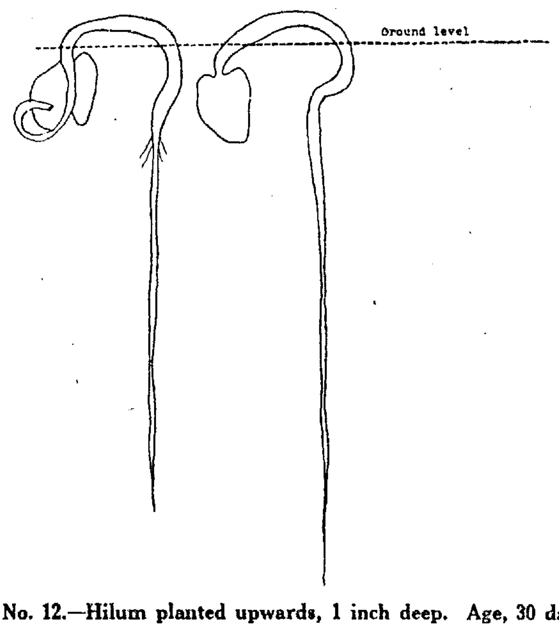


Fig. No. 12.—Hilum planted upwards, 1 inch deep. Age, 30 days.

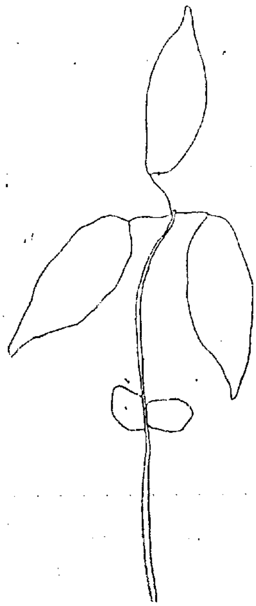


Fig. No. 13.—Above ground, hilum planted sideways, 1 inch deep. Age, 30 days.

In comparing the foregoing illustrations, it will be seen that when the hilum was planted downwards or sideways no distortion occurred, and a normal, well-grown plant was developed. As Figure No. 12 shows, the seedlings were still below ground level, distortion had taken place, and the hypocotyl had hardened when the hilum was planted upwards.

The following illustrations (Figures Nos. 14, 15 and 16) are representative of seedlings taken from the 2-inch depth. Again, normal well-grown plants were

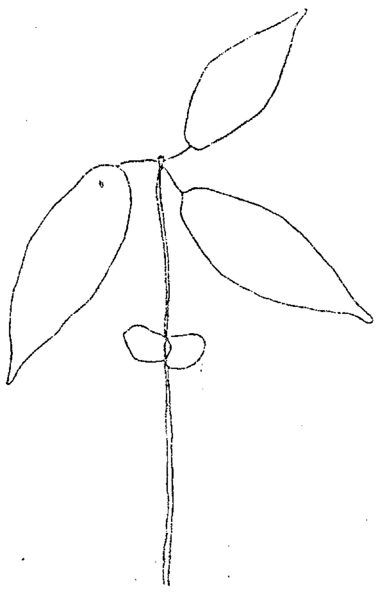


Fig. No. 14.—Hilum planted downward, 2 inches deep. Age, 30 days. (Above ground portion of plant.)

developed when the hilum was planted downwards or sideways. When the hilum was planted upwards, distortion and twisting occurred in all instances, only one seedling appeared above ground level, and it was distorted as shown in Figure No. 15.

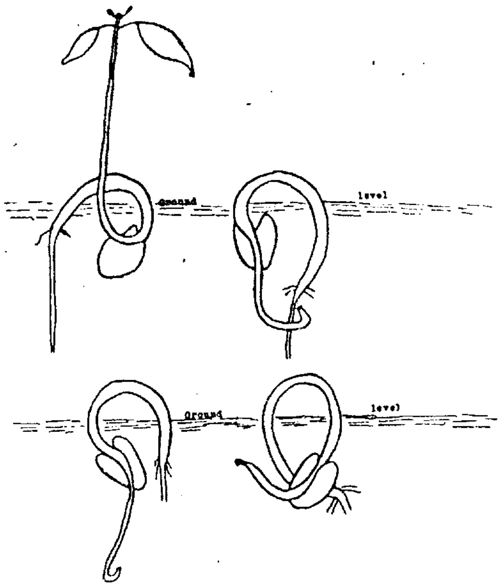


Fig. No. 15.—Hilum planted upwards, 2 inches deep. Age, 30 days.

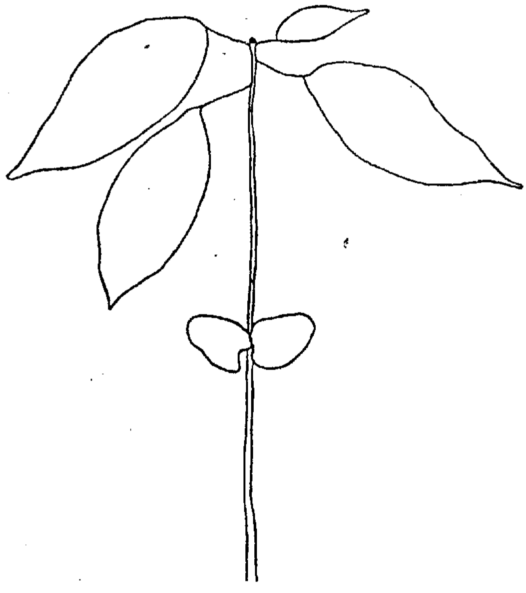
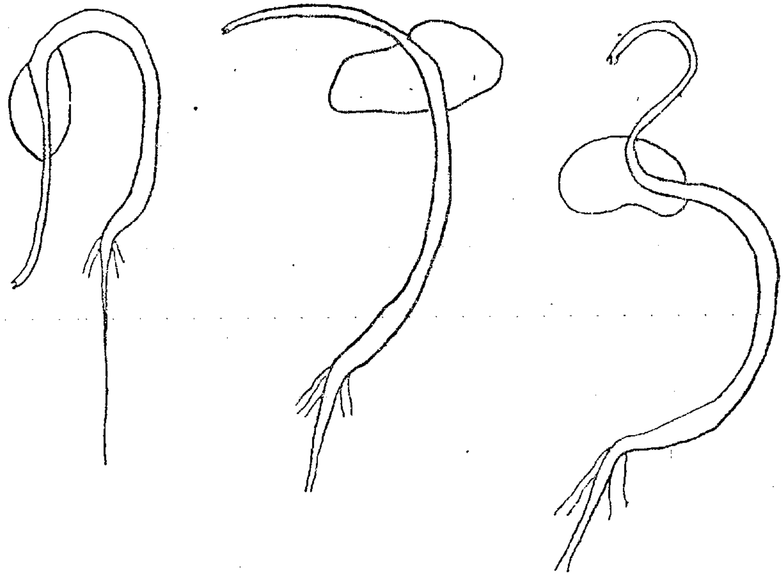


**Fig. No. 16.—Hilum planted sideways, 2 inches deep. Age, 30 days.
(Above ground portion of plant.)**

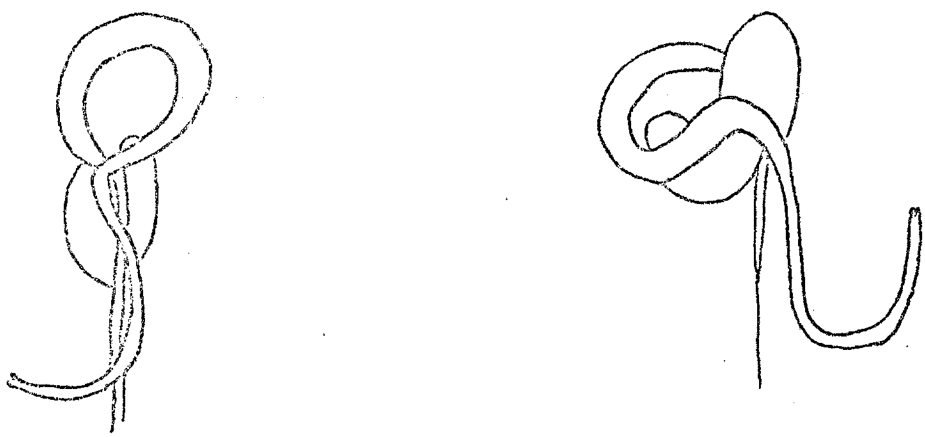
In Figure No. 17, shown below, it will be seen that at the 3-inch depth twisting was evident in all three hilum positions, also no seedlings had appeared above ground level. The hypocotyl was still pliable and fairly soft where the hilum had been planted downwards, or sideways, indicating that had the seedlings been at a shallower depth they would have broken the surface in a normal manner.



Hilum upward. *Hilum downward.* *Hilum sideways.*

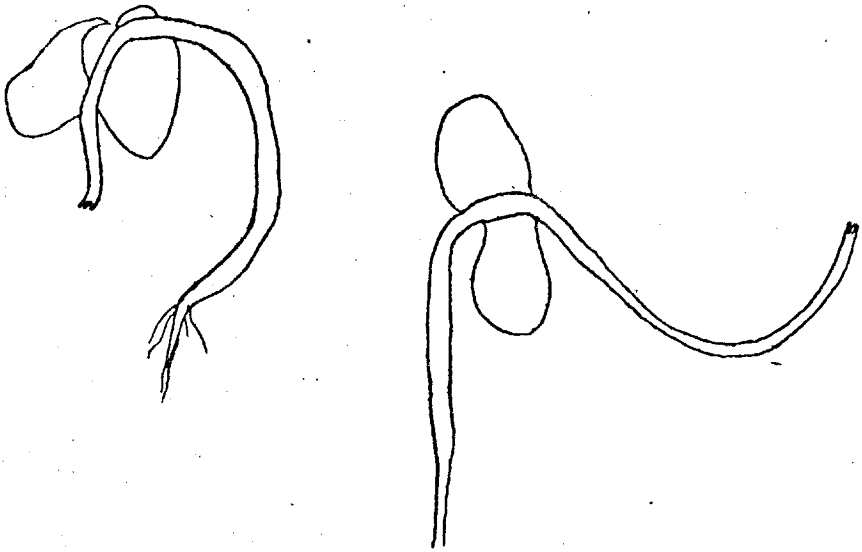
Fig. No. 17.—Planted 3 inches deep. Age, 30 days.

In the following illustrations (Figures 18, 19 and 20), seedlings are shown from the 4-inch depth, and it will be seen that the twisting and distortion which occurred were much greater where the hilum was planted upwards.



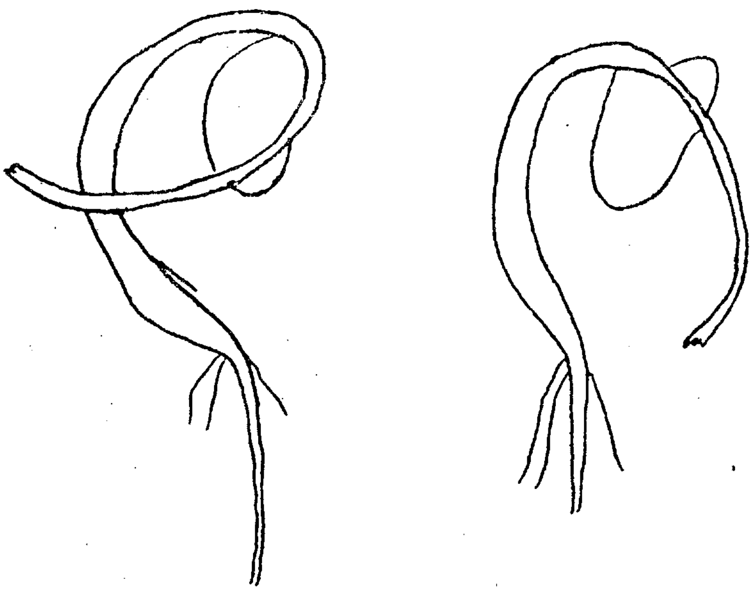
Hilum upward. *Hilum upward.*

Fig. No. 18.—Planted 4 inches deep. Age, 30 days.



Hilum downward. *Hilum downward.*

Fig. No. 19.—Planted 4 inches deep. Age, 30 days.



Hilum sideways. *Hilum sideways.*

Fig. No. 20.—Planted 4 inches deep. Age, 30 days.

The following table (No. 4) shows the maximum, minimum, and average length of the taproot after 30 days, at the 1-inch and 2-inch planting depth:—

TABLE No. 4.

Depth.	Original position of hilum.	Maximum cm.	Minimum cm.	Average cm.
1"	down	16.5	13.8	15.4
1"	side	16.0	11.0	13.0
1"	up	17.0	13.0	15.0
2"	down	13.5	12.0	12.7
2"	side	15.2	12.5	14.0
2"	up	14.5	13.0	14.0

From the above table it will be seen that the root growth was very good, and that there is not a great deal of difference to indicate that the position of the hilum influences the growth of the tap root.

Summary.

Germination commenced on the fifth day, and all beans had germinated by the eighth day. The position of the hilum at the time of planting, and the depth of planting up to four inches do not affect germination of the bean.

The growth of the hypocotyl is affected by the position of the hilum at the time of planting. When the seed was planted 1 and 2 inches deep, with the hilum placed downwards or sideways no distortion occurred, but when placed upwards the hypocotyl was twisted.

At the 3 and 4-inch depths, twisting occurred irrespective of the original position of the hilum, but it was more pronounced when the hilum was planted upwards. The occurrence of twisting or distortion in each instance at these depths, and the fact that none of the seedlings broke through the surface of the ground after 30 days, indicates that 3 or 4 inches is too deep to plant.

The original position of the hilum does not appear to affect the growth of the tap root when the seed is planted 1 or 2 inches deep.

Beans planted 1 or 2 inches deep with the hilum placed downwards or sideways in the soil, produce strong, sturdy, well-formed seedlings, whereas, with the hilum placed upwards, seedlings as they appear above ground are twisted and distorted.

Failure to break the surface when the seed has been planted at shallow depths such as 1 or 2 inches, may be attributed in many instances to the hilum being planted upwards.

Conclusions.

Cacao beans will commence to germinate five days after planting.

Germination of the bean is not affected by the position of the hilum or the depth of planting up to 4 inches.

If seedlings are not above ground after 30 days, then it is probably due to incorrect position of the hilum or depth of planting.

Cacao beans should not be planted with the hilum upwards.

To produce strong, sturdy, well-formed seedlings, the beans should be planted 1 or 2 inches below the surface with the hilum placed downwards or sideways in the soil.

The type of media used gave quite good germination and growth results.

By Authority: L. F. JOHNSTON, Commonwealth Government Printer, Canberra.